AFGHANISTAN NATIONAL POLICE

1 Story Standard Building Design
Uniform Police Headquarters

TECHNICAL SPECIFICATIONS

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US Army
Corps of Engineers
Afghan Engineering District - North

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SECTION 02 41 00

DEMOLITION
10/06

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 T 180	(2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

ASSE/SAFE A10.6	(2006) Safety Requirements for Demolition Operations

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2003) Safety -- Safety and Health Requirements

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

40 CFR 61	National Emission Standards for Hazardous Air Pollutants

1.2 GENERAL REQUIREMENTS

Do not begin demolition until authorization is received from the Contracting Officer. The work of this section is to be performed in a manner that maximizes salvage and recycling of materials. Remove rubbish and debris from the project site; do not allow accumulations inside or outside any buildings. The work includes demolition, salvage of identified items and materials, and removal of resulting rubbish and debris. Remove rubbish and debris from Government property daily, unless otherwise directed. Store materials that cannot be removed daily in areas specified by the Contracting Officer. In the interest of occupational safety and health, perform the work in accordance with EM 385-1-1, Section 23, Demolition, and other applicable Sections.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that

will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Existing Conditions; FIO

SD-07 Certificates

Demolition Plan; FIO

Proposed salvage, demolition, and removal procedures for approval before work is started.

1.4 REGULATORY AND SAFETY REQUIREMENTS

Comply with any local hauling and disposal regulations.

1.4.1 Notifications

1.4.1.1 General Requirements

Furnish timely notification of demolition projects to government authorities in accordance with 40 CFR 61, Subpart M. Notify the government environmental protection organization, local air pollution control district/organization and the Contracting Officer in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61, Subpart M.

If unexpected asbestos/hazardous waste is encountered at the site, the Contracting Officer will investigate the conditions, determine the extent of the affected area, and authorize the Contractor, in writing, to remove and dispose of the asbestos/waste as directed and specified.

1.5 DUST AND DEBRIS CONTROL

Prevent the spread of dust and debris and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.

1.6 PROTECTION

1.6.1 Traffic Control Signs

Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades. Notify the Contracting Officer prior to beginning such work.

1.6.2 Existing Conditions Documentation

Before beginning any demolition work, survey the site and examine the drawings and specifications to determine the extent of the work. Record existing conditions showing the condition of structures and other facilities adjacent to areas of alteration or removal. Include in the record the elevation of the top of foundation walls, finish floor elevations, possible conflicting electrical conduits, plumbing lines, the location and extent of

existing cracks and other damage and description of surface conditions that exist prior to before starting work.

1.6.3 Items to Remain in Place

Take necessary precautions to avoid damage to existing items to be the property of the Government. Repair or replace damaged items if/as required by the Contracting Officer. Coordinate the work of this section with all other work indicated. Construct and maintain shoring, bracing, and supports if/as required.

1.6.4 Existing Construction Limits and Protection

Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove snow, dust, dirt, and debris from work areas daily.

1.6.5 Trees

Protect trees within the project site which might be damaged during demolition or deconstruction.

1.6.6 Utility Service

Maintain existing utilities indicated to stay in service and protect against damage during demolition and deconstruction operations.

1.6.7 Facilities

If/as required or directed, protect electrical and mechanical services and utilities.

1.6.8 Protection of Personnel

Before, during and after the demolition work the Contractor shall continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the project site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

1.7 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

1.8 RELOCATIONS

Perform the removal and reinstallation of relocated items as indicated. Items to be relocated which are damaged by the Contractor shall be repaired or replaced with new undamaged items as approved by the Contracting Officer.

1.9 REQUIRED DATA

Prepare a Demolition Plan. Include in the plan procedures for careful removal and disposition of materials specified to be salvaged and coordination with other work in progress. Provide procedures for safe conduct of the work in accordance with EM 385-1-1. Plan shall be submitted to Contracting Officer prior to work beginning.

1.10 ENVIRONMENTAL PROTECTION

Comply with the Section 01355 requirements specified.

1.11 USE OF EXPLOSIVES

Use of explosives will not be permitted.

1.12 AVAILABILITY OF WORK AREAS

Areas in which the work is to be accomplished will be available at the notice-to-proceed.

PART 2 PRODUCTS

2.1 FILL MATERIAL

Comply with excavating, backfilling, and compacting procedures for soils used as backfill material to fill basements, voids, depressions or excavations resulting from demolition or deconstruction of structures.

Fill material must conform to the definition of satisfactory soil material as defined in Section 31 00 00 EARTHWORK. In addition, fill material must be free from roots and other organic matter, trash, debris, frozen materials, and stones larger than 75 millimeter in any dimension. Fill shall also meet the compaction requirements of 31 00 00 EARTHWORK when tested in accordance with AASHTO T 180.

PART 3 EXECUTION

3.1 EXISTING FACILITIES TO BE REMOVED

Inspect and evaluate existing structures on site for reuse. Existing construction scheduled to be removed for reuse shall be disassembled.

3.1.1 Structures

a. Remove existing structures indicated to be removed to 1.2 meters below grade. Break up basement slabs to permit drainage.

b. Demolish structures in a systematic manner from the top of the structure to the ground. Complete demolition work above each tier or floor before the supporting members on the lower level are disturbed. Demolish concrete and masonry walls in small sections.

c. Locate demolition and deconstruction equipment throughout the structure and remove materials so as to not impose excessive loads to supporting walls, floors, or framing.

d. Building, or the remaining portions thereof, not exceeding 25 m in height may be demolished by a mechanical method of demolition.

3.1.2 Utilities and Related Equipment

3.1.2.1 General Requirements

Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the Contracting Officer. Do not interrupt existing utilities serving facilities occupied and used by the Government except when approved in writing and then only after temporary utility services have been approved and provided.

3.1.2.2 Disconnecting Existing Utilities

Remove existing utilities as directed and terminate in a manner approved by the Contracting Officer.

3.1.3 Chain Link Fencing

Remove chain link fencing, gates and other related salvaged items scheduled for removal and transport to designated areas. Remove gates as whole units.

3.1.4 Paving and Slabs

As directed, remove concrete and asphaltic concrete paving and slabs as indicated or as directed to a depth below existing adjacent or new finish grade. Provide neat sawcuts at limits of pavement removal. Pavement and slabs not to be used in this project shall be removed from the Installation at Contractor's expense.

3.2 CONCURRENT EARTH-MOVING OPERATIONS

Do not begin excavation, filling, and other earth-moving operations that are sequential to demolition work in areas occupied by structures to be demolished until all demolition in the area has been completed and debris removed. Fill holes, open basements and other hazardous openings.

3.3 DISPOSITION OF MATERIAL

3.3.1 Title to Materials

Except for salvaged items specified in related Sections, all materials and equipment removed and not reused or salvaged, shall become the property of the Contractor and shall be removed from Government property. Title to materials resulting from demolition, and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer of the Contractor's demolition, and removal procedures, and authorization by the Contracting Officer to begin demolition and deconstruction. The Government will not be responsible for the condition or loss of, or damage to, such property after contract award. Showing for sale or selling materials and equipment on site is prohibited.

3.4 CLEANUP

Remove debris and rubbish from excavations. Remove and transport the in a manner that prevents spillage on streets or adjacent areas. Apply local regulations regarding hauling and disposal.

3.5 DISPOSAL OF REMOVED MATERIALS

3.5.1 Regulation of Removed Materials

Dispose of debris, rubbish, scrap, and other non-salvageable materials resulting from removal operations with all applicable government regulations. Storage of removed materials on the project site is prohibited.

3.5.2 Removal from Government Property

Transport waste materials removed from demolished structures, from Government property for legal disposal.

-- End of Section --

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 REFERENCES

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

ACI INTERNATIONAL (ACI)

ACI 117	(2006) Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 211.1	(1991; R 2002) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 301	(2005) Specifications for Structural Concrete
ACI 318	(2008) Building Code Requirements for Structural Concrete and Commentary
ACI/MCP 2	(2007) Manual of Concrete Practice Part 2 - ACI 224R-01 to ACI 313R-97
ACI/MCP 3	(2007) Manual of Concrete Practice Part 3 – ACI 315-99 to ACI 343R-95
ACI/MCP 4	(2007) Manual of Concrete Practice Part 4 – ACI 345R-05 to 355.2R-04

ASTM INTERNATIONAL (ASTM)

ASTM A 615/A 615M	(2008a) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C 117	(2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 127	(2004) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C 128	(2004a) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C 138/C 138M	(2001a) Standard Test Method for Density ("Unit Weight"), Yield, and Air Content (Gravimetric) of Concrete
ASTM C 143/C 143M	(2005a) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 150	(2005) Standard Specification for Portland Cement
ASTM C 156	(2003) Standard Test Method for Water Retention by Concrete Curing Materials
ASTM C 171	(2003) Standard Specification for Sheet Materials for Curing Concrete
ASTM C 172	(2004) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 192/C 192M	(2006) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(2004) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 233	(2004) Standard Test Method for Air-Entraining Admixtures for Concrete
ASTM C 260	(2006) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 29/C 29M	(1997; R 2003) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C 309	(2006) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2006) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(2003) Standard Specification for Concrete Aggregates
ASTM C 39/C 39M	(2005e1) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42/C 42M	(2004) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 494/C 494M	(2005a) Standard Specification for Chemical Admixtures for Concrete

ASTM C 566	(1997; R 2004) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C 618	(2005) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 70	(2006) Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C 881/C 881M	(2002) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 932	(2005) Standard Specification for Surface-Applied Bonding Compounds for Exterior Plastering
ASTM C 94/C 94M	(2006) Standard Specification for Ready-Mixed Concrete
ASTM D 1190	(1997) Standard Specification for Concrete Joint Sealer, Hot-Applied Elastic Type
ASTM D 1557	(2002e1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 1751	(2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM E 329	(2005b) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI MSP-2	(1998) Manual of Standard Practice

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST PS 1	(1996) Construction and Industrial Plywood

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS SS-S-200	(Rev E; Am 2) Sealant, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When

used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-03 Product Data

Manufacturer's catalog data for the following items shall include printed instructions for admixtures, bonding agents, epoxy-resin adhesive binders, waterstops, and liquid chemical floor hardeners.

Concrete Aggregates;
Portland Cement;
Ready-Mix Concrete;
Form Facing Materials;
Reinforcement Materials;
Joint Materials;
Concrete Curing Materials;

SD-05 Design Data

Mix design data for each class of Ready-Mix Concrete shall be submitted at least 15 calendar days prior to start of specified work; G

SD-07 Certificates

Mill certificates shall be submitted for Steel Bar according to the paragraph entitled, "Fabrication," of this section.

Certificates for concrete shall be in accordance with the paragraph entitled, "Classification and Quality of Concrete," of this section. Certificates shall contain project name and number, date, name of Contractor, name of concrete testing service, source of concrete aggregates, material manufacturer, brand name of manufactured materials, material name, values as specified for each material, and test results.

Concrete Design Mixes; G
Concrete Aggregates; G

SD-08 Manufacturer's Instructions

Installation instructions shall indicate the manufacturer's recommended method and sequence of installation for the following items:

Admixtures

1.3 QUALIFICATIONS FOR CONCRETE TESTING SERVICE

Concrete testing shall be performed by an approved laboratory and inspection service experienced in sampling and testing concrete. Testing agency shall meet the requirements of ASTM E 329.

1.4 CONCRETE SAMPLING AND TESTING

Testing by the Contractor shall include sampling and testing concrete materials proposed for use in the work and testing the design mix for each class of concrete. Quality control testing during construction shall be performed by the Contractor.

Concrete aggregate materials proposed for use in the work shall be sampled and tested in accordance with ASTM C 33.

Portland cement shall be sampled and tested in accordance with ASTM C 150.

Air-entraining admixtures shall be sampled and tested in accordance with ASTM C 233.

1.5 CONCRETE DESIGN MIXES

Mix proportions for each concrete class shall be determined and tested as follows:

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Specific gravity absorption of fine aggregate	ASTM C 128	As required for the concrete aggregate for each trial mix
Specific gravity and absorption of coarse aggregate	ASTM C 127	
Gradation of fine and coarse aggregates	ASTM C 117 and ASTM C 136	
Moisture content of both fine and coarse aggregates	ASTM C 70 and ASTM C 566	
Dry-rodded unit weight of coarse aggregate	ASTM C 29/C 29M	
Trial mixes using at least three different water/cement ratios, minimum allowable cement content, maximum allowable slump; both with and without air entrainment	ACI 211.1	As required to determine the concrete mix having the properties specified for each concrete class
Making and curing concrete specimens in the laboratory	ASTM C 192/C 192M	Two sets of three specimens for each design mix
Sampling fresh	ASTM C 192/C 192M	One for each set of

concrete in the laboratory		design mix specimens
Slump	ASTM C 143/C 143M	
Air content	ASTM C 231	
Yield	ASTM C 138/C 138M	
Compressive strength	ASTM C 39/C 39M	Three specimens tested at 7 days, and three specimens tested at 28 days for each mix design

Proportions of concrete mixtures shall be determined in accordance with ACI/MCP 205 and Method 1 of ACI 301, Section 3.8.2.1. Separate curves shall be prepared for air-entrained and nonair-entrained concretes.

1.6 DELIVERY AND STORAGE OF MATERIALS

Packaged materials shall be delivered to the project site in their original, unopened package or container bearing label clearly identifying manufacturer's name, brand name, material, weight or volume, and other pertinent information. Packaged materials shall be stored in their original, unbroken package or container in a weathertight and dry place until ready for use in the work.

Unpackaged aggregates shall be stored to avoid excessive segregation, contamination with other materials or other size aggregates, or freezing.

Reinforcement and other metal items shall be protected from corrosion and shall be kept free from ice, grease, and other coatings that would destroy or reduce bond.

PART 2 PRODUCTS

2.1 CONCRETE MATERIALS

2.1.1 Concrete Aggregates

Fine and coarse aggregates shall conform to ASTM C 33.

2.1.2 Portland Cement

Cement shall conform to ASTM C 150, Type I, IA, II, or IIA. One brand and type of cement shall be used for formed concrete having exposed-to-view finished surfaces.

2.1.3 Admixtures

2.1.3.1 Air-Entraining Admixtures

Air-entraining admixtures shall conform to ASTM C 260.

2.1.3.2 Water-Reducing Admixtures

Water-reducing admixtures, retarding admixtures, accelerating admixtures, water-reducing and accelerating admixtures, and water-reducing and retarding admixtures shall conform to ASTM C 494/C 494M.

2.1.3.3 Pozzolan

Fly ash or other pozzolans used as admixtures shall conform to ASTM C 618, Class C or Class F with 4 percent maximum loss on ignition and 20 percent maximum cement replacement by weight.

2.1.4 Water

Water shall be potable.

2.2 READY-MIX CONCRETE

Concrete shall meet the requirements of ASTM C 94/C 94M.

The selected mixture must produce an average compressive strength exceeding the specified strength by the amount indicated in ACI 318. When a concrete production facility has a record of at least 15 consecutive tests, the standard deviation must be calculated and the required average compressive strength must be determined in accordance with ACI 318. When a concrete production facility does not have a suitable record of tests to establish a standard deviation, the required average strength must follow ACI 318 requirements.

Ready-mixed concrete manufacturer shall provide duplicate delivery tickets with each load of concrete delivered. Delivery tickets shall provide the following information in addition to that required by ASTM C 94/C 94M:

Type and brand cement

Cement content in 43 kilogram bags per cubic meter of concrete

Maximum size of aggregate

Amount and brand name of admixtures

Total water content expressed by water/cement ratio

2.3 FORM FACING MATERIALS

2.3.1 Concrete Form Plywood (Standard Rough)

Plywood shall conform to NIST PS 1, B-B, concrete form, not less than 16 millimeter thick.

2.3.2 Overlaid Concrete Form Plywood (Standard Smooth)

Plywood shall conform to NIST PS 1, B-B, high density form overlay, not less than 16 millimeter thick.

2.4 REINFORCEMENT MATERIALS

2.4.1 Reinforcing Bars

Reinforcing bars shall conform to ASTM A 615/A 615M and Supplemental S1, Grade 60, ACI/MCP 405, ACI/MCP 305 and ACI 318/318R, Section 3.5.3.2.; 4218.0 kg./sq. cm yield strength.

2.4.2 Dowels for Load Transfer in Floors

Dowels for load transfer in floors shall be of the type, design, weight, and dimensions indicated. Dowel bars shall be plain-billet steel conforming to ASTM A 615/A 615M, Grade 40. Dowel pipe shall be steel conforming to ASTM A 53/A 53M.

2.4.3 Supports for Reinforcement

Supports shall include concrete brick, bolsters, chairs, spacers, and other devices such as concrete brick necessary for proper spacing, supporting, and fastening reinforcing bars and wire fabric in place.

Supports shall be wire bar type conforming to ACI/MCP 405, ACI/MCP 305ACI 318/318R and CRSI MSP-2.

Legs of supports in contact with formwork shall be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports. When using epoxy-coated reinforcement bars, coat supports with same material.

2.4.4 Anchor Bolts

Anchor bolts shall conform to ASTM A307 using A36 steel.

2.5 JOINT MATERIALS

2.5.1 Preformed Joint Filler Strips

Filler strips shall be nonextruding and resilient nonbituminous type conforming to ASTM D 1752, Type I or II.

2.5.2 Joint Sealant Compound

Compound shall be cold-applied, two-component, elastomeric polymer type conforming to FS SS-S-200.

2.5.3 Bond Break Material

Bond Break shall be polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick.

2.6 CONCRETE CURING MATERIALS

2.6.1 Absorptive Cover

Cover for curing concrete shall be burlap cloth made from jute or kenaf, weighing 300 gram plus or minus 3 percent per square meter when clean and dry, conforming to ASTM C 171, Class 3; or cover may be cotton mats as approved.

2.6.2 Moisture-Retaining Cover

Cover for curing concrete shall be waterproof paper conforming to ASTM C 171, regular or white, or polyethylene sheeting conforming to ASTM C 171, or polyethylene-coated burlap consisting of a laminate of burlap and a white opaque polyethylene film permanently bonded to the burlap; burlap shall conform to ASTM C 171, Class 3, and polyethylene film shall conform to ASTM C 171. When tested for water retention in accordance with ASTM C 156, weight of water lost 72 hours after application of moisture retaining covering material shall not exceed 0.039 gram per square centimeter of the mortar specimen surface.

2.6.3 Water

Water shall be potable.

2.6.4 Membrane-Forming Curing Compound

Compound shall be liquid type conforming to ASTM C 309, Type 1, clear, Type 1D with fugitive dye for interior work and Type 2, white, pigmented for exterior work.

2.7 CLASSIFICATION AND QUALITY OF CONCRETE

2.7.1 Concrete Classes and Usage

Concrete classes, compressive strength, requirements for air entrainment, and usage shall be as follows:

CONCRETE CLASS	MIN. 28-DAY COMPRESSIVE STRENGTH POUNDS PER MEGA pascal	REQUIREMENT FOR AIR ENTRAINMENT	USAGE
4A	28	Air-entrained	For structural concrete work exposed to freezing and thawing, unless otherwise indicated or specified, such as exterior columns and spandrels
4N	28	Nonair-entrained	For structural concrete work not exposed to freezing and thawing such as interior columns, beams, and supported slabs

2.7.2 Limits for Concrete Proportions

Limits for maximum water/cement ratio and minimum cement content for each concrete class shall be as follows:

CONCRETE CLASS	MAX. WATER/CEMENT RATIO BY WEIGHT	MIN. CEMENT FOR 75 TO 100 MM SLUMP, (NO. OF 43 KILO-GRAM SACKS) PER .75 CU. METER

4A	0.45	6.00
4N	0.45	6.00

2.7.3 Maximum Size of Aggregate

Size of aggregate, designated by the sieve size on which maximum amount of retained coarse aggregate is 5 to 10 percent by weight, shall be as follows:

MAXIMUM SIZE OF AGGREGATE	ASTM C 33 SIZE NUMBER	TYPE OF CONSTRUCTION
50.8 mm	357	Nonreinforced footings and other flat work having a depth of not less than 6 inches, and nonreinforced walls and other formed sections having a dimension between forms of not less than 10 inches
38.1 mm	467	Monolithic slabs on ground, concrete fill, and other flat-work having a depth of not less than 5 inches and a clear distance between reinforcing bars of not less than 2 inches
19.1 mm	67	Reinforced walls, columns, girders, beams, and other formed sections having a dimen-sion between forms of not less than 6 inches and clear distance between reinforcing bars or reinforcing bar and face of form of not less than 1 inch

Maximum size of aggregate may be that required for most critical type of construction using that concrete class.

2.7.4 Slump

Slump for concrete at time and in location of placement shall be as follows:

TYPE OF CONSTRUCTION	SLUMP
Footings, unreinforced walls	Not less than 25 millimeter nor more than 75 millimeter
Columns, beams, reinforced walls, monolithic slabs	Not less than 25 millimeter nor more than 100 millimeter
Ramps and other sloping surfaces	0 nor more than 75 millimeter

2.7.5 Total Air Content

Air content of exposed concrete and interior concrete shall be in accordance with ASTM C 260 and/or as follows:

LIMITS CONCRETE EXPOSURE	REQUIREMENT FOR AIR ENTRAINMENT	MAXIMUM SIZE OF AGGREGATE	TOTAL AIR CONTENT BY VOLUME
Exposed to freezing and thawing or subjected to hydraulic pressure	Air-entrained	38.1 or 69.9 mm	4 to 6 percent
			5 to 7 percent
		12.7 or 9.5 mm	6 to 8.5 percent

Concrete exposed to freezing and thawing or subjected to hydraulic pressure shall be air-entrained by addition of approved air-entraining admixture to concrete mix.

PART 3 EXECUTION

3.1 FORMWORK

3.1.1 General

Forms shall be constructed to conform, within the tolerances specified, to shapes dimensions, lines, elevations, and positions of cast-in-place concrete members as indicated. Forms shall be supported, braced, and maintained sufficiently rigid to prevent deformation under load.

3.1.2 Design and Construction of Formwork

Form work design and construction shall conform to ACI/MCP 205 and ACI 301, Chapter 4.

Forms shall be tight to prevent leakage of cement paste during concrete placing.

Form facing materials shall be supported by structural members spaced close to prevent deflection of form facing material. Forms placed in successive units for continuous surfaces shall be fitted to accurate alignment to ensure a smooth completed surface within the tolerances specified. Where necessary to maintain the tolerances specified, such as long spans where immediate supports are not possible, formwork shall be cambered for anticipated deflections in formwork due to weight and pressure of fresh concrete and to construction loads.

Exposed joints, edges, and external corners shall be chamfered a minimum of 19 millimeter by moldings placed in corners of column, beam, and wall forms.

Shores and struts shall be provided with a positive means of adjustment capable of taking up formwork settlement during concrete placing operations. Adjustment shall be obtained with wedges or jacks or a combination thereof. When adequate foundations for shores and struts cannot be secured, trussed supports shall be provided.

Temporary openings shall be provided in wall forms, column forms, and at other points where necessary to permit inspection and to facilitate cleaning.

Forms shall be readily removable without impact, shock, or damage to concrete.

3.1.3 Forms for Standard Rough Form Finish

Rough form finish shall be given concrete formed surfaces that are to be concealed by other construction, unless otherwise specified.

Form facing material for standard rough form finish shall be the specified concrete form plywood or other approved form facing material that will produce concrete surfaces equivalent in smoothness and appearance to that produced by new concrete form plywood panels.

For concrete surfaces exposed only to the ground, undressed, square-edge, 25 millimeter nominal thickness lumber may be used. Horizontal joints shall be level and vertical joints shall be plumb.

3.1.4 Forms for Standard Smooth Form Finish

Smooth form finish shall be given concrete formed surfaces that are to be exposed to view or that are to be covered with coating material applied directly to concrete or with covering material bonded to concrete, such as waterproofing, dampproofing, painting, or other similar coating system.

Form facing material for standard smooth finish shall be the specified overlaid concrete form plywood or other approved form facing material that is nonreactive with concrete and that will produce concrete surfaces equivalent in smoothness and appearance to that produced by new overlaid concrete form plywood panels.

Maximum deflection of form facing material between supports and maximum deflection of form supports such as studs and wales shall not exceed 0.0025 times the span.

Arrangement of form facing sheets shall be orderly and symmetrical, and sheets shall be in sizes as large as practical.

Panels shall be arranged to make a symmetrical pattern of joints. Horizontal and vertical joints shall be solidly backed and butted tight to prevent leakage and fins.

3.1.5 Form Ties

Ties shall be factory fabricated metal, adjustable in length, removable or snap-off type that will not allow form deflection or will not spall concrete upon removal. Portion of form ties remaining within concrete after removal of exterior parts shall be at least 38 millimeter back from concrete surface. Form ties shall be free of devices that will leave a hole larger than 22 millimeter or less than 13 millimeter in diameter in concrete surface. Form ties fabricated at the project site or wire ties of any type are not acceptable.

3.1.6 Tolerances for Form Construction

Formwork shall be constructed to ensure that after removal of forms and prior to patching and finishing of formed surfaces, concrete surfaces shall be in accordance with tolerances specified in ACI 117 and ACI/MCP 205.

3.1.7 Preparation of Form Surfaces

Contact surfaces of forms shall be coated with form-coating compound before reinforcement is placed. Form-coating compound shall be a commercial formulation that will not bond with, stain, nor adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces that entails bonding or adhesion nor impede wetting of surfaces to be cured with water or curing compounds. Excess form-coating compound shall not be allowed to stand in puddles in the forms nor to come in contact with concrete against which fresh concrete will be placed. Thinning of form-coating compound shall be made with thinning agent of the type, in the amount, and under the conditions recommended by form-coating compound manufacturer's printed or written directions.

3.1.8 Removal of Forms

Formwork that does not support weight of concrete, such as sides of beams, walls, columns, and similar vertical parts of the work, may be removed 24 hours after placing concrete, provided concrete is sufficiently hard not to be damaged from form-removal operations.

Formwork that supports weight of concrete, such as beam soffits, slabs, and similar horizontal parts of the work, shall remain in place at least until concrete has attained design minimum laboratory compressive strength at 28 days for applicable concrete class specified.

Form facing material may be removed before concrete has attained its required 28-day compressive strength but in no case less than 6 days after placing concrete, provided shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports. Shores and other vertical supports shall remain in place until concrete has attained its required 28-day compressive strength.

Results of control tests will be used as evidence that concrete has attained sufficient strength to permit removal of supporting forms. Test specimens shall be removed from molds at the end of 24 hours and stored in the structure as near points of sampling as possible; shall receive same protection from elements during curing as is given those portions of the structure which they represent; and shall not be removed from the structure for transmittal to the laboratory prior to expiration of three-fourths of proposed period before removal of forms. Supporting forms of shoring shall not be removed until strength of control-test specimens has attained a value of at least 10.3 Megapascal for columns and 13.8 Megapascal for other work. Contractor shall ensure that newly unsupported portions of the structure are not subjected to heavy construction or material loading.

Tie-rod clamps to be removed from wall shall be loosened 24 hours after concrete is placed; form ties, except for a sufficient number to hold forms in place, may be removed at that time. Ties wholly withdrawn from wall shall be pulled toward inside face.

When formwork is removed during concrete curing period, exposed concrete shall be cured as specified.

3.1.9 Re-Use of Forms

Surfaces of forms that are to be re-used shall be cleaned and repaired, except that split, frayed, or delaminated form facing material shall not be re-used. Contact surfaces of re-used forms shall be coated as specified.

3.2 REINFORCEMENT FABRICATION AND INSTALLATION

3.2.1 General

Details of reinforcement shall be in accordance with ACI/MCP 405, ACI/MCP 305 and ACI 318/318R, and as specified.

3.2.2 Fabrication

Reinforcing bars shall be shop fabricated to conform to shapes and dimensions indicated for reinforcement, and as follows:

Fabrication tolerances shall be in accordance with ACI/MCP 205, ACI/MCP 305, ACI 318/318R, and ACI 117.

Hooks and bends shall be in accordance with ACI/MCP 405, ACI/MCP 305 and ACI 318/318R.

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

Tolerance on nominally square-cut, reinforcing bar ends shall be in accordance with ACI/MCP 305 and ACI 318/318R.

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

Reinforcement which has any of the following defects shall not be used:

Bar lengths, depths, and bends beyond specified fabrication tolerances

Bends or kinks not indicated on drawings or approved shop drawings

Bars with reduced cross-section due to rusting or other cause

Defective reinforcement shall be replaced with new reinforcement having required shape, form, and cross-section area.

3.2.3 Placing Reinforcement

Reinforcement shall be placed in accordance with ACI/MCP 405, ACI/MCP 305 and ACI 318/318R.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, bars or welded wire fabric shall be supported 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 will be less than 25 millimeter from concrete surfaces that will be exposed to view or will be painted shall be of precast concrete units, plastic-coated steel, or stainless steel protected bar supports. Precast concrete units shall be wedge shaped, not larger than 90 by 90 millimeter, and of thickness equal to that indicated for concrete protection of reinforcement. Precast units shall have cast-in galvanized tie wire hooked for anchorage and shall blend with concrete surfaces after finishing is completed.

Contractor shall cooperate with other trades in setting of anchor bolts, inserts, and other embedded items. Where conflicts occur between locating reinforcing and embedded items, the Contractor shall notify the Contracting Officer so that conflicts may be reconciled before placing concrete. Anchors and embedded items shall be positioned and supported with appropriate accessories.

Reinforcement shall be supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

Supports for reinforcing bars shall be sufficient in number and sufficiently heavy to carry the reinforcement they support, and in accordance with ACI/MCP 405, ACI/MCP 305ACI 318/318R and CRSI MSP-2. Supports shall not be used to support runways for concrete conveying equipment and similar construction loads.

Supports on ground and similar surfaces shall be equipped with sand-plates.

Reinforcements shall be secured to supports by means of tie wire. Wire shall be black, soft iron wire, not less than 1.6 millimeters.

With the exception of temperature reinforcement, which shall be tied to main steel approximately 600 millimeter on center, reinforcement shall be accurately placed, securely tied at intersections with 1.3 millimeter annealed wire, and held in position during placing of concrete by spacers, chairs, or other approved supports. Wire-tie ends shall point away from the form. Unless otherwise indicated, numbers, type, and spacing of supports shall conform to ACI/MCP 305and ACI 318/318R.

Bending of reinforcing bars partially embedded in concrete will be permitted only as specified in ACI/MCP 405, ACI/MCP 305 and ACI 318/318R.

3.2.4 Spacing of Reinforcing Bars

Spacing shall be as indicated. If not indicated, spacing shall be in accordance with the ACI/MCP 405, ACI/MCP 305 and ACI 318/318R.

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 shall be subject to approval.

3.2.5 Splices in Reinforcement

Splices shall be as indicated on the approved drawings.

3.2.6 Concrete Protection for Reinforcement

Concrete protection shall be in accordance with the ACI/MCP 405, ACI/MCP 305and ACI 318/318R. Concrete members at or below grade shall have a minimum concrete cover over 75 millimeter.

3.3 JOINTS

3.3.1 Construction Joints

Joints not indicated shall be made and located so as not to impair strength and appearance of the structure and shall be as approved. Construction joints shall be located as follows:

In walls at not more than 18.3 meter in any horizontal direction; 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

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

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 shall offset a distance to twice the width of the beam. Transfer of shear through construction joint shall be made by use of inclined reinforcement.

In slabs on ground, so as to divide slab into areas not in excess of 111.5 square meter

Keyways at least 40 millimeter deep shall be provided in construction joints in walls and slabs and between walls and footings; approved bulkheads may be used for slabs.

Joints shall be perpendicular to main reinforcement. Reinforcement shall be continued across construction joints.

3.3.2 Isolation Joints in Slabs on Ground

Joints shall be provided at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

Joints shall be filled with premolded joint filler strips 13 millimeter thick, extending full slab depth. Filler strips shall be installed 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 19 millimeter in depth where joint will be sealed with sealing compound and not less than 6 millimeter in depth where joint sealing is not required. Wood strip shall be removed after concrete has set. Contractor shall clean groove of foreign matter and loose particles after surface has dried.

3.3.3 Control Joints in Slabs on Ground

Joints shall be provided to form panels as indicated.

Under and on exact line of each control joint, 50 percent of welded wire fabric reinforcement shall be cut before placing concrete.

Joints shall be 4 millimeter wide by 1/5 to 1/4 of slab depth and shall be formed by inserting hand-pressed fiberboard strip into fresh concrete until top surface of strip is flush with slab surface or by cutting the concrete with a saw after the concrete has set. After concrete has cured for at least 7 days, the Contractor shall remove inserts and clean groove of foreign matter and loose particles.

3.3.4 Sealing Joints in Slabs on Ground

Isolation and control joints which will not be covered with finish flooring material shall be sealed with joint sealing compound after concrete curing period. Groove shall be slightly under filled with joint sealing compound to prevent extrusion of compound. Excess material shall be removed as soon after sealing as possible.

Sealing shall not be required for isolation and control joints which will be covered with finish flooring material. Groove shall be left ready to receive filling material that will be provided as part of finish floor covering work.

3.4 INSTALLATION OF ANCHORAGE DEVICES

3.4.1 General

Anchorage devices and embedded items required for other work that is attached to, or supported by, cast-in-place concrete shall be set and built in as part of the work of this section, using setting drawings, instructions, and directions for work to be attached thereto.

3.4.2 Placing Anchorage Devices

Anchorage devices and embedded items shall be positioned accurately and supported against displacement. Openings in anchorage devices such as slots and threaded holes shall be filled with an approved, removable material to prevent entry of concrete into openings.

3.5 PREPARATIONS FOR CONCRETE PLACING

3.5.1 General

Surfaces against which concrete is to be placed shall be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing.

Standing water shall be removed without washing over freshly deposited concrete. Flow of water shall be diverted through side drains provided for such purpose.

3.5.2 Subgrade Under Foundations and Footings

When subgrade material is semiporous and dry, subgrade surface shall be sprinkled with water as required to eliminate suction at the time concrete is deposited. When subgrade material is porous, subgrade surface shall be sealed by covering surface with specified water barrier subgrade cover; this may also be used over semiporous, dry subgrade material instead of water sprinkling.

3.5.3 Subgrade Under Slabs on Ground

Before construction of slabs on ground, underground work on pipes and conduits shall have been completed and approved.

Previously constructed subgrade or fill shall be cleaned of foreign materials and shall be inspected by the Contractor for adequate compaction and surface tolerances as specified.

Actual density of top 300 millimeter of subgrade soil material-in-place shall not be less than the following percentages of maximum density of same soil material compacted at optimum moisture content in accordance with ASTM D 1557.

SOIL MATERIAL	PERCENT MAXIMUM DENSITY
Drainage fill	100
Non-cohesion soil material	100
Cohesive soil material	95

Finish surface of drainage fill under interior slabs on ground shall not show deviation in excess of 6.4 millimeter when tested with a 3000 millimeter straightedge parallel with and at right angles to building lines.

Finished surface of subgrade or fill under exterior slabs on ground shall be not more than 6.10 millimeter above or 30.50 millimeter below elevation indicated.

Subgrade or fill surface under exterior slabs on ground shall be prepared as specified for subgrade under foundations and footings.

3.5.4 Formwork

Formwork shall be complete and approved. Debris and foreign material shall be removed from interior of forms before start of concrete placing.

3.5.5 Edge Forms and Screed Strips for Slabs

Edge forms or bulkheads and intermediate screed strips for slabs shall be set to obtain indicated elevations and contours in finished slab surface and shall be strong to support vibrating bridge screeds or roller pipe screeds

if nature of specified slab finish requires use of such equipment. Concrete surface shall be aligned to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

3.5.6 Reinforcement and Other Embedded Items

Reinforcement, joint materials, and other embedded materials shall be secured in position, inspected, and approved before start of concrete placing.

3.6 CONCRETE CONVEYING

3.6.1 Transfer of Concrete At Project Site

Concrete shall be handled from point of delivery and transfer to concrete conveying equipment and to locations of final deposit as rapidly as practical by methods which will prevent segregation and loss of concrete mix materials.

3.6.2 Mechanical Equipment for Conveying Concrete

Equipment shall ensure continuous delivery/flow of concrete at delivery end and shall be as approved. If/as necessary, runways for wheeled concrete-conveying equipment shall be provided from concrete delivery point to locations of final deposit. Interior surfaces of concrete conveying equipment shall be free of hardened concrete, debris, water, snow, ice, and other deleterious substances.

3.7 CONCRETE PLACING

3.7.1 Weather Limitations and Protection

Concrete shall not be placed when the ambient temperature of the atmosphere exceeds 32 degrees C unless an approved chemical retardant is used, nor when the ambient air temperature is below 5 degrees C, nor during rain, sleet, or snow, unless protection is provided.

When concrete is placed at 32 degrees C or hotter it shall be covered and kept continuously wet for a minimum of 48 hours.

Protection shall be provided during cold weather in accordance with ACI/MCP 205 and ACI 301.

During inclement weather, protection material shall be watertight to prevent entry of rain, sleet, or snow onto surfaces to receive concrete and into fresh concrete.

Protection materials shall be stored at project site for use in event of unforeseen weather changes after start of concrete placing operations.

3.7.2 General Placing Requirements

Concrete shall be deposited continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be provided as specified. Concrete placing shall be performed at such a rate that

concrete which is being integrated with fresh concrete is still plastic. Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Concrete shall not be subjected to procedures which will cause segregation.

Concrete to receive other construction shall be screeded to proper level to avoid excessive skimming or grouting.

Concrete which becomes nonplastic and unworkable or does not meet quality control limits as specified or has been contaminated by foreign materials shall not be used. Use of retempered concrete will not be permitted. Rejected concrete shall be removed from the site.

3.7.3 Placing Concrete in Forms

Concrete placed in forms shall be deposited in horizontal layers not exceeding 600 millimeter.

Temporary spreaders in forms shall be removed when concrete placing has reached elevation of spreaders.

Concrete placed in forms shall be consolidated by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Vibrators shall be designed to operate with vibratory element submerged in concrete and shall maintain a speed of not less than 9,000 impulses per minute when submerged in concrete. Vibrating equipment shall be adequate in number of units and power of each unit to properly consolidate concrete. Vibration of forms and reinforcement shall not be permitted. Vibrators shall not be used to transport concrete inside forms. Vibrators shall be inserted and withdrawn vertically at uniformly spaced points not farther apart than visible effectiveness of machine. Vibrator shall not be inserted into lower courses of concrete that have begun to set. At each insertion, duration of vibration shall be limited to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of concrete mix.

Placing of concrete in supporting elements shall not be started until concrete previously placed in columns and walls is no longer plastic and has been in place a minimum of 2 hours.

3.7.4 Placing Concrete Slabs

Concrete for slabs shall be placed and consolidated in a continuous operation, within the limits of approved construction joints until placing of panel or section is completed.

During concrete placing operations, concrete shall be consolidated by mechanical vibrating equipment so that concrete is worked around reinforcement and other embedded items and into corners. Concrete placed in beams and girders of supported slabs and against bulkheads of slabs on ground shall be consolidated by mechanical vibrators as specified. Concrete in remainder of slabs shall be consolidated by vibrating bridge screeds, roller pipe screeds, or other approved method. Consolidation operations shall be limited to time necessary to obtain consolidation of concrete without bringing an excess of fine aggregate to the surface. Concrete to be consolidated shall be as dry as practical and surfaces thereof shall not be manipulated prior to finishing operations. Concrete shall be brought to

correct level with a straightedge and struck-off. Bull floats or darbies shall be used to smooth surface, leaving it free of humps or hollows. Sprinkling of water on plastic surface shall not be permitted.

Finish of slabs shall be as specified.

3.7.5 Bonding

Surfaces of set concrete at joints, except where bonding is obtained by use of concrete bonding agent, shall be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Surfaces shall be roughened in a manner that will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Bonding of fresh concrete that has set shall be obtained as follows:

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 shall be dampened, but not saturated, immediately prior to placing of fresh concrete.

At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, and other structural members; and at joints in work designed to contain liquids; the roughened and cleaned surface of set concrete shall be dampened but not saturated and covered with a cement grout coating.

Cement grout coating shall consist of equal parts of portland cement and fine aggregate by weight with not more than 22.5 liter of water per sack of cement. Cement grout shall be applied with a stiff broom or brush to a minimum thickness of 1.6 millimeter. Fresh concrete shall be deposited before cement grout has attained its initial set.

Bonding of fresh concrete to concrete that has set may be obtained by use of a concrete bonding agent. Such bonding material shall be applied to cleaned concrete surface in accordance with approved printed instructions of bonding material manufacturer.

3.8 FINISHING OF FORMED SURFACES

3.8.1 Repairing and Patching Defective Areas

Immediately after removal of forms, defective areas shall be repaired and patched with cement mortar.

Honeycomb, rock pockets, voids over 13 millimeter in diameter, and holes left by tie rods and bolts shall be cut out to solid concrete, but in no case to a depth of less than 25 millimeter. Edges of cuts shall be perpendicular to surface of concrete. Before placing cement mortar, area to be patched at least 150 millimeter adjacent thereto shall be cleaned, dampened with water, and brush coated with neat portland cement grout. Cement mortar for patching shall consist of one part standard portland cement to two parts fine aggregate passing 1.18 millimeter mesh sieve and as little water as necessary for handling and placing. Where concrete surface will be exposed to view, portland cement portion of cement mortar shall be a

blend of white and standard portland cement so that when dry, cement mortar will match surrounding concrete in color. Cement mortar shall be compacted in place and struck off slightly higher than the surrounding surface. Holes extending through concrete shall be filled by means of a plunger type gun or other suitable device from unexposed face, using a stop held at exposed face to ensure complete filling.

3.8.2 Standard Rough Form Finish

Finish shall be the concrete surface having texture imparted by form facing material used, defective areas repaired and patched as specified, and fins and other projections exceeding 6 millimeter in height rubbed down with wood blocks.

3.8.3 Standard Smooth Finish

Finish shall be as-cast concrete surface as obtained with form facing material for standard smooth finish. Defective areas shall be repaired and patched as specified; and all fins and other projections on surface shall be removed.

3.8.4 Related Unformed Surfaces

Tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck off smooth after concrete is placed and shall be finished to a texture matching that of adjacent formed surfaces. Final surface treatment on formed surfaces shall continue uniformly across adjacent unformed surfaces.

3.9 FINISHING OF SLABS

3.9.1 Scratch Finish

A scratch finish shall be given to slab surfaces that are to receive concrete floor topping, mortar setting beds, or other bonded, applied, cement, finish flooring material.

After placing concrete slabs, surface shall be plane to a tolerance not exceeding 6.4 millimeter in 600 millimeter or 3.2 millimeter for surfaces requiring subsequent tile finish when tested with a 600 millimeter straightedge placed on the surface at not less than two different angles. Surfaces shall be uniformly sloped to drains. After leveling, surface shall be roughened with stiff brushes or raked before final set.

3.9.2 Float Finish

A float finish shall be given to slab surfaces that are to receive trowel finish and other finishes as specified and to slab surfaces that are to be covered with membrane waterproofing, membrane roofing, or terrazzo.

After placing is completed, concrete shall not be worked further until ready for floating. Floating shall begin when water has disappeared, or when concrete mix has stiffened sufficiently to permit proper operation of a power-driven float, or when both conditions have occurred. Any surface water remaining shall be removed before floating. Surface shall then be consolidated with power-driven floats. Hand floating shall be used in locations inaccessible to power-driven floats. Trueness of surface shall be

checked at this stage with a 3000 millimeter straightedge. Surface shall be plane to a tolerance not exceeding 6.4 millimeter in 3000 millimeter or 3.2 millimeter for surfaces requiring subsequent tile finish when tested with a 3000 millimeter straightedge placed on the surface at not less than two different angles. High spots shall be cut down and low spots shall be filled. Surfaces shall be uniformly sloped to drains. Immediately after completion of leveling, surface shall be refloated to a uniform, smooth, granular texture.

3.9.3 Trowel Finish

Finish shall be given to slab surfaces that are to be exposed to view, and to slab surfaces to be covered with resilient flooring, paint, or other finish coating system.

After completion of float finish as specified above, the surface shall receive a trowel finish. First troweling after completion of float finish shall be done by a power-driven trowel and shall produce a smooth surface which is free of defects but which may contain some trowel marks.

Additional troweling shall be done by hand after surface has hardened sufficiently. Final troweling shall be started when a ringing sound is produced as trowel is moved over surface. Surface shall be consolidated by hand troweling operation. Finished surface shall be free of trowel marks, uniform in texture and appearance, and plane to a tolerance not exceeding 6.4 millimeter in 3000 millimeter or 3.2 millimeter for surfaces requiring subsequent tile finish when tested with a 3000 millimeter straightedge placed on the surface in any direction. Surface defects of sufficient magnitude to show through floor covering shall be removed by grinding.

3.9.4 Non-Slip Broom Finish

Finish shall be given to surfaces of exterior concrete steps and platforms, and elsewhere where indicated.

Immediately after completion of trowel finish, surface shall be slightly roughened by brooming with a fiber-bristle brush in a direction transverse to that of main traffic.

3.10 CONCRETE CURING AND PROTECTION

3.10.1 General

Freshly placed concrete shall be protected from premature drying and cold or hot temperature and shall be maintained without drying at a relatively constant temperature for the period of time necessary for hydration of cement and proper hardening of concrete.

Initial curing shall start as soon as free water has disappeared from surface of concrete after placing and finishing. Concrete shall be kept moist for minimum 72 hours.

Final curing shall immediately follow initial curing and before concrete has dried. Final curing shall continue until cumulative number of hours or fraction thereof (not necessarily consecutive) during which temperature of air in contact with the concrete is above 10 degrees C has totaled 168 hours. Alternatively, if tests are made of cylinders kept adjacent to the

structure and cured by the same methods, final curing may be terminated when the average compressive strength has reached 70 percent of the 28-day design compressive strength. Rapid drying at end of final curing period shall be prevented.

3.10.2 Curing Methods

Curing shall be accomplished by moist curing, by moisture-retaining cover curing, by membrane curing, and by combinations thereof, as specified and approved.

Moist curing:

Moisture curing shall be accomplished by any of the following methods:

Keeping surface of concrete wet by covering with water

Continuous water spraying

Covering concrete surface with specified absorptive cover for curing concrete saturated with water and keeping absorptive cover wet by water spraying or intermittent hosing. Absorptive cover shall be placed to provide coverage of concrete surfaces and edges with a slight overlap over adjacent absorptive covers.

Moisture-cover curing:

Moisture-retaining cover curing shall be accomplished by covering concrete surfaces with specified moisture-retaining cover for curing concrete. Cover shall be placed directly on concrete in widest practical width, with sides and ends lapped at least 75 millimeter. Cover shall be weighted to prevent displacement; tears or holes appearing during curing period shall be immediately repaired by patching with pressure-sensitive, waterproof tape or other approved method.

Membrane curing:

Membrane curing shall be accomplished by applying specified membrane-forming curing compound to damp concrete surfaces as soon as moisture film has disappeared. Curing compound shall be applied uniformly in a two-coat operation by power-spraying equipment using a spray nozzle equipped with a wind guard. Second coat shall be applied in a direction at right angles to direction of first coat. Total coverage for two coats shall be not more than 5 square meter per liter of curing compound. Concrete surfaces which are subjected to heavy rainfall within 3 hours after curing compound has been applied shall be resprayed by method and at rate specified. Continuity of coating shall be maintained for entire curing period and damage to coating during this period shall be repaired immediately.

Membrane-curing compounds shall not be used on surfaces that are to be covered with coating material applied directly to concrete or with a covering material bonded to concrete, such as other concrete, liquid floor hardener, waterproofing, damp proofing, membrane roofing, painting, and other coatings and finish materials.

3.10.3 Curing Formed Surfaces

Curing of formed surfaces, including undersurfaces of girders, beams, supported slabs, and other similar surfaces shall be accomplished 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, final curing of formed surfaces shall be accomplished by any of the curing methods specified above, as applicable.

3.10.4 Curing Unformed Surfaces

Initial curing of unformed surfaces, such as monolithic slabs, floor topping, and other flat surfaces, shall be accomplished by membrane curing.

Unless otherwise specified, final curing of unformed surfaces shall be accomplished by any of curing methods specified above, as applicable.

Final curing of concrete surfaces to receive liquid floor hardener of finish flooring shall be accomplished by moisture-retaining cover curing.

3.10.5 Temperature of Concrete During Curing

When temperature of atmosphere is 5 degrees C and below, temperature of concrete shall be maintained at not less than 13 degrees C throughout concrete curing period or 7 degrees C when the curing period is measured by maturity. When necessary, arrangements shall be made 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 27 degrees C and above or during other climatic conditions which will cause too rapid drying of concrete, arrangements shall be made 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 shall be uniform and shall not exceed 3 degrees C in any 1 hour nor 28 degrees C in any 24-hour period.

3.10.6 Protection from Mechanical Injury

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

3.10.7 Protection After Curing

Finished concrete surfaces shall be protected from damage by construction operations.

3.11 QUALITY-CONTROL TESTING DURING CONSTRUCTION

Concrete shall be sampled and tested for quality control by the Contractor during the placement of the concrete as follows:

REQUIREMENT	TEST METHOD	NUMBER OF TESTS

Sampling fresh concrete	ASTM C 172 except modified for slump per ASTM C 94/C 94M	As required for each test
Slump test	ASTM C 143/C 143M	One for each concrete load at point of discharge and one for each set of compressive strength tests
Air content by pressure method	ASTM C 231	One for each set of compressive strength tests
Compression test specimens	ASTM C 31/C 31M	One set of six standard cylinders for each compressive strength test
Concrete temperature		Hourly when air temperature is 4.4 degrees C or below and 26.7 degrees C or above; each time a set of compression test specimens is made
Compressive strength test	ASTM C 39/C 39M	One set for each 115 cubic meter or fraction thereof of each concrete class placed in any one day; two specimens tested at 7 days, three specimens tested at 28 days and one specimen retained in reserve for testing if required

Test reports for concrete for Chemical Composition, Mechanical Usability and Soundness shall be submitted by the Contractor meeting all design specifications as required by referenced standards within this section.

3.12 INSPECTION AND ACCEPTANCE PROVISIONS

3.12.1 Evaluation of Compressive Strength Tests

Concrete quality control test will be evaluated as specified.

Compressive strength tests will be considered satisfactory if the average of all sets of five consecutive compressive strength tests equal or exceed the

28-day design compressive strength, or if no individual compressive strength test (average of two cylinders) falls below the required 28-day design compressive strength by more than 350 kilopascal.

If compressive strength tests fail to meet minimum requirements specified, concrete represented by such tests will be considered deficient in strength and subject to provisions specified.

3.12.2 Strength of Concrete Structure

Strength of concrete structure in place will be considered deficient if it fails to comply with requirements which control strength of structure, including following conditions:

Failure to meet compressive strength tests as evaluated

Reinforcement not conforming to requirements specified

Concrete which differs from required dimensions or location in such a manner as to reduce strength

Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified

Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration

Poor workmanship likely to result in deficient strength

3.12.3 Testing Concrete Structure for Strength

When there is evidence that strength of concrete structure in place does not meet specification requirements, cores drilled from hardened concrete for compressive strength determination shall be made in accordance with ASTM C 42/C 42M, and as follows:

At least three representative cores shall be taken from each member or area of concrete-in-place that is considered potentially deficient. Location of cores will be determined by the Contracting Officer.

Cores shall be tested after moisture conditioning in accordance with ASTM C 42/C 42M if concrete they represent will be more than superficially wet under service.

Cores shall be air dried, (16 to 27 degrees C with relative humidity less than 60 percent) for 7 days before test and shall be tested dry if concrete they represent will be dry under service conditions.

Strength of cores from each member or area will be 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.

Core specimens will be taken and tested by the Government. If the results of core-boring tests indicate that the concrete as placed does not conform to the drawings and specification, the cost of such tests and restoration required shall be borne by the Contractor.

Core holes shall be filled solid with patching mortar and finished to match adjacent concrete surfaces.

Concrete work that is found inadequate by core tests shall be corrected in a manner approved by the Contracting Officer.

-- End of Section --

SECTION 04 20 00

MASONRY

PART 1 GENERAL

1.1 REFERENCES

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

ACI INTERNATIONAL (ACI)

ACI 318	(2008) Building Code Requirements for Structural Concrete and Commentary
ACI 318M	(2008) Metric Building Code Requirements for Structural Concrete and Commentary
ACI 530	(2008) Building Code Requirements for Masonry Structures Commentaries
ACI 530.1	(2008) Specification for Masonry Structures
ACI SP-66	(2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 167	(1999; R 2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 615/A 615M	(2008a) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 641/A 641M	(2003) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A 82/A 82M	(2005a) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM B 370	(2003) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C 1019	(2005) Standard Test Method for Sampling and Testing Grout
ASTM C 1072	(2006) Standard Test Method for Measurement of Masonry Flexural Bond Strength

ASTM C 1142	(1995; R 2001) Standard Specification for Extended Life Mortar for Unit Masonry
ASTM C 129	(2006) Standard Specification for Non-load bearing Concrete Masonry Units
ASTM C 140	(2006) Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
ASTM C 144	(2004) Standard Specification for Aggregate for Masonry Mortar
ASTM C 150	(2005) Standard Specification for Portland Cement
ASTM C 207	(2006) Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C 270	(2006) Standard Specification for Mortar for Unit Masonry
ASTM C 476	(2002) Standard Specification for Grout for Masonry
ASTM C 494/C 494M	(2005a) Standard Specification for Chemical Admixtures for Concrete
ASTM C 578	(2006) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 593	(1985; R 2000) Fly Ash and Other Pozzolans for Use with Lime
ASTM C 641	(1998e1) Staining Materials in Lightweight Concrete Aggregates
ASTM C 780	(2006) Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ASTM C 90	(2006a) Load bearing Concrete Masonry Units
ASTM C 91	(2005) Masonry Cement
ASTM C 94/C 94M	(2006) Standard Specification for Ready-Mixed Concrete
ASTM D 1972	(1997; R 2005) Standard Practice for Generic Marking of Plastic Products
ASTM D 2000	(2006a) Standard Classification System for Rubber Products in Automotive Applications
ASTM D 2240	(2005) Standard Test Method for Rubber Property - Durometer Hardness

ASTM D 2287	(1996; R 2001) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM E 119	(2007) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E 2129	(2005) Standard Practice for Data Collection for Sustainability Assessment of Building Products
ASTM E 514	(2004) Water Penetration and Leakage Through Masonry

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2006) International Building Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-03A	(2005) 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 information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Structural Masonry; G

Drawings including plans, elevations, and details of wall reinforcement; details of reinforcing bars at corners and wall intersections; offsets; tops, bottoms, and ends of walls; control and expansion joints; lintels; and wall openings. Bar splice locations shall be shown. If the Contractor opts to furnish inch-pound CMU products, drawings showing elevation of walls exposed to view and indicating the location of all cut CMU products shall be submitted for approval. Bent bars shall be identified on a bending diagram and shall be referenced and located on the drawings. Wall dimensions, bar clearances, and wall openings greater than one masonry unit in area shall be shown. No approval will be given to the shop drawings until the Contractor certifies that all openings, including those for mechanical and electrical service, are shown. If, during construction, additional masonry openings are required, the approved shop drawings shall be resubmitted with the additional openings shown along with the proposed changes. Location of these additional openings shall be clearly highlighted. The minimum scale for wall elevations shall be 1 to 50. Reinforcement bending details shall conform to the requirements of ACI SP-66.

SD-03 Product Data

Cold Weather Installation; G

Cold weather construction procedures.

SD-04 Samples

Concrete Masonry Units (CMU)

Color samples of three stretcher units and one unit for each type of special shape. Units shall show the full range of color and texture. Submit sample of colored mortar with applicable masonry unit.

Anchors, Ties, and Bar Positioners;

Two of each type used.

Expansion-Joint Materials

One piece of each type used.

SD-05 Design Data

Pre-mixed Mortar; G
Unit Strength Method; G

Pre-mixed mortar composition. Calculations and certifications of masonry unit and mortar strength.

SD-07 Certificates

Concrete Masonry Units (CMU)
Control Joint Keys
Anchors, Ties, and Bar Positioners
Expansion-Joint Materials
Reinforcing Steel Bars and Rods
Masonry Cement
Admixtures for Masonry Mortar
Admixtures for Grout

Certificates of compliance stating that the materials meet the specified requirements.

SD-08 Manufacturer's Instructions

Masonry Cement

When masonry cement is used, submit the manufacturer's printed instructions on proportions of water and aggregates and on mixing to obtain the type of mortar required.

1.3 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered, handled, stored, and protected 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.

1.3.1 Masonry Units

Cover and protect moisture-controlled concrete masonry units and cementitious materials from precipitation. Conform to all handling and storage requirements of ASTM C 90. Prefabricated lintels shall be marked on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

1.3.2 Reinforcement, Anchors, and Ties

Steel reinforcing bars, coated anchors, ties shall be stored above the ground. Steel reinforcing bars and uncoated ties shall be free of loose mill scale and rust.

1.3.3 Cementitious Materials, Sand and Aggregates

Cementitious and other packaged materials shall be delivered in unopened containers, plainly marked and labeled with manufacturers' names and brands. Cementitious material shall be stored in dry, weather-tight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Sand and aggregates shall be stored in a manner to prevent contamination or segregation.

1.4 STRUCTURAL MASONRY

1.4.1 Special Inspection

A qualified masonry inspector approved by the Contracting Officer shall perform inspection of the masonry work. Minimum qualifications for the masonry inspector shall be 5 years of reinforced masonry inspection experience or acceptance by a State, municipality, or other governmental body having a program of examining and certifying inspectors for reinforced masonry construction. The masonry inspector shall be present during preparation of masonry prisms, sampling and placing of masonry units, placement of reinforcement (including placement of dowels in footings and foundation walls), inspection of grout space, immediately prior to closing of cleanouts, and during grouting operations. The masonry inspector shall assure Contractor compliance with the drawings and specifications. The masonry inspector shall keep a complete record of all inspections and shall submit daily written reports to the Quality Control Supervisory Representative reporting the quality of masonry construction.

1.4.2 Unit Strength Method

Compute compressive strength of masonry system "Unit Strength Method," ACI 530. Submit calculations and certifications of unit and mortar strength.

1.4.3 Seismic Requirement

In addition to design requirements of ICC IBC, the Contractor shall provide additional seismic reinforcement as detailed on the drawings

Bond beams are required at the top of footings, at the bottom and top of openings at roof and floor levels, and at the top of parapet walls and additional locations where indicated.

1.5 QUALITY ASSURANCE

1.5.1 Appearance

Blocks and bricks shall be manufactured at one time and from the same batch.

1.5.2 Contamination

When using bricks containing contaminated soil, supplier shall certify that the hazardous waste is neutralized by the manufacturing process and that no additional pollutants will be released, or that the product is free from hazardous contaminants.

1.5.3 Testing

Masonry strength shall be determined in accordance with ACI 530; submit test reports on three prisms as specified in ACI 530.1. The cost of testing shall be paid by the Contractor.

1.5.4 Spare Vibrator

Maintain at least one spare vibrator on site at all times.

1.5.5 Bracing and Scaffolding

Provide bracing and scaffolding necessary for masonry work. Design bracing to resist wind pressure as required by local code.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

The source of materials which will affect the appearance of the finished work shall not be changed after the work has started except with Contracting Officer's approval. The Contractor has the option to use either hard metric or substitute inch-pound (soft-metric) CMU products. If the Contractor decides to substitute inch-pound CMU products, the following additional requirements shall be met:

a. The metric dimensions indicated on the drawings shall not be altered to accommodate inch-pound CMU products either horizontally or vertically. The 100 mm building module shall be maintained, except for the CMU products themselves.

b. Mortar joint widths shall be maintained as specified.

c. Rebars shall not be cut, bent or eliminated to fit into the inch-pound CMU products module.

d. Inch-pound CMU products shall not be reduced in size by more than one-third (1/3) in height and one-half (1/2) in length. Cut CMU products shall not be located at ends of walls, corners, and other openings.

e. Cut, exposed CMU products shall be held to a minimum and located where they would have the least impact on the architectural aesthetic goals of the facility.

f. Other building components, built into the CMU products, such as window frames, door frames, louvers, grilles, fire dampers, etc., that are required to be metric, shall remain metric.

2.3 CONCRETE BRICK

Concrete brick shall conform to ASTM C 55, Grade N. Concrete brick may be used where necessary for filling out in concrete masonry unit construction.

2.4 CONCRETE MASONRY UNITS (CMU)

Cement shall have a low alkali content and be of one brand. Surfaces of units which are to be plastered or stuccoed shall be sufficiently rough to provide bond elsewhere.

a. Hollow Load-Bearing Units: ASTM C 90, made with normal weight aggregate. Provide load-bearing units for exterior walls, foundation walls, load-bearing walls, and shear walls.

2.4.1 Aggregates

Lightweight aggregates and blends of lightweight and heavier aggregates in proportions used in producing the units, shall comply with the following requirements when tested for stain-producing iron compounds in accordance with ASTM C 641: by visual classification method, the iron stain deposited on the filter paper shall not exceed the "light stain" classification. Use industrial waste by-products (air-cooled slag, cinders, or bottom ash), ground waste glass and concrete, granulated slag, and expanded slag in aggregates. Slag shall comply with ASTM C 989; Grade 80.

2.5 PRECAST CONCRETE ITEMS

Trim, lintels, copings, splash blocks and door sills shall be factory-made units from a plant regularly engaged in producing precast concrete units. Unless otherwise indicated, concrete shall be 21 MPa 3000 psi minimum conforming to Section 03 30 00 CAST-IN-PLACE CONCRETE using 13 mm 1/2 inch to No. 4 nominal-size coarse aggregate, and minimum reinforcement shall be the reinforcement required for handling of the units. Clearance of 19 mm (¾ inch) shall be maintained between reinforcement and faces of units. Unless precast-concrete items have been subjected during manufacture to saturated-steam pressure of at least 827 kPa 120 psi for at least 5 hours, the items, after casting, shall be either damp-cured for 24 hours or steam-cured and shall then be aged under cover for 28 days or longer. Cast-concrete members weighing over 35 kg 80 pounds shall have built-in loops of galvanized wire or other approved provisions for lifting and anchoring. Units shall have beds and joints at right angles to the face, with sharp true arises and shall be cast with drip grooves on the underside where units overhang walls. Exposed-to-view surfaces shall be free of surface voids, spalls, cracks, and chipped or broken edges. Precast units exposed-to-view shall be of uniform appearance and color. Unless otherwise specified, units shall have a smooth dense finish. Prior to use, each item shall be wetted and inspected for crazing. Items showing evidence of

dusting, spalling, crazing, or having surfaces treated with a protective coating will be rejected.

2.5.1 Lintels

Precast lintels, unless otherwise shown, shall be of a thickness equal to the wall and reinforced with two No. 4 bars for the full length. Top of lintels shall be labeled "TOP" or otherwise identified and each lintel shall be clearly marked to show location in the structure. In reinforced SECTION 04 20 00 Page 28 masonry, lintels shall conform to ACI 318M ACI 318 for flexural and shear strength and shall have at least 200 mm 8 inches bearing at each end. Concrete shall have a minimum 28 day compressive strength of 21 MPa 3,000 psi using 13 mm (1/2 inch) to No. 4 nominal-size coarse aggregate. Reinforcement shall conform to ASTM A 615M Grade 400 MPa 60,000 psi. Limit lintel deflection due to dead plus live load to L/600 or 7 mm 0.3 inches. Provide top and bottom bars for lintels over 900 mm (36 inches) in length.

2.5.2 Sills and Copings

Sills and copings shall be cast with washes. Sills for windows having mullions shall be cast in sections with head joints at mullions and a 6 mm 1/4 inch allowance for mortar joints. The ends of sills, except a 19 mm (3/4 inch) wide margin at exposed surfaces, shall be roughened for bond. Treads of door sills shall have rounded nosings. Reinforce sills with not less than two No. 4 bars.

2.5.3 Splash Blocks

Splash blocks shall be as detailed. Reinforcement shall be the manufacturer's standard.

2.5.4 Flue Linings and Thimbles

ASTM C 315, free from fractures. Sizes and shapes shall be as indicated.

2.6 STONE ITEMS

Stone for walls, trim, sills, lintels, and copings shall be granite, and shall be cut to the design shown. Granite shall be a good grade building granite of medium or moderately coarse grain, and a light or medium gray or light tan color.

2.7 MORTAR FOR STRUCTURAL MASONRY

ASTM C 270, Type S. Strength (f'm) of 13 MPa ultimate compressive stength. Test in accordance with ASTM C 780. Do not use admixtures containing chlorides. When structural reinforcement is incorporated, maximum air-content shall be 12 percent in cement-lime mortar and 18 percent in masonry cement mortar. Use up to 40 percent Class F fly ash with type IP cement in cement-lime mortar. Fly ash shall comply with ASTM C 593.

Type N shall be used for all non-structural CMU walls. Type M shall be used for all perimeter wall and all structural masonry walls. Types S and O mortars shall not be used for any purposes on this building useless otherwise approved in writing by the Contracting Officer.

2.8 MASONRY MORTAR

Mortar Type S shall conform to the proportion specification of ASTM C 270 with Type S cement-lime mortar proportions shall be 1 part cement, 1/2 part lime and 4-1/2 parts aggregate. Type S mortar shall be used for non-load-bearing, non-shear-wall interior masonr; and Type S for remaining masonry work; except where higher compressive strength is indicated on structural drawings. When masonry cement ASTM C 91 is used the maximum air content shall be limited to 12 percent and performance equal to cement-lime mortar shall be verified. Verification of masonry cement performance shall be based on ASTM C 780 and ASTM C 1072. Pointing mortar in showers and kitchens shall contain ammonium stearate, or aluminum tri-stearate, or calcium stearate in an amount equal to 3 percent by weight of cement used. Cement shall have a low alkali content and be of one brand. Aggregates shall be from one source.

2.8.1 Admixtures for Masonry Mortar

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494/C 494M, Type C.

2.8.2 Hydrated Lime and Alternates

Hydrated lime shall conform to ASTM C 207, Type S. Lime alternates which have a current ICBO, ICBO UBC, Evaluation Report number whose findings state it may be used as an alternate to lime for Type S mortar will be deemed acceptable provided the user follows the manufacturer's proportions and mixing instructions as set forth in ICBO report.

2.8.3 Cement

Portland cement shall conform to ASTM C 150, Type I. Masonry cement shall conform to ASTM C 91, Type S M. Containers shall bear complete instructions for proportioning and mixing to obtain the required types of mortar. Incorporate to the maximum extent, without conflicting with other requirements of this section, up to 40 percent fly ash, up to 70 percent slag, up to 10 percent cenospheres, and up to 10 percent silica fume. Additives shall conform to requirements in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.8.4 Sand and Water

Sand shall conform to ASTM C 144. Water shall be clean, potable, and free from substances which could adversely affect the mortar.

2.9 GROUT AND READY-MIXED GROUT

Grout shall conform to ASTM C 476, fine. Cement used in grout shall have a low alkali content. Grout slump shall be between 200 and 250 mm. Minimum grout strength shall be 14 MPa in 28 days, as tested by ASTM C 1019. Grout shall be used subject to the limitations of Table III. Proportions shall not be changed and materials with different physical or chemical characteristics shall not be used in grout for the work unless additional evidence is furnished that the grout meets the specified requirements. Ready-Mixed grout shall conform to ASTM C 94/C 94M.

2.9.1 Admixtures for Grout

In cold weather, a non-chloride based accelerating admixture may be used subject to approval; accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494/C 494M, Type C. In general, air-entrainment, anti-freeze or chloride admixtures shall not be used except as approved by the Contracting Officer.

2.9.2 Grout Barriers

Grout barriers for vertical cores shall consist of fine mesh wire, fiberglass, or expanded metal.

2.10 BAR POSITIONERS

Joint reinforcement in interior walls, and in exterior or interior walls exposed to moist environment shall conform to ASTM A 641/A 641M; coordinate with paragraph JOINT REINFORCEMENT below.

2.10.1 Bar Positioners

Bar positioners, used to prevent displacement of reinforcing bars during the course of construction, shall be factory fabricated from 9 gauge steel wire or equivalent, and coated with a hot-dip galvanized finish. Not more than one wire shall cross the cell.

2.11 REINFORCING STEEL BARS AND RODS

Reinforcing steel bars and rods shall conform to ASTM A 615/A 615M, Grade 60.

2.12 CONTROL JOINT KEYS

Control joint keys shall be a factory fabricated solid section of natural or synthetic rubber (or combination thereof) conforming to ASTM D 2000or polyvinyl chloride conforming to ASTM D 2287. The material shall be resistant to oils and solvents. The control joint key shall be provided with a solid shear section not less than 16 mm thick and 10 mm thick flanges, with a tolerance of plus or minus 2 mm. The control joint key shall fit neatly, but without forcing, in masonry unit jamb sash grooves. The control joint key shall be flexible at a temperature of minus 34 degrees C after five hours exposure, and shall have a durometer hardness of not less than 70 when tested in accordance with ASTM D 2240.

2.13 EXPANSION-JOINT MATERIALS

Backer rod and sealant shall be adequate to accommodate joint compression equal to 50 percent of the width of the joint. The backer rod shall be compressible rod stock of polyethylene foam, polyurethane foam, butyl rubber foam, or other flexible, nonabsorptive material as recommended by the sealant manufacturer. Sealant shall conform to Section 07 92 00 JOINT SEALANTS, and shall be penetrating with a maximum volatile organic compound (VOC) content of 600 grams/liter.

2.14 FLASHING

Flashing shall be as specified in Section 07 60 00 FLASHING AND SHEET METAL. Provide one of the following types except that flashing indicated to terminate in reglets shall be metal or coated-metal flashing and except that the material shall be one which is not adversely affected by dampproofing material.

a. Stainless Steel Flashing: Copper, ASTM B 370, minimum 450 kg weight; stainless steel, ASTM A 167, Type 301, 302, 304, or 316, 4 mm thick, No. 2D finish. Provide with factory-fabricated deformations that mechanically bond flashing against horizontal movement in all directions. Deformations shall consist of dimples, diagonal corrugations, or a combination of dimples and transverse corrugations.

PART 3 EXECUTION

3.1 PREPARATION

Prior to start of work, masonry inspector shall verify the applicable conditions as set forth in ACI 530.1, inspection. The Contracting Officer will serve as inspector or will select a masonry inspector.

3.1.1 Hot Weather Installation

The following precautions shall be taken if masonry is erected when the ambient air temperature is more than 37 degrees C in the shade and the relative humidity is less than 50 percent or the ambient air temperature exceeds 32 degrees C and the wind velocity is more than 13 km/h. All masonry materials shall be shaded from direct sunlight; mortar beds shall be spread no more than 1.2 m ahead of masonry; masonry units shall be set within one minute of spreading mortar; and after erection, masonry shall be protected from direct exposure to wind and sun for 48 hours.

3.1.2 Cold Weather Installation

Before erecting masonry when ambient temperature or mean daily air temperature falls below 4 degrees C or temperature of masonry units is below 4 degrees C, a written statement of proposed cold weather construction procedures shall be submitted for approval. The following precautions shall be taken during all cold weather erection. Conform to ACI 530.1 for hot and cold weather masonry erection.

3.1.2.1 Protection

Ice or snow formed on the masonry bed shall be thawed by the application of heat. Heat shall be applied carefully until the top surface of the masonry is dry to the touch. Sections of masonry deemed frozen and damaged shall be removed before continuing construction of those sections.

a. Air Temperature 4 to 0 degrees C. Sand or mixing water shall be heated to produce mortar temperatures between 4 and 49 degrees C

b. Air Temperature 0 to minus 4 degrees C. Sand and mixing water shall be heated to produce mortar temperatures between 4 and 49 degrees C. Temperature of mortar on boards shall be maintained above freezing.

c. Air Temperature minus 4 to minus 7 degrees C. Sand and mixing water shall be heated to provide mortar temperatures between 4 and 49 degrees C. Temperature of mortar on boards shall be maintained above freezing. Sources of heat shall be used on both sides of walls under construction. Windbreaks shall be employed when wind is in excess of 24 km/hour.

d. Air Temperature minus 7 degrees C and below. Sand and mixing water shall be heated to provide mortar temperatures between 4 and 49 degrees C. Enclosure and auxiliary heat shall be provided to maintain air temperature above 0 degrees C. Temperature of units when laid shall not be less than minus 7 degrees C.

3.1.2.2 Completed Masonry and Masonry Not Being Worked On

a. Mean daily air temperature 4 to 0 degrees C. Masonry shall be protected from rain or snow for 24 hours by covering with weather-resistive membrane.

b. Mean daily air temperature 0 to minus 4 degrees C. Masonry shall be completely covered with weather-resistant membrane for 24 hours.

c. Mean Daily Air Temperature minus 4 to minus 7 degrees C. Masonry shall be completely covered with insulating blankets or equally protected for 24 hours.

d. Mean Daily Temperature minus 7 degrees C and Below. Masonry temperature shall be maintained above 0 degrees C for 24 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps, or other approved methods.

3.1.3 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.

3.1.4 Loads

Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed. Provide temporary bracing as required.

3.1.5 Surfaces

Surfaces on which masonry is to be placed shall be cleaned of laitance, dust, dirt, oil, organic matter, or other foreign materials and shall be slightly roughened to provide a surface texture with a depth of at least 3 mm. Sandblasting shall be used, if necessary, to remove laitance from pores and to expose the aggregate.

3.2 LAYING MASONRY UNITS

Coordinate masonry work with the work of other trades to accommodate built-in items and to avoid cutting and patching. Masonry units shall be laid in running bond pattern. Each unit shall be adjusted to its final position

while mortar is still soft and plastic. Units that have been disturbed after the mortar has stiffened shall be removed, cleaned, and relaid with fresh mortar. Air spaces, cavities, chases, expansion joints, and spaces to be grouted shall be kept free from mortar and other debris. Units used in exposed masonry surfaces shall be selected from those having the least amount of chipped edges or other imperfections detracting from the appearance of the finished work. Vertical joints shall be kept plumb. Units being laid and surfaces to receive units shall be free of water film and frost. Solid units shall be laid in a nonfurrowed full bed of mortar. Units shall be shoved into place so that the vertical joints are tight. Vertical joints of brick and the vertical face shells of concrete masonry units, except where indicated at control, expansion, and isolation joints, shall be completely filled with mortar. Mortar will be permitted to protrude up to 13 mm into the space or cells to be grouted. Means shall be provided to prevent mortar from dropping into the space below.

3.2.1 Forms and Shores

Provide bracing and scaffolding as required. Design bracing to resist wind pressure as required by local codes. Forms and shores shall be sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Supporting forms and shores shall not be removed in less than 10 days.

3.2.2 Reinforced Concrete Masonry Units Walls

Where vertical reinforcement occurs and as noted for exterior and shearwalls, fill cores solid with grout. Lay units in such a manner as to preserve the unobstructed vertical continuity of cores to be filled. Embed the adjacent webs in mortar to prevent leakage of grout. Remove mortar fins protruding from joints before placing grout. Minimum clear dimensions of vertical cores shall be 50 by 75 mm. Position reinforcing accurately as indicated before placing grout. As masonry work progresses, secure vertical reinforcing in place at vertical intervals not to exceed 160 bar diameters. Use puddling rod or vibrator to consolidate the grout. Minimum clear distance between masonry and vertical reinforcement shall be not less than 13 mm. Unless indicated or specified otherwise, form splices by lapping bars not less than 40 bar diameters and wire tying them together.

3.2.3 Concrete Masonry Units

Units in piers, pilasters, columns, starting courses on footings, solid foundation walls, lintels, and beams, and where cells are to be filled with grout shall be full bedded in mortar under both face shells and webs. Other units shall be full bedded under both face shells. Head joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell. Foundation walls below grade shall be grouted solid. Jamb units shall be of the shapes and sizes to conform with wall units. Solid units may be incorporated in the masonry work where necessary to fill out at corners, gable slopes, and elsewhere as approved. Double walls shall be stiffened at wall-mounted plumbing fixtures by use of strap anchors, two above each fixture and two below each fixture, located to avoid pipe runs, and extending from center to center of the double wall. Walls and partitions shall be adequately reinforced for support of other work if/as shown.

3.2.5 Tolerances

Masonry shall be laid plumb, true to line, with courses level. Bond pattern shall be kept plumb throughout. Corners shall be square unless noted otherwise. Except for walls constructed of prefaced concrete masonry units, masonry shall be laid within the following tolerances (plus or minus unless otherwise noted):

TABLE II

TOLERANCES

Variation from the plumb in the lines and surfaces of columns, walls and arises	
In adjacent masonry units	3 mm
In 3 m	6 mm
In 6 m	10 mm
In 12 m or more	13 mm
Variations from the plumb for external corners, expansion joints, and other conspicuous lines	
In 6 m	6 mm
In 12 m or more	13 mm
Variations from the level for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines	
In 6 m	6 mm
In 12 m or more	13 mm
Variation from level for bed joints and top surfaces of bearing walls	
In 3 m	6 mm
In 12 m or more	13 mm
Variations from horizontal lines	
In 3 m	6 mm
In 6 m	10 mm
In 12 m or more	13 mm
Variations in cross sectional dimensions of columns and in thickness of walls	
Minus	6 mm
Plus	13 mm

3.2.6 Cutting and Fitting

Full units of the proper size shall be used wherever possible, in lieu of cut units. Cutting and fitting, including that required to accommodate the work of others, shall be done by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Wet cut units, before being placed in the work, shall be dried to the same surface-dry appearance as uncut units being laid in the wall. Cut edges shall be clean, true and sharp. Openings in the masonry shall be made carefully so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Reinforced masonry lintels shall be provided above openings over 300 mm wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.

3.2.7 Jointing

Joints shall be tooled when the mortar is thumbprint hard. Horizontal joints shall be tooled last. Joints shall be brushed to remove all loose and excess mortar. Mortar joints shall be finished as follows:

3.2.7.1 Flush Joints

Joints in concealed masonry surfaces and joints at electrical outlet boxes in wet areas shall be flush cut. Flush cut joints shall be made by cutting off the mortar flush with the face of the wall. Joints in unparged masonry walls below grade shall be pointed tight. Flush joints for architectural units, such as fluted units, shall completely fill both the head and bed joints.

3.2.7.2 Tooled Joints

Joints in exposed exterior and interior masonry surfaces shall be tooled slightly concave. Joints shall be tooled with a jointer slightly larger than the joint width so that complete contact is made along the edges of the unit. Tooling shall be performed so that the mortar is compressed and the joint surface is sealed. Jointer of sufficient length shall be used to obtain a straight and true mortar joint.

3.2.7.3 Door and Window Frame Joints

On the exposed interior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 10 mm. On the exterior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 10 mm.

3.2.8 Joint Widths

Joint widths shall be as follows:

3.2.8.1 Concrete Masonry Units

Concrete masonry units shall have 10 mm joints, except for prefaced concrete masonry units.

3.2.9 Embedded Items

Spaces around built-in items shall be filled with mortar. Openings around flush-mount electrical outlet boxes in wet locations shall be pointed with mortar. Anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in shall be embedded as the masonry work progresses. Anchors, ties and joint reinforcement shall be fully embedded in the mortar. Cells receiving anchor bolts and cells of the first course below bearing plates shall be filled with grout.

3.2.10 Unfinished Work

Unfinished work shall be stepped back for joining with new work. Toothing may be resorted to only when specifically approved. Loose mortar shall be removed and the exposed joints shall be thoroughly cleaned before laying new work.

3.2.11 Masonry Wall Intersections

Each course shall be masonry bonded at corners and elsewhere as shown. Masonry walls shall be anchored or tied together at corners and intersections with bond beam reinforcement and prefabricated corner or tee pieces of joint reinforcement as shown.

3.2.12 Partitions

Partitions shall be continuous from floor to underside of floor or roof deck where shown. Openings in firewalls around joists or other structural members shall be filled as indicated or approved. Where suspended ceilings on both sides of partitions are indicated, the partitions other than those shown to be continuous may be stopped approximately 100 mm above the ceiling level. An isolation joint shall be placed in the intersection between partitions and structural or exterior walls as shown. Interior partitions having 100 mm nominal thick units shall be tied to intersecting partitions of 100 mm units, 125 mm into partitions of 150 mm units, and 175 into partitions of 200 mm or thicker units. Cells within vertical plane of ties shall be filled solid with grout for full height of partition or solid masonry units may be used. Interior partitions having masonry walls over 100 mm thick shall be tied together with joint reinforcement. Partitions containing joint reinforcement shall be provided with prefabricated pieces at corners and intersections or partitions.

3.3 MORTAR

Mortar shall be mixed in a mechanically operated mortar mixer for at least 3 minutes, but not more than 5 minutes. Measurement of ingredients for mortar shall be by volume. Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units. Mortar that has stiffened because of loss of water through evaporation shall be retempered by adding water to restore the proper consistency and workability. Mortar that has reached its initial set or that has not been used within 2.5 hours after mixing shall be discarded.

3.4 REINFORCING STEEL

Reinforcement shall be cleaned of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond prior to

placing grout. Bars with kinks or bends not shown on the drawings shall not be used. Reinforcement shall be placed prior to grouting. Unless otherwise indicated, vertical wall reinforcement shall extend to within 50 mm of tops of walls.

3.4.1 Positioning Bars

Vertical bars shall be accurately placed within the cells at the positions indicated on the drawings. A minimum clearance of 13 mm shall be maintained between the bars and masonry units. Minimum clearance between parallel bars shall be one diameter of the reinforcement. Vertical reinforcing may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement. Column and pilaster ties shall be wired in position around the vertical steel. Ties shall be in contact with the vertical reinforcement and shall not be placed in horizontal bed joints.

3.4.2 Splices

Bars shall be lapped a minimum of 48 diameters of the reinforcement. Welded or mechanical connections shall develop at least 125 percent of the specified yield strength of the reinforcement.

3.5 JOINT REINFORCEMENT INSTALLATION

Joint reinforcement shall be installed at 400 mm on center or as indicated. Reinforcement shall be lapped not less than 150 mm. Prefabricated sections shall be installed at corners and wall intersections. The longitudinal wires of joint reinforcement shall be placed to provide not less than 16 mm cover to either face of the unit.

3.6 PLACING GROUT

Cells containing reinforcing bars shall be filled with grout. Hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, and other indicated spaces shall be filled solid with grout. Cells under lintel bearings on each side of openings shall be filled solid with grout for full height of openings. Walls below grade, lintels, and bond beams shall be filled solid with grout. Units other than open end units may require grouting each course to preclude voids in the units. Grout not in place within 1-1/2 hours after water is first added to the batch shall be discarded. Sufficient time shall be allowed between grout lifts to preclude displacement or cracking of face shells of masonry units. If blowouts, flowouts, misalignment, or cracking of face shells should occur during construction, the wall shall be torn down and rebuilt.

3.6.1 Vertical Grout Barriers for Fully Grouted Walls

Grout barriers shall be provided not more than 10 m apart, or as required, to limit the horizontal flow of grout for each pour.

3.6.2 Horizontal Grout Barriers

Grout barriers shall be embedded in mortar below cells of hollow units receiving grout.

3.6.3 Grout Holes and Cleanouts

3.6.3.1 Grout Holes

Grouting holes shall be provided in slabs, spandrel beams, and other in-place overhead construction. Holes shall be located over vertical reinforcing bars or as required to facilitate grout fill in bond beams. Additional openings spaced not more than 400 mm on centers shall be provided where grouting of all hollow unit masonry is indicated. Openings shall not be less than 100 mm in diameter or 75 by 100 mm in horizontal dimensions. Upon completion of grouting operations, grouting holes shall be plugged and finished to match surrounding surfaces.

3.6.3.2 Cleanouts for Hollow Unit Masonry Construction

Cleanout holes shall be provided at the bottom of every pour in cores containing vertical reinforcement when the height of the grout pour exceeds 1.5 m. Where all cells are to be grouted, cleanout courses shall be constructed using bond beam units in an inverted position to permit cleaning of all cells. Cleanout holes shall be provided at a maximum spacing of 800 mm where all cells are to be filled with grout. A new series of cleanouts shall be established if grouting operations are stopped for more than 4 hours. Cleanouts shall not be less than 75 by 100 mm openings cut from one face shell. Manufacturer's standard cutout units may be used at the Contractor's option. Cleanout holes shall not be closed until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, cleanout holes shall be closed in an approved manner to match surrounding masonry.

3.6.4 Grouting Equipment

3.6.4.1 Grout Pumps

Pumping through aluminum tubes will not be permitted. Pumps shall be operated to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of each day's pumping, waste materials and debris shall be removed from the equipment, and disposed of outside the masonry.

3.6.4.2 Vibrators

Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout. At least one spare vibrator shall be maintained at the site at all times. Vibrators shall be applied at uniformly spaced points not further apart than the visible effectiveness of the machine. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing segregation.

3.6.5 Grout Placement

Masonry shall be laid to the top of a pour before placing grout. Grout shall not be placed in two-wythe solid unit masonry cavity until mortar joints have set for at least 3 days during hot weather and 5 days during cold damp weather. Grout shall not be placed in hollow unit masonry until mortar joints have set for at least 24 hours. Grout shall be placed using a hand bucket, concrete hopper, or grout pump to completely fill the grout spaces without segregation of the aggregates. Vibrators shall not be

inserted into lower pours that are in a semi-solidified state. The height of grout pours and type of grout used shall be limited by the dimensions of grout spaces as indicated in Table III. Low-lift grout methods may be used on pours up to and including 1.5 m in height. High-lift grout methods shall be used on pours exceeding 1.5 m in height.

3.6.5.1 Low-Lift Method

Grout shall be placed at a rate that will not cause displacement of the masonry due to hydrostatic pressure of the grout. Mortar protruding more than 13 mm into the grout space shall be removed before beginning the grouting operation. Grout pours 300 mm or less in height shall be consolidated by mechanical vibration or by puddling. Grout pours over 300 mm in height shall be consolidated by mechanical vibration and reconsolidated by mechanical vibration after initial water loss and settlement has occurred. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. Low-lift grout shall be used subject to the limitations of Table III.

TABLE III

POUR HEIGHT AND TYPE OF GROUT FOR VARIOUS GROUT SPACE DIMENSIONS

Maximum Grout Pour Height (m) (4)	Grout Type	Grouting Procedure	Minimum Dimensions of the Total Clear Areas Within Grout Spaces and Cells (mm) (1,2) Multiwythe Masonry (3)	Hollow-unit Masonry
0.3	Fine	Low Lift	20	40 x 50
1.5	Fine	Low Lift	50	50 x 75
0.3	Coarse	Low Lift	40	40 x 75
1.5	Coarse	Low Lift	50	65 x 75

Notes:

(1) The actual grout space or cell dimension must be larger than the sum of the following items:

a) The required minimum dimensions of total clear areas given in the table above;

b) The width of any mortar projections within the space;

c) The horizontal projections of the diameters of the horizontal reinforcing bars within a cross section of the grout space or cell.

(2) The minimum dimensions of the total clear areas shall be made up of one or more open areas, with at least one area being 20 mm or greater in width.

(3) For grouting spaces between masonry wythes.

(4) Where only cells of hollow masonry units containing reinforcement are grouted, the maximum height of the pour shall not exceed the distance between horizontal bond beams.

3.7 BOND BEAMS

Bond beams shall be filled with grout and reinforced as indicated on the drawings. Grout barriers shall be installed under bond beam units to retain the grout as required. Reinforcement shall be continuous, including around corners, except through control joints or expansion joints, unless otherwise indicated on the drawings. Where splices are required for continuity, reinforcement shall be lapped 48 bar diameters. A minimum clearance of 13 mm shall be maintained between reinforcement and interior faces of units.

3.8 CONTROL JOINTS

Control joints shall be provided as indicated in accordance with the details shown on the drawings. Sash jamb units shall have a 19 by 19 mm groove near the center at end of each unit. The vertical mortar joint at control joint locations shall be continuous, including through all bond beams. This shall be accomplished by utilizing half blocks in alternating courses on each side of the joint. The control joint key shall be interrupted in courses containing continuous bond beam steel. In single wythe exterior masonry walls, the exterior control joints shall be raked to a depth of 19 mm; backer rod and sealant shall be installed in accordance with Section 07 92 00 JOINT SEALANTS. Exposed interior control joints shall be raked to a depth of 6 mm. Concealed control joints shall be flush cut.

3.9 SHELF ANGLES

Shelf angles shall be adjusted as required to keep the masonry level and at the proper elevation. Shelf angles shall be galvanized. Shelf angles shall be provided in sections not longer than 3 m and installed with a 6 mm gap between sections. Shelf angles shall be mitered and welded at building corners with each angle not shorter than 1.2 m, unless limited by wall configuration.

3.10 LINTELS

3.10.1 Lintels

All lintels shall be constructed as cast-in-place concrete as shown and reinforced with a minimum of two No. 13 bars in the bottom course unless otherwise indicated on the drawings. Lintel reinforcement shall extend beyond each side of masonry opening 40 bar diameters or 600 mm, whichever is greater. Reinforcing bars shall be supported in place and shall be located 13 mm above the bottom inside surface of the lintel unit.

3.11 SILLS AND COPINGS

Sills and copings shall be set in a full bed of mortar with faces plumb and true.

3.12 ANCHORAGE TO CONCRETE AND STRUCTURAL STEEL

3.12.1 Anchorage to Concrete

Anchorage of masonry to the face of concrete columns, beams, or walls shall be with dovetail anchors spaced not over 400 mm on centers vertically and 600 mm on center horizontally.

3.12.2 Anchorage to Structural Steel

Masonry shall be anchored to vertical structural steel framing with adjustable steel wire anchors spaced not over 400 mm on centers vertically, and if applicable, not over 600 mm on centers horizontally.

3.13 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, mortar and grout daubs or splashings shall be completely removed from masonry-unit surfaces that will be exposed or painted. Before completion of the work, defects in joints of masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Immediately after grout work is completed, scum and stains which have percolated through the masonry work shall be removed using a high pressure stream of water and a stiff bristled brush. Masonry surfaces shall not be cleaned, other than removing excess surface mortar, until mortar in joints has hardened. Masonry surfaces shall be left clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

3.13.1 Concrete Masonry Unit and Concrete Brick Surfaces

Exposed concrete masonry unit and concrete brick surfaces shall be dry-brushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

3.14 BEARING PLATES

Bearing plates for beams, joists, joist girders and similar structural members shall be set to the proper line and elevation with damp-pack bedding mortar, except where non-shrink grout is indicated. Bedding mortar and non-shrink grout shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.15 PROTECTION

Facing materials shall be protected against staining. Top of walls shall be covered with nonstaining waterproof covering or membrane when work is not in progress. Covering of the top of the unfinished walls shall continue until the wall is waterproofed with a complete roof or parapet system. Covering shall extend a minimum of 600 mm down on each side of the wall and shall be held securely in place. Before starting or resuming, top surface of masonry in place shall be cleaned of loose mortar and foreign material.

3.16 TEST REPORTS

3.16.1 Field Testing of Mortar

At least three specimens of mortar shall be taken each day. A layer of mortar 13 to 16 mm thick shall be spread on the masonry units and allowed to stand for one minute. The specimens shall then be prepared and tested for compressive strength in accordance with ASTM C 780.

3.16.2 Field Testing of Grout

Field sampling and testing of grout shall be in accordance with the applicable provisions of ASTM C 1019. A minimum of three specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of 13.8 MPa at 28 days.

3.16.3 Efflorescence Test

Brick which will be exposed to weathering shall be tested for efflorescence. Tests shall be scheduled far enough in advance of starting masonry work to permit retesting if necessary. Sampling and testing shall conform to the applicable provisions of ASTM C 67. Units meeting the definition of "effloresced" will be subject to rejection.

3.16.4 Prism Tests

At least one prism test sample shall be made for each 465 square meters of wall but not less than three such samples shall be made for any building. Three prisms shall be used in each sample. Prisms shall be tested in accordance with ACI 530.1. Seven-day tests may be used provided the relationship between the 7- and 28-day strengths of the masonry is established by the tests of the materials used. Compressive strength shall not be less than 10.3 MPa at 28 days. If the compressive strength of any prism falls below the specified value by more than 3.5 MPa, steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized. If the likelihood of low-strength masonry is confirmed and computations indicate that the load-carrying capacity may have been significantly reduced, tests of cores drilled, or prisms sawed, from the area in question may be required. In such case, three specimens shall be taken for each prism test more than 3.5 MPa below the specified value. Masonry in the area in question shall be considered structurally adequate if the average compressive strength of three specimens is equal to at least 85 percent of the specified value, and if the compressive strength of no single specimen is less than 75 percent of the specified value. Additional testing of specimens extracted from locations represented by erratic core or prism strength test results shall be permitted.

3.17 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

Special inspections and testing for seismic-resisting systems and components shall be done in accordance with IBC.

-- End of Section --

SECTION 04 43 00

STONE MASONRY AND CONCRETE PERIMETER WALL

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 A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 615/A 615M	(2008a) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 641/A 641M	(2003) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM C 1142	(1995; R 2001) Standard Specification for Extended Life Mortar for Unit Masonry
ASTM C 144	(2004) Standard Specification for Aggregate for Masonry Mortar
ASTM C 150	(2005) Standard Specification for Portland Cement
ASTM C 207	(2006) Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C 476	(2002) Standard Specification for Grout for Masonry
ASTM C 494/C 494M	(2005a) Standard Specification for Chemical Admixtures for Concrete
ASTM C 593	(1985; R 2000) Fly Ash and Other Pozzolans for Use with Lime
ASTM C 780	(2006) Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ASTM E 514	(2004) Water Penetration and Leakage Through Masonry

1.3 SYSTEM DESCRIPTION

Provide the specified and indicated perimeter wall including materials (stone, mortar, concrete, reinforcement, metal pipe or tube, angle, concertina string, barbed wire, galvanized wire, sniper screen, and accessories) installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing in accordance with this section except as modified elsewhere in this contract.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Stone Masonry; G

Drawings including plans and elevations, and details of wall reinforcement; details of reinforcing bars at corners and wall intersections; offsets; tops, bottoms, and ends of walls; and expansion joints. Bar splice locations shall be shown. Bent bars shall be identified on a bending diagram and shall be referenced and located on the drawings. The minimum scale for wall elevations shall be 1 to 50. Reinforcement bending details shall conform to the requirements of ACI SP-66.

SD-03 Product Data

Cold Weather Installation; G

Cold weather construction procedures.

SD-04 Samples

Stone;

Construct a sample stone wall laid up in mortar and pointed, for approval of the AE. Each sample shall show examples of the specified stone finishes, quality of the workmanship in preparing the stone and placing them, and pointing of the beds and joints, and shall be sufficient area to illustrate the distribution of both the coloring and the stone size. The sample wall shall contain at least one representative corner. The top shall be dressed to show how the stone will abut the cap. Upon approval of such a sample by the AE, it shall become the standard for stone masonry in the entire work. In general, the size of stone masonry sample wall shall not be less than 12 feet long and 6 feet high.

Samples of three stretcher and header type stones. Stones shall show the full range of quality, shape, color and texture. Submit sample of mortar with stone.

Anchors, Ties, and Bar Positioners;

Two of each type used.

SD-07 Certificates

Anchors, Ties, and Bar Positioners
Expansion-Joint Materials
Reinforcing Steel Bars and Rods
Admixtures for Masonry Mortar
Admixtures for Grout

Certificates of compliance stating that the materials meet the specified requirements.

1.5 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered, handled, stored, and protected 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.

1.5.1 Stone

Cover and protect stone and cementitious materials from precipitation. Conform to all handling and storage requirements of ASTM C 90.

1.5.2 Reinforcement, Anchors, and Ties

Steel reinforcing bars, coated anchors, ties shall be stored above the ground. Steel reinforcing bars and uncoated ties shall be free of loose mill scale and rust.

1.5.3 Cementitious Materials, Sand and Aggregates

Cementitious and other packaged materials shall be delivered in unopened containers, plainly marked and labeled with manufacturers' names and brands. Cementitious material shall be stored in dry, weathertight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Sand and aggregates shall be stored in a manner to prevent contamination or segregation.

1.6 STONE MASONRY

1.6.1 Special Inspection

A qualified masonry inspector approved by the Contracting Officer shall perform inspection of the stone masonry work. Minimum qualifications for the masonry inspector shall be 5 years of stone masonry inspection experience or acceptance by a State, municipality, or other governmental body having a program of examining and certifying inspectors for reinforced masonry construction. The stone masonry inspector shall be present during sampling and placing of stone, placement of reinforcement (including placement of bars in footings and walls), (as applicable) inspection of

grout space, immediately prior to grouting, and during grouting operations. The stone masonry inspector shall assure Contractor compliance with the drawings and specifications. The masonry inspector shall keep a complete record of all inspections and shall submit daily written reports to the Quality Control Supervisory Representative reporting the quality of masonry construction.

1.7 QUALITY ASSURANCE

1.7.1 Appearance

Stone shall be from the same quarry or area.

1.7.2 Bracing and Scaffolding

Provide bracing and scaffolding necessary for stone masonry and concrete core wall work. Design bracing to resist wind pressure as required by applicable code.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

The source of materials which will affect the appearance of the finished work shall not be changed after the work has started except with Contracting Officer's approval.

2.2 CEMENT CONCRETE

Cement concrete shall conform to Section 03 30 00, CAST-IN-PLACE CONCRETE.

2.3 STONE

Stone for stone masonry walls shall consist of sound durable blasted or field stone free from seams, cracks and other structural defects and of an approved and satisfactory quality and shape.

The stone shall consist of angular blasted or field stones having straight edges without re-entrant angles. The faces shall be flat but not necessarily rectangular in shape.

Individual stone shall have, when set in the wall, no face dimension less than 200 millimeters. Stretchers shall have a depth in the wall at least 1 1/2 times the rise, and a length on the face at least twice the rise. Headers shall have a length on the face at least equal to the rise. Headers shall hold in the heart of the wall the same size as on the face and shall extend at least 300 millimeters more than the stretchers into the backing.

2.4 MASONRY MORTAR

Mortar Type S shall conform to the proportion specification of ASTM C 270 except Type S cement-lime mortar proportions shall be 1 part cement, 1/2 part lime and 4-1/2 parts aggregate.

2.4.1 Admixtures for Masonry Mortar

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494/C 494M, Type C. Use a water repellent mortar additive following the manufacturer's instructions.

2.4.2 Hydrated Lime and Alternates

Hydrated lime shall conform to ASTM C 207, Type S. Lime alternates which have a current ICBO, ICBO UBC, Evaluation Report number whose findings state it may be used as an alternate to lime for Type S mortar will be deemed acceptable provided the user follows the manufacturer's proportions and mixing instructions as set forth in ICBO report.

2.4.3 Cement

Portland cement shall conform to ASTM C 150, Type I. Containers shall bear complete instructions for proportioning and mixing to obtain the required types of mortar. Incorporate to the maximum extent, without conflicting with other requirements of this section, up to 40 percent fly ash, up to 70 percent slag, up to 10 percent cenospheres, and up to 10 percent silica fume. Additives shall conform to requirements in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.4.4 Sand and Water

Sand shall conform to ASTM C 144. Water shall be clean, potable, and free from substances which could adversely affect the mortar.

2.5 GROUT AND READY-MIXED GROUT

Grout shall conform to ASTM C 476, fine or coarse. Cement used in grout shall have a low alkali content. Grout slump shall be between 200 and 250 mm. Minimum grout strength shall be 14 MPa in 28 days, as tested by ASTM C 1019. Grout shall be used subject to the limitations of Table III. Proportions shall not be changed and materials with different physical or chemical characteristics shall not be used in grout for the work unless additional evidence is furnished that the grout meets the specified requirements. Ready-Mixed grout shall conform to ASTM C 94/C 94M.

2.5.1 Admixtures for Grout

In cold weather, a non-chloride based accelerating admixture may be used subject to approval; accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494/C 494M, Type C. In general, air-entrainment, anti-freeze or chloride admixtures shall not be used except as approved by the Contracting Officer.

2.6 BAR POSITIONERS

Bar positioners, used to prevent displacement of reinforcing bars during the course of construction, shall be factory fabricated from 9 gauge steel wire or equivalent, and coated with a hot-dip galvanized finish.

2.7 REINFORCING STEEL BARS, RODS AND TIES

Reinforcing steel bars, rods and ties shall conform to ASTM A 615/A 615M, Grade 60. Steel tie wire minimum 9 gage steel wire or equivalent with hot tip galvanized finish meeting ASTM A82-97A.

2.8 EXPANSION-JOINT MATERIALS

Sealant shall be adequate to accommodate joint compression equal to 50 percent of the width of the joint. Compressible filler shall comply to ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness shown; formulated from neoprene, urethane or PVC. Sealant shall be penetrating with a maximum volatile organic compound (VOC) content of 600 grams/liter.

2.9 CONCERTINA STRING AND BARBED WIRE SUPPORTING ARMS

Supporting arms for barbed wire shall be steel, complete with provisions for anchorage to posts and for attaching the concertina string and 3 rows of barbed wire to each arm. Supporting arms may either be attached to posts or integral with the post top weather cap.

Contractor shall provide a double V of two 45-degree arms for six strands of wire, one set for each post where barbed wire is indicated.

2.10 BARBED WIRE

Wire shall conform to ASTM A 116, ASTM A 121, ASTM A 390, ASTM A 702 and ASTM F 626, two-strand, 2.6 millimeter wire with 2.0 millimeter 4-point round barbs spaced 125 millimeter on center.

2.11 CONCERTINA STRING AND BARBED TAPE

Reinforced barbed tape, single coil, for fence toppings shall be fabricated from 430 series stainless steel with a hardness range of Rockwell (30N) 37-45 conforming to the requirements of ASTM A 176. The stainless steel strip shall be 0.6 mm thick by 25 mm wide before fabrication. Each barb shall be a minimum of 30.5 mm in length, in groups of 4, spaced on 102 mm centers. The stainless steel core wire shall have a 2.5 mm diameter with a minimum tensile strength of 9.68 MPa and shall be in accordance with ASTM A 478. Sixteen gauge stainless steel twistable wire ties shall be used for attaching the barbed tape to the barbed wire.

PART 3 EXECUTION

3.1 CEMENT CONCRETE

Concrete and reinforcement work for the footing, concrete core wall and cap shall be in accordance with the requirements of Section 03 30 00.00 40, CAST-IN-PLACE CONCRETE.

3.2 PREPARATION

Prior to start of work, stone masonry inspector shall verify the applicable conditions as set forth in ACI 530.1, inspection. The Contracting Officer will serve as inspector or will select a masonry inspector.

3.2.1 Hot Weather Installation

The following precautions shall be taken if masonry is erected when the ambient air temperature is more than 37 degrees C in the shade and the relative humidity is less than 50 percent or the ambient air temperature exceeds 32 degrees C and the wind velocity is more than 13 km/h. All stone masonry materials shall be shaded from direct sunlight; mortar beds shall be spread no more than 1.2 m ahead of masonry; stone shall be set within one minute of spreading mortar; and after erection, masonry shall be protected from direct exposure to wind and sun for 48 hours.

3.2.2 Cold Weather Installation

Before erecting stone masonry when ambient temperature or mean daily air temperature falls below 4 degrees C or temperature of stone is below 4 degrees C, a written statement of proposed cold weather construction procedures shall be submitted for approval. The following precautions shall be taken during all cold weather erection. Conform to ACI 530.1 for hot and cold weather masonry erection.

3.2.2.1 Protection

Ice or snow formed on the masonry bed shall be thawed by the application of heat. Heat shall be applied carefully until the top surface of the masonry is dry to the touch. Sections of masonry deemed frozen and damaged shall be removed before continuing construction of those sections.

a. Air Temperature 4 to 0 degrees C. Sand or mixing water shall be heated to produce mortar temperatures between 4 and 49 degrees C

b. Air Temperature 0 to minus 4 degrees C. Sand and mixing water shall be heated to produce mortar temperatures between 4 and 49 degrees C. Temperature of mortar on boards shall be maintained above freezing.

c. Air Temperature minus 4 to minus 7 degrees C. Sand and mixing water shall be heated to provide mortar temperatures between 4 and 49 degrees C. Temperature of mortar on boards shall be maintained above freezing. Sources of heat shall be used on both sides of walls under construction. Windbreaks shall be employed when wind is in excess of 24 km/hour.

d. Air Temperature minus 7 degrees C and below. Sand and mixing water shall be heated to provide mortar temperatures between 4 and 49 degrees C. Enclosure and auxiliary heat shall be provided to maintain air temperature above 0 degrees C. Temperature of units when laid shall not be less than minus 7 degrees C.

3.2.2.2 Completed Stone Masonry and Stone Masonry Not Being Worked On

a. Mean daily air temperature 4 to 0 degrees C. Masonry shall be protected from rain or snow for 24 hours by covering with weather-resistive membrane.

b. Mean daily air temperature 0 to minus 4 degrees C. Masonry shall be completely covered with weather-resistant membrane for 24 hours.

c. Mean Daily Air Temperature minus 4 to minus 7 degrees C. Masonry shall be completely covered with insulating blankets or equally protected for 24 hours.

d. Mean Daily Temperature minus 7 degrees C and Below. Masonry temperature shall be maintained above 0 degrees C for 24 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps, or other approved methods.

3.2.3 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.

3.2.4 Loads

Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after stone masonry is constructed. Provide temporary bracing as required.

3.2.5 Surfaces

Concrete footer on which stone masonry is to be placed shall be cleaned of laitance, dust, dirt, oil, organic matter, or other foreign materials and shall be slightly roughened to provide a surface texture with a depth of at least 3 mm. Sandblasting shall be used, if necessary, to remove laitance from pores and to expose the aggregate.

3.3 SHAPING STONES

Selected stone, roughly shaped to provide suitable faces, shall be used at all angles and ends of walls. All shaping of stone shall be done before the stone is laid in the wall. If a stone is loosened after the mortar has set, it shall be removed, the mortar cleaned off and the stone relaid in fresh mortar.

3.4 LAYING STONE

The stone shall be laid in two 200 mm wythes separated by 200 mm core concrete and the face pattern shall be of uniform appearance throughout. The stones shall decrease in size from bottom to top of wall. The stones shall be laid on horizontal beds parallel to the natural bed of the stone. The stone wythes shall be interconnected using wire tie connections at maximum 450 mm spacing in both directions. Vertical joints shall be broken by at least 150 millimeters and no vertical joint shall be located directly above or below a header. Each stone to be set in mortar shall be cleaned and thoroughly wetted before being set. They shall be set on full beds of mortar, and mortar joints shall be full and the stone settled in place before the mortar has set. The wall shall be compactly laid having all interior joints completely filled with suitable stones or spalls thoroughly bedded in mortar.

3.4.1 Placing Concrete Core

Place concrete core between stone masonry wythes in uniform lifts not to exceed 600 mm after stone masonry construction has cured minimum 72 hours.

3.4.2 Forms and Shores

Provide bracing and scaffolding as required. Design bracing to resist wind pressure as required by applicable codes. Forms and shores shall be sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Supporting forms and shores shall not be removed in less than 10 days.

3.4.3 Vertical Reinforcement

Place reinforcement in accordance with Section 03 30 00.00 40.

3.4.4 Tolerances

Stone masonry shall be laid plumb, true to line, with courses level. Bond pattern shall be kept plumb throughout. Corners shall be square unless noted otherwise. Masonry shall be laid within the following tolerances (plus or minus unless otherwise noted):

TABLE II

TOLERANCES

Variation from the plumb in the lines and surfaces of walls and arises	
In adjacent stone	3 mm
In 3 m	6 mm
In 6 m	10 mm
In 12 m or more	13 mm
Variations from the plumb for external corners, expansion joints, and other conspicuous lines	
In 6 m	6 mm
In 12 m or more	13 mm
Variations from the level for exposed caps and other conspicuous lines	
In 6 m	6 mm
In 12 m or more	13 mm
Variation from level for bed joints and top surfaces of stone wall	
In 3 m	6 mm
In 12 m or more	13 mm
Variations from horizontal lines	

In 3 m	6 mm
In 6 m	10 mm
In 12 m or more	13 mm

Variations in thickness of walls

Minus	6 mm
Plus	13 mm

3.4.5 Cutting and Fitting

Cutting and fitting, including that required to accommodate the work of others, shall be done by stone masons using power stone masonry saws. Stone may be wet or dry cut. Wet cut stone, before being placed in the work, shall be dried to the same surface-dry appearance as uncut stone being laid in the wall. Cut edges shall be clean, true and sharp.

3.4.6 Jointing

Joints shall be tooled when the mortar is thumbprint hard. Horizontal joints shall be tooled last. Joints shall be brushed to remove all loose and excess mortar. Mortar joints shall be finished as follows:

3.4.6.1 Tooled Joints

As directed, joints in exposed exterior stone masonry surfaces shall be tooled slightly concave. Joints shall be tooled with a jointer slightly larger than the joint width so that complete contact is made along the edges of the unit. Tooling shall be performed so that the mortar is compressed and the joint surface is sealed. Jointer of sufficient length shall be used to obtain a straight and true mortar joint.

3.4.7 Joint Widths

Joint widths shall be as follows:

3.4.7.1 Stone Masonry

Stone shall have minimum 10 mm joints.

3.4.8 Embedded Items

Reinforcement and pipe sleeves or metal tubes and other items required to be built-in shall be embedded as the concrete work progresses. Reinforcement and pipe sleeves for metal tubes shall be fully embedded in the concrete. Pipe sleeves or metal tubes shall be fully embedded in concrete cap to accept the vertical reinforcement and support (V) arms.

3.4.9 Unfinished Work

Unfinished work shall be stepped back for joining with new work. Toothing may be resorted to only when specifically approved. Loose mortar shall be removed and the exposed joints shall be thoroughly cleaned before laying new work.

3.4.10 Stone Masonry Wall Intersections

Each wythe shall be masonry bonded at corners and elsewhere. Stone masonry walls shall be tied together at corners and intersections with proper corner construction.

3.5 MORTAR

Mortar shall be mixed in a mechanically operated mortar mixer for at least 3 minutes, but not more than 5 minutes. Measurement of ingredients for mortar shall be by volume. Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units. Mortar that has stiffened because of loss of water through evaporation shall be retempered by adding water to restore the proper consistency and workability. Mortar that has reached its initial set or that has not been used within 2.5 hours after mixing shall be discarded.

3.6 REINFORCING STEEL

Reinforcement shall be cleaned of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond prior to placing grout. Bars with kinks or bends not shown on the drawings shall not be used. Reinforcement shall be placed as part of foundation work as shown and prior to stone mortar work. Vertical wall reinforcement shall extend to within 50 mm of top of cap and grouted inside embedded pipe sleeves or metal tubes as shown.

3.6.1 Positioning Bars

Vertical bars shall be accurately placed within the wall at the position and spacing indicated on the drawings. A minimum clearance of 13 mm shall be maintained between the bars and stone. Vertical reinforcing may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement. Ties shall be in contact with the vertical reinforcement and shall not be placed in horizontal bed joints.

3.6.2 Splices

Bars shall be lapped a minimum of 48 diameters of the reinforcement. Welded or mechanical connections shall develop at least 125 percent of the specified yield strength of the reinforcement.

3.7 PLACING GROUT

Wall space containing reinforcing bars may be filled with grout for full height of reinforcement in wall. Grout not in place within 1-1/2 hours after water is first added to the batch shall be discarded. Sufficient time shall be allowed between grout lifts to preclude displacement or cracking of stone.

3.8 STONE WALL EXPANSION JOINTS

Stone wall expansion joints shall be provided and constructed as shown on the drawings. Compressible filler and sealant shall fill and seal joints. Joints shall be kept free of mortar and other debris.

3.9 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, mortar and grout daubs or splashings shall be completely removed from masonry-unit surfaces that will be exposed. Before completion of the work, defects in joints of masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Immediately after any grout work is completed, scum and stains which have percolated through the masonry work shall be removed using a high pressure stream of water and a stiff bristled brush. Stone masonry surfaces shall not be cleaned, other than removing excess surface mortar, until mortar in joints has hardened. Stone masonry surfaces shall be left clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

3.9.1 Stone Masonry Surfaces

Exposed stone masonry surfaces shall be dry-brushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

3.10 PROTECTION

Facing materials shall be protected against staining. Top of walls shall be covered with nonstaining waterproof covering or membrane when work is not in progress. Covering of the top of the unfinished walls shall continue until the wall is waterproofed with a complete cap. Covering shall extend a minimum of 600 mm down on each side of the wall and shall be held securely in place. Before starting or resuming, top surface of stone masonry in place shall be cleaned of loose mortar and foreign material.

3.11 BARBED WIRE SUPPORTING ARMS, CONCERTINA STRING AND BARBED WIRE

3.11.1 Installation

Barbed wire supporting arms, concertina string and barbed wire shall be installed as indicated and as recommended by the manufacturer. Supporting V shaped arms shall be anchored to the posts. Concertina string and barbed wire shall be fixed and pulled as shown and attached to the arms with clips or other means that will prevent easy removal.

3.12 TEST REPORTS

3.12.1 Field Testing of Mortar

At least three specimens of mortar shall be taken each day. A layer of mortar 13 to 16 mm thick shall be spread on the stone and allowed to stand for one minute. The specimens shall then be prepared and tested for compressive strength in accordance with ASTM C 780.

3.12.2 Field Testing of Grout

Field sampling and testing of grout shall be in accordance with the applicable provisions of ASTM C 1019. A minimum of three specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of 13.8 MPa at 28 days.

3.12.3 Efflorescence Test

Stone shall be tested for efflorescence. Tests shall be scheduled far enough in advance of starting masonry work to permit retesting if necessary. Sampling and testing shall conform to the applicable provisions of ASTM C 67. Units meeting the definition of "effloresced" will be subject to rejection.

-- End of Section --

SECTION 04 57 13

MASONRY WOOD STOVE

PART 1 GENERAL

1.1 REFERENCES

None.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and 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 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Wood Stoves: G

Detail drawings for the complete wood burning stoves including concrete forms, exhaust flue, fire brick installation, dimensions and any other features of work. Detail drawings shall indicate dimensions for the cast iron stove top, ash removal tray, fire wood feed door, adjustable air vent and steel grating. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

PART 2 PRODUCTS

2.1 MASONRY WOOD STOVE

2.1.1 Stove

Construction as follows:
- Concrete housekeeping pad
- Steel support angle and channel
- Firebrick
- Steel flue box
- Cast iron stove top
- Cast iron door with hinge and latch
- Cast iron door with hinge and latch and adjustable vent
- Cast iron open grate

2.1.2 Materials

Except as modified herein, provide materials for wood stove as per this Section and Sections 04 20 00 (firebrick/refractory brick, CMU), 03 30 00 (CIP concrete), 05 12 00 (support angles and channels), 05 50 00 (cast iron stove top, doors and grate and steel flue box, steel ash tray and vent), and 09 66 16 (terrazzo tile). Provide quantities, physical dimensions, colors, and characteristics as specified and indicated.

PART 3 EXECUTION

3.1 INSTALLATION

Construct wood stove encasement and chimney (Sections 04 20 00 Masonry, 05 50 00 Metal: Miscellaneous and Fabrications and 09 66 16 Terrazzo Tile) on concrete housekeeping pad (Section 03 30 00 Cast-in-place-Concrete) as per specifications and AED provided design. Field verify actual stove dimensions prior to fabrication of cast iron stove top, grate and doors.

3.2 FIELD QUALITY CONTROL

Conduct inspection and testing in the presence of the Contracting Officer to certify compliance with specifications and proper operation. Affect repairs and retest until no deficiencies exist.

3.2.1 Field Inspection

Before and after installation, inspect wood stove and ancillary work for compliance with specified requirements.

3.2.2 Operation Tests

Upon completion but before final acceptance, perform wood stove operation tests to determine that components, including adjustable components, operate properly and in accordance with specified requirements.

-- End of Section --

SECTION 05 12 00

STRUCTURAL STEEL

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 303	(2005) Code of Standard Practice for Steel Buildings and Bridges
AISC 316	(2005) Manual of Steel Construction
AISC 317	(1992; Reprint 1999) ASD Manual of Steel Construction, Vol II: Connections
AISC 325	(2005e13) Manual of Steel Construction
AISC 326	(2002) Detailing for Steel Construction
AISC 341	(2005; Supp 1) Seismic Provisions for Structural Steel Buildings
AISC 348	(2000) Structural Joints Using ASTM A325 or A490 Bolts
AISC 350	(2005) Load and Resistance Factor Design (LRFD) Specification for Structural Steel Buildings
AISC 360	(2005) Specification for Structural Steel Buildings, with Commentary
AISC 810	(1997) Erection Bracing of Low-Rise Structural Steel Frames/Fisher and West
AISC FCD	(1995a) Quality Certification Program Description

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(1998) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2006; Errata 2006) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 108	(2003e1) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A 143/A 143M	(2003) Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 307	(2004e1) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 36/A 36M	(2005) Standard Specification for Carbon Structural Steel
ASTM A 500	(2003a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 514/A 514M	(2005) Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A 53/A 53M	(2006a) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 563	(2004a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 563M	(2006) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A 6/A 6M	(2006a) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A 618	(2004) Standard Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing
ASTM A 668/A 668M	(2004) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A 992/A 992M	(2006a) Standard Specification for Structural Steel Shapes
ASTM C 1107/C 1107M	(2007) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM F 844	(2004) Washers, Steel, Plain (Flat), Unhardened for General Use

ASTM F 959	(2004) Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners
ASTM F 959M	(2002) Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners (Metric)

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2000; E 2004) Shop, Field, and Maintenance Painting
SSPC Paint 25	(1997; 2004e1) Paint Specification No. 25 Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel Type I and Type II
SSPC SP 3	(2004e1) Power Tool Cleaning
SSPC SP 6	(2000; E 2004) Commercial Blast Cleaning

1.2 SYSTEM DESCRIPTION

Provide the structural steel system, including shop primer, complete and ready for use. Structural steel systems including materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing shall be provided in accordance with AISC 316 and AISC 317 except as modified in this contract.

1.3 MODIFICATIONS TO REFERENCES

Conform to AISC 316, AISC 317, AISC 360, AISC 303, and AISC 348, except as modified in this section.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Erection Plan, including description of temporary supports; G

Fabrication drawings including description of connections; G

SD-03 Product Data

Shop primer

Welding electrodes and rods; G

Non-Shrink Grout

Include test report for Class B primer.

SD-06 Test Reports

Class B coating

Bolts, nuts, and washers

Supply the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners.

SD-07 Certificates

Steel

Bolts, nuts, and washers

Galvanizing

AISC Quality Certification

Welding procedures and qualifications; G

1.5 AISC QUALITY CERTIFICATION

Work shall be fabricated in an AISC certified Category STD fabrication plant.

1.6 QUALITY ASSURANCE

1.6.1 Drawing Requirements

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 326, AISC 316 and AISC 317. Fabrication drawings shall not be reproductions of contract drawings. Sign and seal fabrication drawings by a professional engineer registered in the State where the project is located. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details with structural analysis as to compliance to specified design loads, if/as directed, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols. Shoring and temporary bracing shall be designed and sealed by a registered professional engineer and submitted for record purposes, with calculations, as part of the drawings. Member substitutions of details shown on the contract drawings shall be clearly highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

1.6.2 Certifications

1.6.2.1 Erection Plan

Submit for record purposes. Indicate the sequence of erection, temporary shoring and bracing, and a detailed sequence of welding, including each welding procedure required.

1.6.2.2 Welding Procedures and Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. If the qualification date of the welding operator is more than one-year old, the welding operator's qualification certificate shall be accompanied by a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months. Conform to all requirements specified in AWS D1.1/D1.1M.

PART 2 PRODUCTS

2.1 STEEL

2.1.1 Structural Steel

ASTM A 36/A 36M.

2.1.2 Structural Shapes for Use in Building Framing
Wide flange shapes, ASTM A 992/A 992M.

2.1.3 Structural Steel Tubing

ASTM A 500, Grade B; ASTM A 501.

2.1.4 Steel Pipe

ASTM A 53/A 53M, Type E or S, Grade B, weight class STD (Standard) .

2.2 BOLTS, NUTS, AND WASHERS

Provide the following unless indicated otherwise.

2.2.1 Structural Steel, Steel Pipe

2.2.1.1 Bolts

ASTM A 325, Type 1. The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

2.2.1.2 Nuts

ASTM A 563M, Grade A, heavy hex style, except nuts under M36 may be provided in hex style.

2.2.1.3 Washers

ASTM F 436 washers for ASTM A 325 bolts.

2.2.2 Foundation Anchorage

2.2.2.1 Anchor Bolts

ASTM A 307.

2.2.2.2 Anchor Nuts

ASTM A 563, Grade A, hex style.

2.2.2.3 Anchor Washers

ASTM F 844.

2.3 STRUCTURAL STEEL ACCESSORIES

2.3.1 Welding Electrodes and Rods

AWS D1.1/D1.1M.

2.3.2 Non-Shrink Grout

ASTM C 1107/C 1107M, with no ASTM C 827 shrinkage.

2.4 SHOP PRIMER

SSPC Paint 25, (alkyd primer). Primer shall conform to Federal, State, and local VOC regulations. If flash rusting occurs, re-clean the surface prior to application of primer.

2.5 GALVANIZING

ASTM A 123/A 123M or ASTM A 153/A 153M, as indicated and applicable, unless specified otherwise galvanize after fabrication where practicable.

2.6 FABRICATION

2.6.1 Markings

Prior to erection, members shall be identified by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections shall be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded. Do not locate match markings in areas that will decrease member strength or cause stress concentrations.

2.6.2 Shop Primer

Shop prime structural steel, except as modified herein, in accordance with SSPC PA 1. Do not prime steel surfaces embedded in concrete, or surfaces within 13 mm of the toe of the welds prior to welding (except surfaces on which metal decking is to be welded). Prior to assembly, prime surfaces which will be concealed or inaccessible after assembly. Do not apply primer in foggy or rainy weather; when the ambient temperature is below 7 degrees C or over 35 degrees C; or when the primer may be exposed to temperatures below 4 degrees C within 48 hours after application, unless approved otherwise by the Contracting Officer.

2.6.2.1 Cleaning

SSPC SP 6, except steel exposed in spaces above ceilings, attic spaces, furred spaces, and chases that will be hidden to view in finished

construction may be cleaned to SSPC SP 3 when recommended by the shop primer manufacturer. Maintain steel surfaces free from rust, dirt, oil, grease, and other contaminants through final assembly.

2.6.2.2 Primer

Apply primer to a minimum dry film thickness of 0.05 mm except provide the Class B coating for slip critical joints in accordance with the coating manufacturer's recommendations. Repair damaged primed surfaces with an additional coat of primer.

2.7 DRAINAGE HOLES

Adequate drainage holes shall be drilled to eliminate water traps. Hole diameter shall be 13 mm and location shall be indicated on the detail drawings. Hole size and location shall not affect the structural integrity.

PART 3 EXECUTION

3.1 FABRICATION

Fabrication shall be in accordance with the applicable provisions of AISC 316. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under the AISC FCD for Category STD structural steelwork.

Compression joints depending on contact bearing shall have a surface roughness not in excess of 13 micrometer as determined by ASME B46.1, and ends shall be square within the tolerances for milled ends specified in ASTM A 6/A 6M.

Shop splices of members between field splices will be permitted only where indicated on the Contract Drawings. Splices not indicated require the approval of the Contracting Officer.

3.2 ERECTION

Erection of structural steel shall be in accordance with the applicable provisions of AISC 316 or endorsement F of AISC FCD. Erection plan shall be reviewed, stamped and sealed by a licensed structural engineer.
Provide for drainage in structural steel. After final positioning of steel members, provide full bearing under base plates and bearing plates using nonshrink grout. Place nonshrink grout in accordance with the manufacturer's instructions.

3.2.1 STORAGE

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

3.3 CONNECTIONS

Except as modified in this section, connections not detailed shall be designed in accordance with AISC 360. Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque wrenches.

Punch, subpunch and ream, or drill bolt holes perpendicular to the surface of the member. Holes shall not be cut or enlarged by burning. Bolts, nuts, and washers shall be clean of dirt and rust, and lubricated immediately prior to installation.

3.3.1 Common Grade Bolts

ASTM A 307 bolts shall be tightened to a "snug tight" fit. "Snug tight" is the tightness that exists when plies in a joint are in firm contact. If firm contact of joint plies cannot be obtained with a few impacts of an impact wrench, or the full effort of a man using a spud wrench, contact the Contracting Officer for further instructions.

3.3.2 High-Strength Bolts

ASTM A 325 bolts shall be fully tensioned to 70 percent of their minimum tensile strength. Provide load indicator bolts or washers in all ASTM A 325M bolted connections. Direct tension indicator tightening, shall be the only acceptable tightening methods. Bolts shall be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, bolts shall be fully tensioned, progressing from the most rigid part of a connection to the free edges.

3.4 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 Officers.

3.5 WELDING

AWS D1.1/D1.1M, except use only shielded metal arc welding and low hydrogen electrodes for ASTM A 514/A 514M steel. Do not stress relieve ASTM A 514/A 514M steel by heat treatment. Grind exposed welds smooth as indicated. Provide AWS D1.1/D1.1M qualified welders, welding operators, and tackers.

The Contractor shall develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures. Prequalified procedures may be submitted for information only; however, procedures that are not prequalified shall be submitted for approval.

3.5.1 Removal of Temporary Welds, Run-Off Plates, and Backing Strips

Remove only from finished areas.

3.6 SHOP PRIMER REPAIR

Repair shop primer in accordance with the paint manufacturer's recommendation for surfaces damaged by handling, transporting, cutting, welding, or bolting.

3.6.1 Field Priming

Field priming of steel exposed to the weather, or located in building areas without HVAC for control of relative humidity. After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat shall

be cleaned and primed with paint of the same quality as that used for the shop coat.

3.7 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required for testing, except that electric power for field tests will be furnished as set forth in Division 1. The Contracting Officer shall be notified in writing of defective welds, bolts, nuts, and washers within 7 working days of the date of weld inspection.

3.7.1 Welds

3.7.1.1 Visual Inspection

AWS D1.1/D1.1M. Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections. Welding inspectors shall visually inspect and mark welds, including fillet weld end returns.

3.7.2 Testing

The Government has the option to perform nondestructive tests on 5 percent of the installed bolts to verify compliance with pre-load bolt tension requirements. The nondestructive testing will be done in-place using an ultrasonic measuring device or any other device capable of determining in-place pre-load bolt tension. The test locations shall be selected by the Contracting Officer. If more than 10 percent of the bolts tested contain defects identified by testing, then all bolts used from the batch from which the tested bolts were taken, shall be tested. Retest new bolts after installation.

-- End of Section --

SECTION 05 40 00

COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG-973	(2002) Cold-Formed Steel Design Manual
AISI SG02-1	(2001) North American Specification for the Design of Cold-Formed Steel Structural Members

AMERICAN WELDING SOCIETY (AWS)

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

ASTM INTERNATIONAL (ASTM)

ASTM A 1008/A 1008M	(2006a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened
ASTM A 1011/A 1011M	(2006b) Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 370	(2006) Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A 653/A 653M	(2006a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 633	(1998e1) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

ASTM C 955	(2006) Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases
ASTM E 329	(2005b) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J78	(1998) Steel Self Drilling Tapping Screws

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 25	(1997; 2004e1) Paint Specification No. 25Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel Type I and Type II

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. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Framing Components; G

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

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

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

SD-03 Product Data

Steel studs,joists, tracks, bracing, bridging and accessories

SD-05 Design Data

Metal framing calculations; G

SD-07 Certificates

Load-bearing cold-formed metal framing

Mill certificates or test reports from independent testing agency, qualified in accordance with ASTM E 329, showing that the

steel sheet used in the manufacture of each cold-formed component complies with the minimum yield strengths and uncoated steel thickness specified. Test reports shall be based on the results of three coupon tests in accordance with ASTM A 370.

Welds

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

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to job site and store in adequately ventilated, dry locations. Storage area shall permit easy access for inspection and handling. If necessary to store materials outside, stack off the ground, support on a level platform, and protect from the weather as approved. Handle materials to prevent damage. Finish of the framing members shall be maintained at all times, using an approved high zinc dust content, galvanizing repair paint whenever necessary to prevent the formation of rust. Replace damaged items with new, as directed by the Contracting Officer.

1.4 LOAD-BEARING COLD-FORMED METAL FRAMING

Include top and bottom tracks as applicable and as indicated, bracing, fastenings, and other accessories necessary for complete installation. Framing members shall have the structural properties indicated. Where physical structural properties are not indicated, they shall be as necessary to withstand all imposed loads. Design framing in accordance with AISI SG-973. Non-load-bearing metal framing, furring, and ceiling suspension systems are specified in Section 09 22 00 METAL SUPPORT ASSEMBLIES.

1.5 MAXIMUM DEFLECTION

a. Exterior Studs:

Deflection Criteria	Exterior Finish
L/240 or L/360	Synthetic Plaster, Metal Panels
L/360	Cement Plaster, Wood Veneer
L/600	Brick Veneer, Stone Panels

Wall deflections shall be computed on the basis that studs withstand all lateral forces independent of any composite action from sheathing materials. Studs abutting windows or louvers shall also be designed not to exceed 6 mm maximum deflection.

b. Floor Joists:

L/360 - Live load only
L/240 - Total load

c. Roof Rafters:

L/240 - Live load only

1.6 QUALITY ASSURANCE

1.6.1 Drawing Requirements

Submit framing components to show sizes, thicknesses, layout, material designations, methods of installation, and accessories.

1.6.2 Design Data Required

Submit metal framing calculations to verify sizes, gages, and spacing of members and connections. Show methods and practices used in installation.

PART 2 PRODUCTS

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

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

2.1.1 Studs and Joists of 1.5 mm and Heavier

Galvanized steel, ASTM A 653/A 653M, SS Grade 50.

2.1.2 Studs and Joists of 1.2 mm and Lighter

Studs and Joists of 1.2 mm and Lighter, Track, and Accessories (All Gages): Galvanized steel, ASTM A 653/A 653M, SS, Grade 345 230 MPa Z180<ENG> G60</ENG>; or carbon steel, ASTM A 1008/A 1008M, Grade C, painted.

2.1.3 Sizes, Gages, Section Modulus, and Other Structural Properties

Size and gage as indicated. Steel stud deflection shall be limited to L/600 for exterior wall brick veneer construction.

2.2 MARKINGS

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

a. An ICBO number.

b. Manufacturer's identification.

c. Minimum delivered uncoated steel thickness.

d. Protective coating designator.

e. Minimum yield strength.

2.3 CONNECTIONS

Screws for steel-to-steel connections shall be self-drilling tapping in compliance with SAE J78 of the type, size, and location as shown on the drawings. Electroplated screws shall have a Type II coating in accordance with ASTM B 633. Screws, bolts, and anchors shall be hot-dipped galvanized in accordance with ASTM A 123/A 123M or ASTM A 153/A 153M as appropriate.

Screws bolts, and anchors shall be hot dipped galvanized in accordance with ASTM A 123/A 123M or ASTM A 153/A 153M as appropriate.

2.4 PAINT

Ungalvanized steel, if used, shall be thoroughly cleaned, phosphate treated, and coated with corrosion-inhibiting primer, SSPC Paint 25.

2.5 PLASTIC GROMMETS

Supply plastic grommets, recommended by stud manufacturer, to protect electrical wires. Prevent metal to metal contact for plumbing pipes.

PART 3 EXECUTION

3.1 FASTENING

Fasten framing members together by welding or by using self-drilling or self-tapping screws. Electrodes and screw connections shall be as required and indicated in the design calculations.

3.1.1 Welds

All welding shall be performed in accordance with AWS D1.3, as modified by AISI SG02-1. All welders, welding operations, and welding procedures shall be qualified according to AWS D1.3. All welds shall be cleaned and coated with rust inhibitive galvanizing paint. Do not field weld materials lighter than 1.2 mm.

3.1.2 Screws

Screws shall be of the self-drilling self-tapping type, size, and location shown on the drawings. Screw penetration through joined materials shall not be less than three exposed threads. Minimum spacings and edge distances for screws shall be as specified in AISI SG02-1. Screws covered by sheathing materials shall have low profile heads.

3.1.3 Anchors

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

3.2 INSTALLATION

3.2.1 Tracks

Provide accurately aligned runners at top and bottom of partitions. Anchor tracks as indicated in design calculations. Butt weld joints in tracks or splice with stud inserts. Fasteners shall be at least 75 mm from the edge of concrete slabs.

3.2.2 Studs

Cut studs square and set with firm bearing against webs of top and bottom tracks. Position studs vertically in tracks and space as indicated in design. Do not splice studs. Provide at least two studs at jambs of doors and other openings 600 mm wide or larger. Provide jack studs over openings, as necessary, to maintain indicated stud spacing. Provide tripled studs at

corners, positioned to receive interior and exterior finishes. Fasten studs to top and bottom tracks by welding or screwing both flanges to the tracks. Framed wall openings shall include headers and supporting components as shown on the drawings. Headers shall be installed in all openings that are larger than the stud spacing in a wall. In curtain wall construction, provide for vertical movement where studs connect to the structural frame. Provide horizontal bracing in accordance with the design calculations and AISI SG-973, consisting of, as a minimum, runner channel cut to fit between and welded to the studs or hot- or cold-rolled steel channels inserted through cutouts in web of each stud and secured to studs with welded clip angles. Bracing shall be not less than the following:

LOAD	HEIGHT	BRACING
Wind load only	Up to 3000 mm	One row at mid-height
	Over 3000 mm	Rows 1500 mm o.c. maximum
Axial load	Up to 3000 mm	Two rows at 1/3 points
	Over 3000 mm	Rows 900 mm o.c. maximum

3.2.3 Joists and Trusses

Locate each joist or truss directly above a stud. Provide doubled joists under parallel partitions wherever partition length exceeds 1/2 of joist span. Joists shall have at least 60 mm of bearing on steel, 100 mm on masonry, and shall be reinforced over bearings where required to prevent web crippling. Splice joists over bearings only. Lap and weld splices as indicated. Provide manufacturer's standard bridging which shall not be less than the following:

CLEAR SPAN	BRIDGING
Up to 4200 mm	One row near center
4200 mm to 6000 mm	Two rows at 1/3 points
6000 mm to 7800 mm	Three rows at 1/4 points
7800 mm to 10600 mm	Four rows at 1/5 points

Temporary bracing shall be provided and remain in place until work is permanently stabilized.

3.2.4 Erection Tolerances

a. Framing members which will be covered by finishes such as wallboard, plaster, or ceramic tile set in a mortar setting bed, shall be within the following limits:

(1) Layout of walls and partitions: 6 mm from intended position;

(2) Plates and runners: 6 mm in 2400 mm from a straight line;

(3) Studs: 6 mm in 2400 mm out of plumb, not cumulative; and

(4) Face of framing members: 6 mm in 2400 mm from a true plane.

b. Framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive shall be within the following limits:

(1) Layout of walls and partitions: 6 mm from intended position;

(2) Plates and runners: 3 mm in 2400 mm from a straight line;

(3) Studs: 3 mm in 2400 mm out of plumb, not cumulative; and

(4) Face of framing members: 3 mm in 2400 mm from a true plane.

-- End of Section --

SECTION 05 50 00

METAL: MISCELLANEOUS AND FABRICATIONS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 303	(2005) Code of Standard Practice for Steel Buildings and Bridges
AISC 350	(2005) Load and Resistance Factor Design (LRFD)Specification for Structural Steel Buildings
AISC 360	(2005) Specification for Structural Steel Buildings, with Commentary

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2005; Supp 1) Minimum Design Loads for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2006; Errata 2006) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B18.2.2	(1987; R 2005) Square and Hex Nuts (Inch Series)
ASME B18.21.1	(1999; R 2005) Lock Washers (Inch Series)
ASME B18.21.2M	(1999; R 2005) Lock Washers (Metric Series)
ASME B18.22.1	(1965; R 2003) Plain Washers
ASME B18.22M	(1981; R 2005) Metric Plain Washers
ASME B18.52.1	(1996; R 2005) Square and Hex Bolts and Screws Inch Series
ASME B18.6.2	(1998; R 2005) Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws: Inch Series
ASME B18.6.3	(2003) Machine Screws and Machine Screw Nuts

ASTM INTERNATIONAL (ASTM)

ASTM A 240/A 240M	(2009a) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A 278/A 278M	(2001; R 2006) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 degrees F (350 degrees C)
ASTM A 307	(2004e1) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 319	(1971; R 2006) Standard Specification for Gray Iron Castings for Elevated Temperatures for Non-Pressure Containing Parts
ASTM A 36/A 36M	(2005) Standard Specification for Carbon Structural Steel
ASTM A 48/A 48M	(2003; R 2008) Standard Specification for Gray Iron Castings
ASTM A 500	(2003a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 53/A 53M	(2006a) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 666	(2003) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar

MASTER PAINTERS INSTITUTE (MPI)

MPI 79	(2004) Alkyd Anti-Corrosive Metal Primer

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 10	(2006; Errata 2006) Standard for Portable Fire Extinguishers
NFPA 101	(2006) Life Safety Code, 2006 Edition
NFPA 211	(2006) Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 3	(2004e1) Power Tool Cleaning
SSPC SP 6	(2000; E 2004) Commercial Blast Cleaning

UNDERWRITERS LABORATORIES (UL)

UL 103	(2006) Standard for Safety for Factory-Built Chimneys for Residential Type and Building Heating Appliances

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication drawings of structural steel door frames;

Access doors and panels, installation drawings;

Cover plates and frames, installation drawings;

Expansion joint covers, installation drawings;

Floor gratings and exterior stair trends, and landings installation drawings;

Handrails, installation drawings; G

Ladders, installation drawings; G

Embedded angles and plates, installation drawings;

Metal Window Sills, Installation Drawings;

Steel Corner Guards, Installation Drawings;

Stainless Steel Back Splash, Installation Drawings;

Submit fabrication drawings showing layout(s), connections to structural system, and anchoring details as specified in AISC 303.

Submit templates, erection and installation drawings indicating thickness, type, grade, class of metal, and dimensions. Show construction details, reinforcement, anchorage, and installation with relation to the building construction.

SD-03 Product Data;

Access doors and panels;

Cover plates and frames;

Control-joint covers;

Expansion joint covers;

Handrails;

Ladders;

Steel stairs;

Window sub sill;

Cast iron plate for wood stove top;

Cast iron grid plate for wood stove fire box;

Cast iron insert for wood stove;

Cast iron hinged cleanout door for wood stove;

Cast iron sliding fire box door for wood stove;

Structural steel door frames;

Window and door guards;

Roof hatch

Floor hatch

Steel corner guard

Stainless steel back splash

SD-04 Samples

Expansion joint covers

Control-joint covers

Steel corner guards

Stainless steel back splash

Samples shall be full size, taken from manufacturer's stock, and shall be complete as required for installation in the structure. Samples may be installed in the work, provided each sample is clearly identified and its location recorded.

1.3 QUALIFICATION OF WELDERS

Qualify welders in accordance with AWS D1.1/D1.1M. Use procedures, materials, and equipment of the type required for the work.

1.4 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Structural Carbon Steel

ASTM A 36/A 36M.

2.1.2 Steel Pipe

ASTM A 53/A 53M, Type E or S, Grade B.

2.1.3 Floor Plates, Patterned

Floor plate ASTM A 786/A 786M. Steel plate shall not be less than 1.9 mm.

2.1.4 Anchor Bolts

ASTM A 307. Where exposed, shall be of the same material, color, and finish as the metal to which applied.

2.1.4.1 Lag Screws and Bolts

ASME B18.52.1, type and grade best suited for the purpose.

2.1.4.2 Toggle Bolts

ASME B18.52.1.

2.1.4.3 Bolts, Nuts, Studs and Rivets

ASME B18.2.2 and ASTM A 687 or ASTM A 307.

2.1.4.4 Powder Driven Fasteners

Follow safety provisions of ASSE A10.3.

2.1.4.5 Screws

ASME B18.52.1, ASME B18.6.2, and ASME B18.6.3.

2.1.4.6 Washers

Provide plain washers to conform toASME B18.22M. Provide beveled washers for American Standard beams and channels, square or rectangular, tapered in thickness, and smooth. Provide lock washers to conform to ASME B18.21.2M.

2.1.5 Stainless Steel Back Splash

ASTM A240 A or ASTM A666 (Type 304)

2.1.6 Cast Iron

ASTM A 319, Class III.

2.2 FABRICATION FINISHES

2.2.1 Galvanizing

Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing: ASTM A 123/A 123M, ASTM A 153/A 153M, ASTM A 653/A 653M or ASTM A 924/A 924M, Z275, as applicable.

2.2.2 Galvanize

Anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

2.2.3 Repair of Zinc-Coated Surfaces

Repair damaged surfaces with galvanizing repair method and paint conforming to ASTM A 780 or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Contracting Officer. Clean areas to be repaired and remove slag from welds. Heat surfaces to which stick or paste material is applied, with a torch to a temperature sufficient to melt the metallics in stick or paste; spread molten material uniformly over surfaces to be coated and wipe off excess material.

2.2.4 Shop Cleaning and Painting

2.2.4.1 Surface Preparation

Blast clean surfaces in accordance with SSPC SP 6. Surfaces that will be exposed in spaces above ceiling or in attic spaces, crawl spaces, furred spaces, and chases may be cleaned in accordance with SSPC SP 3 in lieu of being blast cleaned. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Steel to be embedded in concrete shall be free of dirt and grease. Do not paint or galvanize bearing surfaces, including contact surfaces within slip critical joints, but coat with rust preventative applied in the shop.

2.2.4.2 Pretreatment, Priming and Painting

Apply pretreatment, primer, and paint in accordance with manufacturer's printed instructions. On surfaces concealed in the finished construction or not accessible for finish painting, apply an additional prime coat to a minimum dry film thickness of 0.03 mm. Tint additional prime coat with a small amount of tinting pigment.

2.3 ACCESS DOORS AND PANELS

Provide flush type access doors and panels unless otherwise indicated. Fabricate frames for access doors of steel not lighter than 1.9 mm with welded joints and anchorage for securing into construction. Provide access doors with a minimum of 600 by 600 mm and of not lighter than 1.9 mm steel, with stiffened edges and welded attachments. Provide access doors hinged to frame and with a flush-face, turn-screw-operated latch. Provide exposed metal surfaces with a shop applied prime coat.

2.4 CONTROL-JOINT COVERS

Provide control-joint covers to be located on wall surfaces of concrete, masonry and tile work. Provide protective coating on the surface in contact with concrete, masonry or tile.

2.5 GUARD POSTS (BOLLARDS/PIPE GUARDS)

Provide extra strong weight steel pipe as specified in ASTM A 53/A 53M. Anchor posts in concrete as indicated and fill solidly with concrete with minimum compressive strength of 21 MPa.

2.6 LADDERS

Fabricate vertical ladders conforming to Section 7 of 29 CFR 1910.27. Use 65 by 10 mm steel flats for stringers and 20 mm diameter steel rods for rungs. Rungs to be not less than 400 mm wide, spaced one foot apart, plug welded or shouldered and headed into stringers. Install ladders so that the distance from the rungs to the finished wall surface will not be less than 175 mm. Provide heavy clip angles riveted or bolted to the stringer and drilled for not less than two 12 mm diameter expansion bolts as indicated. Provide intermediate clip angles not over 1200 mm on centers.

2.7 MISCELLANEOUS PLATES AND SHAPES

Provide for items that do not form a part of the structural steel framework, such as lintels, sill angles, miscellaneous mountings and frames. Provide lintels fabricated from structural steel shapes over openings in masonry walls and partitions as required to support wall loads over openings. Provide with connections and fasteners. Construct to have at least 200 mm bearing on masonry at each end.

Provide angles and plates, ASTM A 36/A 36M, for embedment as indicated. Galvanize embedded items exposed to the elements according to ASTM A 123/A 123M.

2.8 CHIMNEYS, VENTS, AND SMOKESTACKS

Chimneys and vents shall be designed and constructed in accordance with NFPA 211 and UL 103 HT (stainless steel vent). Chimney connectors shall be formed of not lighter than 1.01 mm (20 gauge) galvanized steel. Stacks shall be designed and constructed to withstand a wind velocity as indicated on the structural drawings. Seams and joints shall be welded, except that an angle flange shall be provided for connection to equipment, and stack support.

2.9 CLEANOUT DOORS

Cleanout doors shall be cast iron, shall be provided with frames, and unless otherwise indicated, shall be sized to match flues. The frames shall have a continuous flange and anchors for securing into masonry. The doors shall be smokeproof, hinged, and shall have fastening devices to hold the door closed.

2.10 STOVE PLATES , GRATES AND DOORS

Stove plates and doors shall be cast iron and configured for wood burning stove. The doors shall have fastening devices to hold the doors closed.

2.11 WINDOW SUB-SILL

Window sub-sill shall be of galvanized steel alloy of 1 mm (20 gage) and design indicated. Not less than two anchors per window section shall be provided for securing into mortar joints of masonry sill course. The metal window sills shall have a turn down of 50 mm over the exterior masonry and stucco. Metal sills shall extend from side to side of the masonry opening in a single piece. Sills for banks of windows shall have standard mill finish with a protective coating, prior to shipment, of two coats of a clear, colorless, methacrylate lacquer applied to all surfaces of the sills.

2.12 ALUMINUM SILL

Aluminum sill enclosures shall be extruded at 20 gage and dimensions and profile as required and indicated.

2.13 STAINLESS STEEL BACK SPLASH

Stainless steel back splash at propane stove shall be 18' gage with #4 brushed finish, and dimensions and profile as required and indicated.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated, according to manufacturer's instructions. The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and shall harmonize with the material to which fastenings are applied. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Poor matching of holes for fasteners shall be cause for rejection. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Joints exposed to the weather shall be formed to exclude water. Items listed below require additional procedures.

3.2 WORKMANSHIP

Miscellaneous metalwork shall be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Welding shall be continuous along the entire area of contact except where tack welding is permitted. Exposed connections of work in place shall not be tack welded. Exposed welds shall be ground smooth. Exposed surfaces of work in place shall have a smooth finish, and unless otherwise approved, exposed riveting shall be flush. Where tight fits are required, joints shall be milled. Corner joints shall be coped or mitered, well formed, and in true alignment. Work shall be accurately set to established lines and elevations and securely fastened in place. Installation shall be in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

Provide anchorage where necessary for fastening miscellaneous metal items securely in place. Include for anchorage not otherwise specified or

indicated slotted inserts, expansion shields, and powder-driven fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish, to which fastenings are applied. Conceal fastenings where practicable.

3.4 BUILT-IN WORK

Form for anchorage metal work built-in with concrete or masonry, or provide with suitable anchoring devices as indicated or as required. Furnish metal work in ample time for securing in place as the work progresses.

3.5 WELDING

Perform welding, welding inspection, and corrective welding, in accordance with AWS D1.1/D1.1M. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation.

3.6 FINISHES

3.6.1 Dissimilar Materials

Where dissimilar metals are in contact, protect surfaces with a coat conforming to MPI 79 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, plaster, mortar, masonry, wood, or absorptive materials subject to wetting, protect with ASTM D 1187, asphalt-base emulsion.

3.7 ACCESS PANELS

Install a removable access panel not less than 300 by 300 mm directly below each valve, flow indicator, damper, or air splitter that is located above the ceiling, other than an acoustical ceiling, and that would otherwise not be accessible.

3.8 CONTROL-JOINT COVERS

Provide covers over control-joints and fasten on one side only with fasteners spaced to give positive contact with wall surfaces on both sides of joint throughout the entire length of cover.

3.9 HANDRAILS

Toeboards and brackets shall be installed where indicated. Splices, where required, shall be made at expansion joints. Removable sections shall be installed as indicated.

3.9.1 Steel Handrail

Install in pipe sleeves embedded in concrete and filled with non-shrink grout or quick setting anchoring cement with anchorage covered with standard pipe collar pinned to post or by means of pipe sleeves secured to masonry with expansion shields and bolts or toggle bolts or by means of base plates bolted to stringers or structural steel frame work. Secure rail ends by steel pipe flanges anchored by expansion shields and bolts.

3.10 LADDERS

Secure to the adjacent construction with the clip angles attached to the stringer. Secure to masonry or concrete with not less than two 12 mm diameter expansion bolts. Install intermediate clip angles not over 1200 mm on center. Install brackets as required for securing of ladders welded or bolted to structural steel or built into the masonry or concrete. In no case shall ends of ladders rest upon floor.

3.11 STEEL STAIRS

Provide anchor bolts, grating fasteners, washers, and all parts or devices necessary for proper installation. Provide lock washers under nuts.

3.12 INSTALLATION OF CHIMNEYS, VENTS, AND SMOKESTACKS

Chimneys and vents shall be installed in accordance with NFPA 211 and UL 103 HT. A cleanout opening with a tight-fitting, hinged, cast-iron door and frame shall be provided at the base of each smokestack. As applicable, a top band shall be provided on stacks for attachment of painter's rigging. Roof housing, rain cap, downdraft diverter, fire damper, and other accessories required for a complete installation shall be provided. Sections of prefabricated lined stacks shall be joined with acid-resisting high-temperature cement and steel draw bands. Means to prevent accumulation of water in the smokestack shall be provided.

3.13 INSTALLATION OF GUARD POSTS (BOLLARDS/PIPE GUARDS)

Pipe guards shall be set vertically in concrete piers. Piers shall be constructed of, and the hollow cores of the pipe filled with, concrete specified in Section 03 30 00.00 40 CAST-IN-PLACE CONCRETE.

3.14 INSTALLATION OF SAFETY NOSINGS

Nosing shall be completely embedded in concrete before the initial set of the concrete occurs and shall finish flush with the top of the concrete surface.

3.15 INSTALLATION OF METAL WINDOW SUB-SILL

Extend the metal window sill a minimum of 20 mm under the bottom of the aluminum windows. Install masonry mortar under the metal sub-sill as required for a smooth surface under the window sills. Sills shall slope a minimum of 6 mm to the exterior and not allow water to puddle.

3.16 INSTALLATION OF STAINLESS STEEL BACK SPLASH

Attach to surface with stainless steel screws.

3.17 INSTALLATION OF PROPANE STOVE STEEL CORNER GUARDS

Weld miter corners, attach to surface with 6 mm anchors, 300 mm or center, minimum 2 anchors per angle, as indicated.

-- End of Section --

SECTION 06 10 00

ROUGH CARPENTRY
07/06

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. Equivalent standards may be used in lieu of the standards listed below upon review and acceptance by the Government.

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)

AITC OT-01	(2004) Timber Construction Manual

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA E30	(2005) Engineered Wood Construction Guide
APA E445S	(2001; R 2002) Performance Standards and Qualification Policy for Structural-Use Panels (APA PRP-108)
APA F405L	(1999) Performance Rated Panels
APA PS 1	(1995) Voluntary Product Standard for Construction and Industrial Plywood
APA PS 2	(2004) Voluntary Product Standard for Wood-Based Structural-Use Panels

ASME INTERNATIONAL (ASME)

ASME B18.2.2	(1987; R 2005) Square and Hex Nuts (Inch Series)
ASME B18.5.2.1M	(2006) Metric Round Head Short Square Neck Bolts
ASME B18.5.2.2M	(1982; R 2005) Metric Round Head Square Neck Bolts
ASME B18.52.1	(1996; R 2005) Square and Hex Bolts and Screws Inch Series
ASME B18.6.1	(1981; R 1997) Wood Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A 307	(2004e1) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 653/A 653M	(2007) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 687	(1993) Standard Specification for High-Strength Nonheaded Steel Bolts and Studs
ASTM C 1136	(2006) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM F 1667	(2003) Driven Fasteners: Nails, Spikes, and Staples
ASTM F 547	(2001) Nails for Use with Wood and Wood-Base Materials

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2006) International Building Code

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Nailers and Nailing Strips

Drawings of field erection details, including materials and methods of fastening nailers in conformance with Factory Mutual or equivalent wind uplift rated systems specified in other Sections of these specifications.

SD-03 Product Data

Adhesives

Submit manufacturer's product data.

SD-07 Certificates

Certificates of grade

Manufacturer's certificates (**approved by an American Lumber Standards approved agency or recognized European or Indian standard**) attesting that lumber and material not normally grade marked meet the specified requirements. Certificate of Inspection for grade marked material by an American Lumber Standards Committee (ALSC) recognized inspection agency prior to shipment.

Preservative treatment

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. 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 shall be certified by the Board of Review, American Lumber Standards Committee, to grade the species used or an equivalent standard as determined/acceptance by the Contracting Officer. Surfaces that are to be exposed to view shall not bear grademarks, stamps, or any type of identifying mark. Hammer marking will be permitted on timbers when all surfaces will be exposed to view.

1.4.2 Plywood

Mark each sheet with the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the plywood. The mark shall identify the plywood by species group or span rating, exposure durability classification, grade, and compliance with APA PS 1 or equivalent standard. Surfaces that are to be exposed to view shall not bear grademarks or other types of identifying marks.

1.5 SIZES AND SURFACING

APA PS 20 or equivalent standard for dressed sizes of yard and structural lumber. Lumber shall be surfaced four sides. Size references, unless otherwise specified, are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced. Other measurements are IP or SI standard. All wood product dimensions shall be in metric.

1.6 MOISTURE CONTENT

Air-dry or kiln-dry lumber. Kiln-dry treated lumber after treatment. Maximum moisture content of wood products shall be as follows at the time of delivery to the job site:

a. Framing lumber and boards - 19 percent maximum

b. Timbers 125 mm and thicker - 25 percent maximum

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.

2.1.2 Recovered Lumber

Use recovered lumber where practical. Unless otherwise noted, recovered lumber shall be delivered clean and free of contamination. Provide grading certificates for any recovered wood materials used in structural applications.

2.2 PLYWOOD PANELS

APA PS 1, APA PS 2, APA E445S, and APA F405L respectively or equivalent standards.

2.2.1 Exposed Exterior Canopy Ceiling Sheathing

2.2.1.1 Plywood

C-D Grade, Exposure 1, with an Identification Index of not less than 24/0.

2.3 OTHER MATERIALS

2.3.1 Building Paper

FS UU-B-790, Type I, Grade D, Style 1. Or equivalent

2.4 ROUGH HARDWARE

Unless otherwise indicated or specified, rough hardware shall be of the type and size necessary for the project requirements. Sizes, types, and spacing of fastenings of manufactured building materials shall 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 shall be zinc-coated. Use ASME/ASTM standards listed below or European or Indian equivalents, as determined by the Contracting Officer.

2.4.1 Bolts, Nuts, Studs, and Rivets

ASME B18.52.1, ASME B18.5.2.1M, ASME B18.5.2.2M, ASME B18.2.2, and ASTM A 687.

2.4.2 Anchor Bolts

ASTM A 307, size as indicated, complete with nuts and washers.

2.4.3 Expansion Shields

CID A-A-1923, CID A-A-1924, and CID A-A-1925. Except as shown otherwise, maximum size of devices shall be 10 mm.

2.4.4 Lag Screws and Lag Bolts

ASME B18.52.1.

2.4.5 Toggle Bolts

FS FF-B-588.

2.4.6 Wood Screws

ASME B18.6.1.

2.4.7 Nails and Staples

ASTM F 547, size and type best suited for purpose; staples shall be as recommended by the manufacturer of the materials to be joined. For sheathing and subflooring, length of nails shall be sufficient to extend 25 mm into supports. In general, 8-penny or larger nails shall be used for nailing through 25 mm thick lumber and for toe nailing 50 mm thick lumber; 16-penny or larger nails shall be used for nailing through 50 mm thick lumber. Nails used with treated lumber and sheathing shall be galvanized. Where detailed nailing requirements are not specified, nail size and spacing shall be sufficient to develop an adequate strength for the connection. . Reasonable judgment backed by experience shall ensure that the designed connection will not cause the wood to split. If a load situation exceeds a reasonable limit for nails, a specialized connector shall be used.

2.4.8 Wire Nails

ASTM F 1667.

2.4.9 Tacks

FS FF-T-1813.

2.4.10 Clip Angles

Steel, 5 mm thick, size best suited for intended use; or zinc-coated steel or iron commercial clips designed for connecting wood members.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be accomplished by standard industry practices as determined by the Contracting Officer. Select lumber sizes to minimize waste. Fit 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. Provide adequate support as appropriate to the application, climate, and modulus of elasticity of the product. 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 shall be in accordance with the Nailing Schedule contained in ICC IBC; perform bolting in an approved manner. Spikes, nails, and bolts shall be drawn up tight. Provide 50 mm minimum clearance between chimneys and wood framing; provide 100 mm minimum clearance at fireplaces. Fill the spaces with strips of approved noncombustible material.

3.1.1 Plywood and Structural-Use Panel Sheathing

Install with the grain of the outer plies or long dimension at right angles to supports. Stagger end joints and locate over the centerlines of supports. Allow 3 mm spacing at panel ends and 6 mm at panel edges. Nail panels with 8-penny common nails or 6-penny annular rings or screw-type nails spaced 150 mm o.c. at supported edges and 300 mm o.c. at intermediate bearings.

3.2 MISCELLANEOUS

3.2.1 Wood Roof Nailers, Edge Strips, Crickets, Curbs, and Cants

Provide sizes and configurations indicated or specified and anchored securely to continuous construction.

3.2.1.1 Roof Edge Strips and Nailers

Provide at perimeter of roof, around openings through roof, and where roofs abut walls, curbs, and other vertical surfaces. Except where indicated otherwise, nailers shall be 150 mm wide and the same thickness as the insulation. Anchor nailers securely to underlying construction. Anchor perimeter nailers in accordance with industry standards. Strips shall be grooved as indicated for edge venting; install at walls, curbs, and other vertical surfaces with a 6 to 12 mm air space.

3.2.1.2 Crickets, Cants, and Curbs

Provide wood saddles or crickets, cant strips, curbs for scuttles and ventilators, and wood nailers bolted to tops of concrete or masonry curbs and at expansion joints, as necessary and of lumber or 19 mm thick exterior plywood.

3.2.2 Rough Wood Bucks

Size as indicated. Set wood bucks true and plumb. Anchor bucks to concrete or masonry with steel straps extending into the wall 200 mm minimum. Place anchors near the top and bottom of the buck and space uniformly at 600 mm maximum intervals.

3.2.3 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.

3.2.4 Wood Grounds

Provide for fastening wood trim, finish materials, and other items to plastered walls and ceilings. Install grounds in proper alignment and true with an 2400 mm straightedge.

3.2.5 Temporary Closures

Provide with hinged doors and padlocks and install during construction at exterior doorways and other ground level openings that are not otherwise closed. Cover windows and other unprotected openings with polyethylene or other approved material, stretched on wood frames. Provide dustproof barrier partitions to isolate areas as directed.

3.2.6 Temporary Centering, Bracing, and Shoring

Provide for the support and protection of masonry work during construction as specified in Section 04 20 00, "MASONRY". Forms and centering for cast-in-place concrete work are specified in Section 03 30 00.00 40 CAST-IN-PLACE CONCRETE.

-- End of Section --

SECTION 07 13 53

ELASTOMERIC SHEET WATERPROOFING
04/06

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; the contractor may use European or Indian standards as accepted by the Contracting Officer.

ASTM INTERNATIONAL (ASTM)

ASTM D 1004	(2003) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 41	(2005) Asphalt Primer Used in Roofing, Damp proofing, and Waterproofing
ASTM D 429	(2003e1) Rubber Property-Adhesion to Rigid Substrates
ASTM D 751	(2006) Coated Fabrics
ASTM D 903	(1998; R 2004) Peel or Stripping Strength of Adhesive Bonds
ASTM E 154	(1999) Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-03 Product Data

Elastomeric waterproofing sheet material

Protection board

Primers, adhesives, and mastics

SD-04 Samples

Materials

Submit material samples showing resolution of corner and field conditions.

SD-08 Manufacturer's Instructions

Submit Manufacturer's material safety data sheets for primers, adhesives and mastics.

1.3 QUALITY ASSURANCE

1.3.1 Shop Drawing Requirements

Include description and physical properties; termination details; application details; recommendations regarding shelf life, application procedures; requirements for protective covering; and precautions for flammability.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver and store materials out of the weather, in manufacturer's original packaging with brand name and product identification clearly marked. Do not permit uncertified materials in the work area.

1.5 ENVIRONMENTAL CONDITIONS

Do not apply waterproofing during inclement weather or when there is ice, frost, surface moisture, or visible dampness on the surface to receive waterproofing and when ambient and surface temperatures are 4 degrees C or below. The restriction on the application of waterproofing materials when ambient and surface temperatures are below 4 degrees C will be waived by the Contracting Officer if the Contractor devises a means, approved by the Contracting Officer, of maintaining the surface and ambient temperatures above 4 degrees C.

PART 2 PRODUCTS

2.1 MATERIALS

Provide one of the types of elastomeric waterproofing sheet material and related primers, adhesives, and mastics as specified herein. Ensure compatibility of waterproofing materials within a specific type, with each other, and with the materials on which they will be applied. Materials shall conform to the applicable performance requirements cited below when tested in accordance with the referenced ASTM publications or equivalent standard as approved by the Contracting Officer.

2.2 BUTYL RUBBER SHEETING

Not less than 1.5 mm minimum thickness.

2.2.1 Butyl Rubber Sheeting Performance Requirements: provide certification of the ASTM testing requirements or equivalency as determined by the Contracting Officer.

a. Thickness Tolerance, ASTM D 412: Plus or minus 10 percent;

b. Specific Gravity, ASTM D 297: 1.20, plus or minus 0.05;

c. Tensile Strength, ASTM D 412: 7.7 MP a minimum;

d. Tensile Stress at 300 percent elongation, ASTM D 412: 3.85 MPa minimum;

e. Elongation, ASTM D 412: 300 percent minimum;

f. Tear Resistance, Die C, ASTM D 624: 26.3 newtons per millimeter (N/mm) minimum;

g. Water Vapor Transmission, 26.7 Degrees C Permeance, ASTM E 96, Procedure B or BW: 8.58 x 10-7 g/Pa.s.m2 maximum.

2.2.2 Adhesive, Cement, and Tape for Use with Butyl Rubber

As recommended by the butyl rubber waterproofing membrane manufacturer.

2.3 THERMOPLASTIC MEMBRANE: POLYVINYL CHLORIDE (PVC)

Polyvinyl chloride (PVC) flexible sheets with non-woven fiberglass reinforcing not less than 1.5 mm minimum thickness.

2.3.1 Thermoplastic Membrane Performance Requirements provide certification of the ASTM testing requirements or equivalency as determined by the Contracting Officer.

a. Overall thickness, ASTM D 751:, 1.50 mm min.;

b. Tensile strength ASTM D 638:, 11.03 MPa, min.;

c. Elongation at break, ASTM D 638:, 250 percent minimum;

d. Seam strength, ASTM D 638:, 90 percent minimum of tensile strength;

f. Tensile strength, ASTM D 638:, 95 percent of original;

g. Elongation, ASTM D 638:, 95 percent of original;

h. Tear resistance, ASTM D 1004:, 7.7 Kilogram Force;

i.
and

k. Weight Change After Immersion in Water, ASTM D 570:, 2.0 percent maximum.

2.3.2 Adhesives

a. Adhesive for thermoplastic flashings and sub-membrane grid as recommended by manufacturer.

2.3.3 Accessories

a. Securing Strip: 14 gauge stainless steel metal bar, 2.54 cm wide, pre-punched 2.54 cm on center for securement.

2.4 COMPOSITE, SELF-ADHERING MEMBRANE SHEETING

Cold applied composite sheet consisting of rubberized asphalt and cross laminated, high density polyethylene film. Not less than 1.5 mm minimum thickness is required.

2.4.1 Composite, Self-Adhering Sheeting Performance Requirements provide certification of the ASTM testing requirements or equivalency as determined by the Contracting Officer.

a. Tensile Strength, ASTM D 412, Die C: 1.6 MPa minimum;

b. Ultimate Elongation, ASTM D 412, Die C: 200 percent minimum;

c. Water Absorption, ASTM D 570; 0.1% maximum.

2.4.2 Primer: as recommended by the membrane manufacturer.

2.4.3 Mastic

Polymer modified asphalt in suitable solvent of trowel-grade consistency and as recommended by the membrane manufacturer.

PART 3 EXECUTION

3.1 VERIFICATION OF CONDITIONS

Before starting the work, verify that surfaces to be waterproofed are in satisfactory condition. Notify the Contracting Officer of defects or conditions that will prevent a satisfactory application. Do not start application until defects and conditions have been corrected.

3.2 SURFACE PREPARATION

Ensure surfaces to be treated are clean, dry, smooth, and free from deleterious materials and projections. Thoroughly wet holes, joints, cracks, and voids in concrete with water and fill with Portland cement mortar, strike flush, and permit to dry. Cut off high spots or grind smooth. Finish top surfaces of projecting masonry or concrete ledges below grade, except footings, to a steep bevel with Portland cement mortar. Sweep surfaces to be covered before applying waterproofing to remove dust and

foreign matter. Cure concrete by a method compatible with the waterproofing system.

3.3 APPLICATION

Follow manufacturer's printed installation instructions. When using solvent welding liquid, avoid prolonged contact with skin and breathing of vapor. Provide adequate ventilation. Carry waterproofing of horizontal surfaces up abutting vertical surfaces as indicated and adhere solid to the substrate. Avoid wrinkles and buckles in applying membrane and joint reinforcement.

a. Non-Self-Adhering Membrane: Unroll membrane and allow to remain flat for at least one-half hour before application. Apply an asphalt concrete primer prior to application of asphaltic adhesive. Where solvent adhesive is applied, allow major portion of solvent to evaporate so that bonding adhesive does not stick to a dry finger touching it. Apply elastomeric waterproofing membrane in a full bed of adhesive at a uniform coverage rate in accordance with the recommendations in the membrane manufacturer's printed instructions. Where membrane on horizontal surfaces are to receive concrete fill, apply adhesive in 100 mm wide strips at 600 mm on center. Pull membrane tight without stretching. As soon as adhesive is fully set and dry, recheck lap splices. Where openings or “fishmouths” appear, reseal and reroll lap splices.

b. Self-Adhering Membrane: Apply composite, self-adhering membrane on surfaces primed at a uniform coverage rate in accordance with membrane manufacturer's printed instructions. Remove release sheet and apply with tacky surface in contact with dried primer.

c. Protection: Protect membrane over horizontal surfaces from abnormal traffic during installation. Use only equipment with rubber tires. Provide walkway protection where heavy traffic from other trades is expected. Do not store material on membrane.

3.3.1 Butyl Rubber

Lap sheets at sides and ends a minimum of 150 mm over the preceding sheet. Apply lap splicing cement over entire 150 mm splice area prior to application of sealant. Sealant shall be continuous along the entire length of the splice. Maintain a continuous bead of sealant at all membrane splices or as required by the manufacturer. When membrane will be below water table, provide a tongue and groove cemented splice a minimum of 150 mm with factory made heat vulcanized seam not less than 50 mm or as required by the manufacturer.

3.3.2 Thermoplastic Membrane (PVC)

Deck shall be clean, smooth and dry without surface irregularities. Consult with membrane manufacturer prior to grid application. Install 30.48 cm wide sub-membrane containment grid as required by manufacturer. Provide and install the containment grid at intervals across the width and length of the substrate, at the base of all transitions, walls, curbs, penetrations, and at the perimeter of each deck/substrate section. Fully adhere strips to the deck in a full bedding of two-part urethane adhesive medium. Adjacent sheets shall be welded in accordance with manufacturer's instructions. All side and end lap joints shall be hot-air welded. Lap area shall be a

minimum of 7.62 cm wide when machine welding, and a minimum of 10.16 cm wide when hand welding but not less than recommended by the manufacturer. Overlaps shall be with the flow of water.

3.4 COMPOSITE, SELF-ADHERING MEMBRANE

Lap sheets at edges and ends a minimum of 65 mm over the preceding sheet. All side laps shall be minimum 65 mm and end laps shall be 127 mm. Laps shall be self adhesive, mastic as per manufacturer's recommendation. Roll or firmly press to adhere membrane to substrate. Cover corners and joints with two layers of reinforcement by first applying a 300 mm width of membrane centered along the axis. Flash drains and projections with a second ply of membrane for a distance of 150 mm from the drain or projection. Finish exposed, terminated edges of membrane on horizontal or vertical surfaces with a trowelled bead of mastic. Apply mastic around edges of membrane, and drains and projections. Apply mastic at end of each work day.

3.5 FLASHING

Flash penetrations through membrane. Ensure that where reinforcing bars penetrate a waterproofing membrane, each of those penetrations be sealed with the appropriate sealant or mastic flashing component. Embed elastomeric membrane in a heavy coat of adhesive, except for self-adhering membrane. Continuous metal reglets shall be installed, horizontally on footing and vertically on intersecting and connecting walls, and as specified in Section 07 60 00 FLASHING AND SHEET METAL. Metal reglets shall receive exposed edges of membrane waterproofing. Secure membrane into reglets by lead wedges and fill with cement as recommended by manufacturer of waterproofing materials. Counterflash upper edge of membrane waterproofing and protective covering as specified in Section 07 60 00 FLASHING AND SHEET METAL.

3.6 FIELD QUALITY CONTROL

Notify the Contracting Officer one day prior to date of performing tests. Before concealment, cover elastomeric waterproofing on horizontal surfaces over finished spaces with 75 mm of ponded water for 24 hours. Do not add water after start of 24 hour period. Carefully measure water level at beginning and end of 24 hour period. If water level falls, remove water and inspect waterproofing membrane. Make repairs or replacement as directed, and repeat test. Do not proceed with work that conceals membrane waterproofing before receiving approval and acceptance of Contracting Officer.

-- End of Section --

SECTION 07 21 13

BOARD INSULATION
04/06

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; the contractor may refer to European or Indian standards as accepted by the Contracting Officer.

ASTM INTERNATIONAL (ASTM)

ASTM C 1289	(2006) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM C 553	(2002) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 578	(2006) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 591	(2005) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 612	(2004) Mineral Fiber Block and Board Thermal Insulation
ASTM E 136	(2004) Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C
ASTM E 154	(1999) Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 211	(2006) Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

NFPA 70 (2005; TIA 2005) National Electrical Code

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-03 Product Data

Board insulation; G

Vapor retarder

SD-08 Manufacturer's Instructions

Board Insulation

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery

Deliver materials to the site in original sealed wrapping bearing manufacturer's name and brand designation, type, grade, R-value, and class. Store and handle to protect from damage. Do not allow insulation materials to become wet, soiled, crushed, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storing, and protecting of materials before and during installation.

1.3.2 Storage

Inspect materials delivered to the site for damage; unload and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling.

PART 2 PRODUCTS

2.1 BOARD INSULATION

Provide only thermal insulating materials recommended by manufacturer for type of application indicated.

2.1.1 Thermal Resistance

As indicated.

2.1.2 Fire Protection Requirement: provide certification of the ASTM testing requirements or equivalency as determined by the Contracting Officer.

a. Flame spread index of 75 or less when tested in accordance with ASTM E 84.

b. Smoke developed index of 200 or less when tested in accordance with ASTM E 84.

2.1.3 Other Material Properties:

As recommended by insulation manufacturer.

2.1.4 Prohibited Materials

Do not provide materials containing more than one percent of asbestos containing materials (ACM).

2.2 VAPOR RETARDER AND DAMPPROOFING

2.2.1 Vapor Retarder in Frame Walls and Roofs: As recommended by insulation manufacturer.

2.3 PRESSURE SENSITIVE TAPE

As recommended by insulation manufacturer.

2.4 PROTECTION BOARD OR COATING

As recommended by insulation manufacturer.

2.5 ACCESSORIES

2.5.1 Adhesive

As recommended by insulation manufacturer.

2.5.2 Mechanical Fasteners

Corrosion resistant fasteners as recommended by the insulation manufacturer.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

Before installing insulation, ensure that all areas that will be in contact with the insulation are dry and free of projections which could cause voids, compressed insulation, or punctured vapor retarders. If installing perimeter or under slab insulation, check that the fill is flat, smooth, dry, and well tamped. If moisture or other conditions are found that do not allow the proper installation of the insulation, do not proceed but notify the Contracting Officer of such conditions.

3.2 PREPARATION

3.2.1 Blocking Around Heat Producing Devices

install non-combustible blocking around heat producing devices to provide the following clearances, where applicable:

a. Masonry chimneys or masonry enclosing a flue: 50 mm from outside face of masonry. Masonry chimneys for medium and high heat operating appliances: Minimum clearances required by NFPA 211 (or equivalent standard).

b. Vents and vent connectors used for venting products of combustion, flues, and chimneys other than masonry chimneys: minimum clearances as required by NFPA 211.

3.3 INSTALLATION

3.3.1 Insulation Board

Install and handle insulation in accordance with the manufacturer's installation instructions. Keep material dry and free of extraneous materials. Observe safe work practices.

3.3.2 Electrical Wiring

Do not install insulation in a manner that would sandwich electrical wiring between two layers of insulation.

3.3.3 Cold Climate Requirement

Place insulation to the outside of pipes.

3.3.4 Continuity of Insulation

Butt tightly against adjoining boards, studs, rafters, joists, sill plates, headers and obstructions. Provide continuity and integrity of insulation at corners, wall to ceiling joint, roof, and floor. Avoid creating any thermal bridges or voids.

3.4 INSTALLATION ON WALLS

3.4.1 Installation using Furring Strips

Install insulation between members as recommended by insulation manufacturer.

3.4.2 Installation on Masonry Walls

Apply board directly to masonry with adhesive or fasteners as recommended by the insulation manufacturer. Fit between obstructions without impaling board on ties or anchors. Apply in parallel courses with joints breaking midway over course below. Put ends in moderate contact with adjoining insulation without forcing. Cut and shape as required to fit around wall penetrations, projections or openings to accommodate conduit or other services. Seal around cut-outs with sealant.

3.4.3 Mechanical Attachment on Concrete and Masonry Walls

Cut insulation to cover walls. Apply adhesive to wall and set clip or other mechanical fastener in adhesive as recommended by manufacturer. After

curing of adhesive, install insulation over fasteners, bend split prongs flush with insulation. Butt all edges of insulation and seal with tape.

3.4.4 Protection Board or Coating or Plastering

Install protection board or coating or plastering (stucco) in accordance with manufacturer's instructions or acceptable construction standards per stucco specifications of this contract and instructions from the contracting officer. Install protection over all exterior exposed insulation board and down to 150 mm below grade.

3.5 VAPOR RETARDER

Apply a continuous vapor retarder as indicated. Overlap all joints at least 150 mm and seal with pressure sensitive tape. Seal at sill, header, windows, doors and utility penetrations. Repair punctures or tears with pressure sensitive tape.

-- End of Section --

SECTION 07 21 16

MINERAL FIBER BLANKET INSULATION
04/06

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; equivalent European or Indian publications and standards may be used in lieu of as determined/accepted by the Contracting Officer.

ASTM INTERNATIONAL (ASTM)

ASTM C 665	(2006) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM D 4397	(2002) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D 828	(1997; R 2002) Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus
ASTM E 136	(2004) Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 211	(2006) Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances
NFPA 70	(2005; TIA 2005) National Electrical Code

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-03 Product Data

Blanket insulation; G

Vapor retarder;

Pressure sensitive tape;

Accessories;

SD-08 Manufacturer's Instructions

Insulation;

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery

Deliver materials to site in original sealed wrapping bearing manufacturer's name and brand designation, specification number, type, grade, R-value, and class. Store and handle to protect from damage. Do not allow insulation materials to become wet, soiled, crushed, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storing, and protecting of materials before and during installation.

1.3.2 Storage

Inspect materials delivered to the site for damage; unload and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling.

1.4 SAFETY PRECAUTIONS

1.4.1 Respirators

Provide installers with dust/mist respirators, training in their use, and protective clothing, all approved by National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration (MSHA) in accordance with 29 CFR 1910.134 or recognized European or Indian equivalencies, as determined and accepted by the Contracting Officer.

PART 2 PRODUCTS

2.1 BLANKET INSULATION

As recommended by the manufacturer; the Contracting Officer will make the determination of acceptance per ASTM C 665 type I blanket insulation standard or European or Indian equivalent.

2.1.1 Thermal Resistance Value (R-VALUE)

As indicated

2.1.2 Prohibited Materials

Do not provide asbestos-containing materials (defined as 1% or less ACM).

2.3 BLOCKING

Wood, metal, unfaced mineral fiber blankets in accordance with ASTM C 665, Type I, or other approved materials. Use only non-combustible materials for blocking around chimneys and heat producing devices.

2.4 VAPOR RETARDER: AS RECOMMENDED BY THE MANUFACTURER OR CONFORMING TO ASTM D 4397 OR EQUIVALENT

2.5 PRESSURE SENSITIVE TAPE

As recommended by the vapor retarder manufacturer and having a water vapor permeance rating of 5.72 x 10-8 g/Pa.s.m2 or less when tested in accordance with ASTM D 3833/D 3833M.

2.6 ACCESSORIES

2.6.1 Adhesive

As recommended by the insulation manufacturer.

2.6.2 Mechanical Fasteners

Corrosion resistant fasteners as recommended by the insulation manufacturer.

2.6.3 Wire Mesh

Corrosion resistant and as recommended by the insulation manufacturer.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

Before installing insulation, ensure that areas that will be in contact with the insulation are dry and free of projections which could cause voids, compressed insulation, or punctured vapor retarders. If moisture or other conditions are found that do not allow the workmanlike installation of the insulation, do not proceed but notify Contracting Officer of such conditions.

3.2 PREPARATION

3.2.1 Blocking at Attic Vents and Access Doors

Prior to installation of insulation, install permanent blocking to prevent insulation from slipping over, clogging, or restricting air flow through soffit vents at eaves. Install permanent blocking around attic trap doors. Install permanent blocking to maintain accessibility to equipment or controls that require maintenance or adjustment.

3.2.2 Blocking Around Heat Producing Devices

Install non-combustible blocking around heat producing devices to provide the following clearances:

a. Recessed lighting fixtures, including wiring compartments, ballasts, and other heat producing devices, unless these are certified by the manufacturer for installation surrounded by insulation: 75 mm from outside face of fixtures and devices or as required by NFPA 70 and, if insulation is to be placed above fixture or device, 600 mm above fixture.

b. Masonry chimneys or masonry enclosing a flue: 50 mm from outside face of masonry. Masonry chimneys for medium and high heat operating appliances: Minimum clearances required by NFPA 211.

c. Vents and vent connectors used for venting the products of combustion, flues, and chimneys other than masonry chimneys: Minimum clearances as required by NFPA 211.

Blocking around flues and chimneys is not required when insulation blanket, including any attached vapor retarder, , in addition to meeting all other requirements stipulated in Part 2. Blocking is also not required if the chimneys are certified by the manufacturer for use in contact with insulating materials.

3.3 INSTALLATION

3.3.1 Insulation

Install and handle insulation in accordance with manufacturer's instructions. Keep material dry and free of extraneous materials. Ensure personal protective clothing and respiratory equipment is used as required. Observe safe work practices.

3.3.1.1 Electrical wiring

Do not install insulation in a manner that would sandwich electrical wiring between two layers of insulation.

3.3.1.2 Continuity of Insulation

Install blanket insulation to butt tightly against adjoining blankets and to studs, rafters, joists, sill plates, headers and any obstructions. Where insulation required is thicker than depth of joist, provide full width blankets to cover across top of joists. Provide continuity and integrity of insulation at corners, wall to ceiling joints, roof, and floor. Avoid creating thermal bridges.

3.3.1.3 Installation at Bridging and Cross Bracing

Insulate at bridging and cross bracing by splitting blanket vertically at center and packing one half into each opening. Butt insulation at bridging and cross bracing; fill in bridged area with loose or scrap insulation.

3.3.1.4 Cold Climate Requirement

Place insulation to the outside of pipes.

3.3.1.5 Insulation Blanket with Affixed Vapor Retarder

Locate vapor retarder as indicated. Do not install blankets with affixed vapor retarders unless so specified. Unless the insulation manufacturer's instructions specifically recommend not to staple the flanges of the vapor retarder facing, staple flanges of vapor retarder at 150 mm intervals flush with face or set in the side of truss, joist, or stud. Avoid gaps and bulges in insulation and "fishmouth" in vapor retarders. Overlap both flanges when using face method. Seal joints and edges of vapor retarder with pressure sensitive tape. Stuff pieces of insulation into small cracks between trusses, joists, studs and other framing, such as at attic access doors, door and window heads, jambs, and sills, band joists, and headers. Cover these insulated cracks with vapor retarder material and tape all joints with pressure sensitive tape to provide air and vapor tightness.

3.3.1.6 Insulation without Affixed Vapor Retarder

Provide snug friction fit to hold insulation in place. Stuff pieces of insulation into cracks between trusses, joists, studs and other framing, such as at attic access doors, door and window heads, jambs, and sills, band joists, and headers.

3.3.1.7 Sizing of Blankets

Provide only full width blankets when insulating between trusses, joists, or studs. Size width of blankets for a snug fit where trusses, joists or studs are irregularly spaced.

3.3.1.8 Special Requirements for Ceilings

Place insulation under electrical wiring occurring across joists. Pack insulation into narrowly spaced framing. Do not block flow of air through soffit vents. Attach insulation to attic door by adhesive or staples.

3.3.1.9 Installation of Sill Sealer

Size sill sealer insulation and place insulation over top of masonry or concrete perimeter walls or concrete perimeter floor slab on grade. Fasten sill plate over insulation.

3.3.1.10 Special Requirements for Floors

Hold insulation in place with corrosion resistant wire mesh, wire fasteners, or wire lacing.

3.3.1.11 Access Panels and Doors

Affix blanket insulation to access panels greater than one square foot and access doors in insulated floors and ceilings. Use insulation with same R-Value as that for floor or ceiling.

3.3.2 Installation of Separate Vapor Retarder

Apply continuous vapor retarder as indicated. Overlap joints at least 150 mm and seal with pressure sensitive tape. Seal at sill, header, windows,

doors and utility penetrations. Repair punctures or tears with pressure sensitive tape.

-- End of Section --

SECTION 07 41 13

NON-STRUCTURAL METAL ROOFING
04/06

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; European or Indian publications and standards may be used in lieu of as determined by the Contracting Officer.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2005; Supp 1) Minimum Design Loads for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM A 463/A 463M	(2006) Standard Specification for Steel Sheet, Aluminum-Coated
ASTM A 653/A 653M	(2007) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 755/A 755M	(2006) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
ASTM A 792/A 792M	(2006a) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM B 209	(2006) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 209M	(2006) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

MBMA RSDM	(2000) Metal Roofing Systems Design Manual

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 0405	(2001; R 2003, 5th Ed) Roofing and Waterproofing Manual

UNDERWRITERS LABORATORIES (UL)

UL 580 (2006) Tests for Uplift Resistance of Roof Assemblies

1.2 DESCRIPTION OF METAL ROOF SYSTEM

Galvanized metal panel roof system with exposed fastener attachment through to deck substrate. Roof panel profile shall be corrugated except where indicated otherwise.

1.2.1 Design Requirements

1.2.2 Wind Uplift Resistance

Metal roof panel assembly shall resist wind loads as indicated.

1.2.2.1 Performance Requirements

The installed roof assembly shall be watertight, conform to the roof slope, and resist the uplift pressures calculated or indicated. The Contractor shall furnish a commercially available roofing system which satisfies all specified requirements.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Metal Roofing; G

Drawings consisting of catalog cuts, panel configuration, system assembly, attachment details, roof curb details, flashing details, erection drawings, and other data as necessary to clearly describe layouts, construction details, fasteners, and erection.

SD-03 Product Data

Roof panels;

Accessories;

Fasteners;

Underlayments;

Gaskets and Insulating Compounds

Roof curbs

SD-04 Samples

Roof Panels;

One piece of each type and finish to be used, 200 mm long, full width.

Factory-applied Color Finish Charts; G

Provide standard color charts for roof panel and accessory color selection.

Accessories;

One sample of each type of roof curb, flashing, trim, fascia, closure, cap and similar items. Size shall be sufficient to show construction and configuration.

Fasteners;

Two samples of each type to be used with statement regarding intended use.

Gaskets and Insulating Compounds

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

Sealant;

SD-05 Design Data

Wind Uplift Resistance;

Engineering calculations validating the wind resistance of non-tested roof system. Calculations shall be prepared, signed, and sealed by a registered structural engineer.

SD-06 Test Reports

Roof Assembly;

Factory Color Finish Performance Requirements

SD-07 Certificates

Roof Panels;

Certificates from the roof panel manufacturer attesting that the panels and accessories conform to the specified requirements and are suitable for the installation environment at the indicated design slope.

Self-Adhering Modified Bitumen Underlayment

Certify underlayment compatibility with service conditions of the roof installation.

Qualification of Manufacturer;

Certify that the manufacturer of the roof membrane meets requirements specified under paragraph entitled "Qualification of Manufacturer."

Qualification of Applicator;

Certify that the applicator meets requirements specified under paragraph entitled "Qualification of Applicator."

SD-08 Manufacturer's Instructions

INSULATION

INSTALLATION

Roof panel installation manual;

Submit manufacturer's printed installation manual and instructions.

SD-11 Closeout Submittals

Warranties

Information card

1.4 QUALITY ASSURANCE

1.4.1 Qualification of Manufacturer

Metal roof panel manufacturer shall have been in the business of manufacturing metal roof panels for a period of not less than 5 years.

1.4.2 Qualification of Applicator

Metal roof system applicator shall be approved, authorized, or licensed in writing by the roof panel manufacturer and shall have a minimum of three years experience as an approved, authorized, or licensed applicator (as determined by the contracting officer) with that manufacturer and be approved at a level capable of providing the specified warranty. The applicator shall supply the names, locations and client contact information of 3 projects of similar size and scope that the applicator has constructed using the manufacturer's roofing products submitted for this project within the previous three years.

1.4.3 Pre-roofing Conference

After approval of submittals and before performing roofing system installation work, hold a pre-roofing conference to review the following:

a. Drawings and specifications and submittals related to the roof work;

b. Roof system components installation;

c. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing; and

d. Quality control plan for the roof system installation;

e. Safety requirements.

Pre-roofing conference scheduling shall be coordinated with the Contracting Officer. The conference shall be attended by the Contractor, the Contracting Officer's designated personnel, personnel directly responsible for the installation of metal roof system, flashing and sheet metal work, mechanical and electrical work, other trades interfacing with the roof work, and representative of the metal roofing manufacturer. Before beginning roofing work, provide a copy of meeting notes and action items to all attending parties. Note action items requiring resolution prior to start of roof work.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle panel materials, bulk roofing products, accessories, and other manufactured items in a manner to prevent damage and deformation, as recommended by the manufacturer, and as specified.

1.5.1 Delivery

Deliver materials to the site in undamaged condition. Provide adequate packaging to protect materials during shipment. Crated materials shall not be uncrated until ready for use, except for inspection. Immediately upon arrival of materials at jobsite, inspect materials for damage, deformation, dampness, and staining. Remove affected materials from the site. Remove moisture from wet materials not otherwise affected, restack and protect from further moisture exposure.

1.5.2 Storage

Stack materials stored on site on platforms or pallets, and cover with tarpaulins or other weather tight covering which prevents trapping of water or condensation under the covering. Store roof panels so that water which may have accumulated during transit or storage will drain off. Do not store panels in contact with materials that might cause staining. Secure coverings and stored items to protect from wind displacement.

1.5.3 Handling

Handle materials in a manner to avoid damage. Select and operate material handling equipment so as not to damage materials or applied roofing.

1.6 WARRANTIES

Provide metal roof system material and workmanship warranties meeting specified requirements. Revision or amendment to manufacturer's standard warranty shall be provided as required to comply with the specified requirements.

1.6.1 Metal Roof Panel Manufacturer Warranty

Furnish the metal roof panel manufacturer's 10-year no dollar limit roof system materials and installation workmanship warranty, including flashing, insulation, components, trim, and accessories necessary for a watertight roof system construction. The warranty shall run directly to the Government and commence at time of Government's acceptance of the roof work. The warranty shall state that:

a. If within the warranty period the metal roof system, as installed for its intended use in the normal climatic and environmental conditions of the facility, becomes non-watertight, shows evidence of moisture intrusion within the assembly, displaces, corrodes, perforates, separates at the seams, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged materials of the metal roof system and correction of defective workmanship shall be the responsibility of the metal roof panel manufacturer. All costs associated with the repair or replacement work shall be the responsibility of the metal roof panel manufacturer.

b. When the manufacturer or his approved applicator fail to perform the repairs within 72 hours of notification, emergency temporary repairs performed by others shall not void the warranty.

1.6.2 Manufacturer's Finish Warranty

Provide a manufacturer's 20 year exterior material finish warranty warranting that the factory color finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk; or fade or change colors as determined by the Contracting Officer.

1.6.3 Metal Roof System Installer Warranty

Provide the "Contractors Five (5) Year No Penal Sum Warranty for Non-Structural Metal Roof System" attached at the end of this section.

1.6.4 Continuance of Warranty

Repair or replacement work that becomes necessary within the warranty period shall be approved, as required, and accomplished in a manner so as to restore the integrity of the roof system assembly and validity of the metal roof system manufacturer warranty for the remainder of the manufacturer warranty period.

1.7 CONFORMANCE AND COMPATIBILITY

The entire metal roofing and flashing system shall be in accordance with specified and indicated requirements, including wind resistance requirements. Work not specifically addressed and any deviation from specified Any deviation from specified or indicated requirements shall be submitted to the Contracting Officer for approval prior to installation.

PART 2 PRODUCTS

2.1 ROOF PANELS

Roof panels shall be steel with a factory-applied color finish. Panel attachment shall be with exposed fasteners. Panel profile shall be

corrugated unless indicated otherwise. Roof panels shall provide nominal 300 mm (12 inches) of coverage in place. Minimum height of corrugations at overlap of adjacent roof sheets shall be the panel manufacturer's standard for the indicated roof slope. Individual panels shall be of continuous length sufficient to cover the entire length of any unbroken roof slope with no joints or seams, except where indicated or approved otherwise by the Contracting Officer. Panels shall be formed without warping, waviness, or ripples that are not a part of the panel profile and shall be free of damage to the finish coating system. Provisions shall be made for thermal expansion and contraction consistent with the type of system to be used. All sheets shall be either square-cut or miter-cut.

2.1.1 Steel Panels

Zinc-coated steel conforming to ASTM A 653/A 653M, Structural Grade 40 and minimum G90 galvanized smooth metallic coating; aluminum-zinc alloy coated steel conforming to ASTM A 792/A 792M, AZ 50 coating; or aluminum-coated steel conforming to ASTM A 463/A 463M, Type 2, coating designation T2 65. Pre-painted steel sheet shall also comply with ASTM A 755/A 755M or equivalent European or Indian standards as determined/accepted by the Contracting Officer. Roof panel material shall be minimum 0.76 mm (22 gage) (or thickness as noted on the contract drawings and specifications) thick prior to coating application, and as required to meet wind uplift requirements. Panels shall be within 95 percent of the nominal thickness. Prior to shipment, mill finish panels shall be treated with a passivating chemical and oiled to inhibit the formation of oxide corrosion products. Panels that have become wet during shipment and have started to oxidize shall be rejected.

2.2 ROOF PANEL FACTORY COLOR FINISH

Provide factory-applied, thermally cured coating system on roof panel surfaces. Provide exterior coat of primer and color finish coat on the exposed side. Prime coat shall be not less than 0.005 mm (0.2 mil). Color finish coat shall be not less than 0.02 mm (0.8 mil). Total color coating system thickness shall be not less than 0.030 mm and with any additional primer and finish coat thickness required to meet the color finish performance requirements specified. Provide manufacturer's standard factory-applied clear coat system over color finish coat. Underside coating shall consist of roof panel manufacturer recommended protective backer coat suitable for the application conditions, not less than 0.008 mm (0.3 mil) thick unless approved otherwise by the Contracting Officer. Finish coat color shall be as selected by Contracting Officer from manufacturer standard color charts. The exterior color finish shall meet the performance requirements specified.

2.2.1 Factory Color Finish Performance Requirements

2.3 ACCESSORIES

Accessories shall be compatible with the metal roof panels. Sheet metal flashing, trim, metal closure strips, caps, and similar metal accessories shall be not less than the minimum thicknesses specified for roof panels. Exposed metal accessories shall be finished to match the panels furnished. Molded foam rib, ridge and other closure strips shall be closed-cell or

solid-cell synthetic rubber or neoprene pre-molded to match configuration of the panels and shall not absorb or retain water.

2.3.1 Pre-manufactured Accessories

Pre-manufactured accessories shall be manufacturer's standard for intended purpose, comply with applicable specification section, compatible with the metal roof system and approved for use by the metal roof panel manufacturer. Curbs shall be constructed to match roof slope and shall meet requirements in Section 13 34 19.

2.4 FASTENERS

Fasteners for roof panels shall be corrosion resistant coated steel, aluminum, stainless steel, or nylon capped steel, compatible with the sheet panel or flashing material and of type and size recommended by the manufacturer to meet the performance requirements. Fasteners for accessories shall be the manufacturer's standard. Exposed fasteners shall have integral metal washer head and compressible sealing EPDM washer. Sealing washer shall be approximately 2.4 mm (3/32 inch) thick. Exposed portion of fasteners shall match color of attached material.

2.4.1 Screws

Not smaller than 6 mm (No. 14) diameter self-tapping type and not less than 4 mm (No. 12) diameter self-drilling type.

2.4.2 Rivets

Closed-end type where watertight connections are required.

2.5 UNDERLAYMENTS

2.5.1 Self-Adhering Modified Bitumen Underlayment

Self-adhering modified bitumen membrane underlayment material in compliance with ASTM D 1970 or equivalent standard, and suitable for use as underlayment for metal roofing. Membrane resistant to cyclical elevated temperatures for extended period of time shall be used in high heat service conditions. Membrane shall have integral non-tacking top surface of polyethylene film or other surface material to serve as separator between bituminous material and metal products to be applied above.

2.5.2 Slip Sheet

Slip Sheet shall be 0.24 kg per square meter (5 pounds per 100 sf) rosin sized unsaturated building paper.

2.6 SEALANT

Sealant shall be an elastomeric type containing no oil or asphalt, as recommended by the roof panel manufacturer. Silicone based sealants are prohibited, unless approved otherwise by the roof panel manufacturer and the Contracting Officer. Exposed sealant shall be high quality polyurethane and shall be colored to match adjacent components and shall cure to a rubberlike consistency. Concealed sealant shall be non-hardening type. Sealant placed in the roof panel standing seam ribs shall be provided in accordance with the manufacturer's recommendations.

2.7 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be non-absorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be non-running after drying.

PART 3 EXECUTION

3.1 EXAMINATION

Examine surfaces to receive metal roof panel and flashing installation. Ensure surfaces are suitable, dry and fee of defects and projections which might affect the installation.

3.2 INSTALLATION

Installation shall meet specified requirements and be in accordance with the manufacturer's installation instructions and approved shop drawings. Correct defects or errors in materials and installation. Do not install damaged materials. Dissimilar materials which are not compatible when contacting each other shall be insulated by means of gaskets or insulating compounds. Exposed surfaces and edges shall be kept clean and free from sealant, metal cuttings, hazardous burrs, and other foreign material. Stained, discolored, or damaged materials shall be removed from the site.

3.2.1 Underlayment

Install underlayment parallel to roof slope and in a water-shedding fashion. Install self-adhering underlayment in accordance with manufacturer's instructions. Self-adhering underlayment may be installed parallel to roof slope with the approval of the Contracting Officer. Provide a minimum 1 meter (36 inch) wide sheet of self-adhering modified bitumen membrane underlayment at all penetrations, eaves, rakes, hips, ridges, valleys, slope transitions, and side wall and head wall transitions. Ice dam protection shall extend minimum 36 inches inside of building wall line and as otherwise necessary to provide effective protection from water intrusion due to ice daming. Turn underlayment up minimum 4 inches at vertical transitions, except as otherwise indicated. Underlayment shall be concealed by finished flashing and cladding construction. Ensure underlayment is attached in a manner to hold in place until metal roof panels are installed. The underlayment shall ensure that any water that penetrates below the metal roofing panels will drain outside of the building envelope.

3.2.1.1 Slip Sheet

Apply specified slip sheet at time of roof panel installation when felt or other underlayment is used that may be in direct contact with and adhere to or adversely impact the underside of roof panels, and as otherwise recommended by the roof panel manufacturer.

3.2.2 Roofing

Apply roofing panels with longitudinal configurations in the direction of the roof slope. Provide roofing panels in unbroken lengths from peak to low point with no transverse joints except at junction of ventilators, curbs, skylights, chimneys, and similar openings, unless otherwise indicated or approved by the Contracting Officer. Where panel end laps are required,

form and install to shed water and seal in a watertight manner as recommended by the panel manufacturer's installation instructions. Attach roof panels in the manner, type and frequency required by the roof panel manufacturer and to resist required wind uplift pressures. Close panel ribs or side laps as required by the manufacturer to meet specified requirements. Lay side laps away from prevailing wind. Side and end lap distances, joint sealing, and fastening and spacing of fasteners shall be in accordance with manufacturer's instructions. Flash seal roof at ridge, eaves, rakes, and at projections through roof. All sheet metal laps, including but not limited to panel side laps end laps, flashing laps and junctures at accessories and penetrations flashings, shall be sealed watertight within the lap area. Closure strips, flashing, and sealing material shall be provided as indicated and where otherwise necessary to provide complete weather tight construction.

3.2.2.1 Field Forming of Roof Panels

Roll forming equipment shall be maintained in proper working order and operated by a factory trained technician. Field formed panels shall meet all specified requirements. Where UL 580 classified materials are required, roll-former equipment certification shall be provided. In cold weather conditions, warming of the steel coils to be field formed shall be performed as necessary just prior to the rolling operations.

3.2.3 Accessories

Provide all roof curb, flashings, related closures, and accessories necessary for a complete, watertight installation. Minimize exposed fastening of flashings. On sloped planes, form flashing lap joints to shed water and provide sealant within the lap area. Laps joints shall have minimum 100 mm (4 inch) overlap except where greater overlap is indicated, or otherwise required by the roof panel manufacturer. For butt joints of flashings, provide joint splice and cover plates supplemented by waterproof sealants and sealant tapes to form a watertight joint condition. Ensure firm underlying support for joints greater than 200 mm (8 inches) wide and where otherwise indicated or required by the roof panel manufacturer. Installation shall allow for expansion and contraction of flashing without impacting watertight integrity. Set roof curbs so top surface of roof curb is level.

3.2.4 Exposed Fastener Installation

Where exposed fastening is required, provide fastener spacings in accordance with manufacturer's recommendations, in straight lines and to present a uniform appearance. Drive fasteners normal to surface and to uniform depth to seat washers with gaskets without tearing or cracking gasketing material. Exercise extreme care when drilling pilot hole for fastenings to keep drills perpendicular and centered. After drilling, remove metal filings and burrs from holes prior to installing fasteners and washers. Torque used when applying fasteners shall not exceed that recommended by manufacturer. Remove metal shavings and filings from roofs upon completion to prevent rusting and discoloration of panels.

3.3 PROTECTION OF APPLIED ROOFING

Do not permit storing, walking, wheeling, and trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards or planks as necessary to avoid damage to applied

roofing materials, and to distribute weight to conform to indicated live load limits of roof construction.

3.4 CLEAN UP AND FINISH TOUCH-UP

Clean exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from roofs. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces shall be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating. Touch up scratches in panel finish with manufacturer supplied touch-up paint system to match panel finish. Treat exposed cut edges with manufacturer supplied clear coat.

3.5 CORRECTION OF DEFICIENCIES

Where any form of deficiency is found, additional measures shall be taken as deemed necessary by the Contracting Officer to determine the extent of the deficiency and corrective actions shall be as directed by the Contracting Officer.

3.6 FIELD QUALITY CONTROL

3.6.1 Construction Monitoring

During progress of the roof work, Contractor shall make visual inspections as necessary to ensure compliance with specified requirements. Additionally, verify the following:

Materials comply with the specified requirements.

All materials are properly stored, handled and protected from damage. Damaged materials are removed from the site.

a. Substrates are in acceptable condition, in compliance with specification, prior to application of underlayment, roof panel, and flashing materials.

Nailers and blocking are provided where and as needed.

Underlayment is installed as required and of type required.

Slip sheet, if required, is installed as roof panels are installed.

Panels are installed without buckles, ripples, or waves and in uniform alignment and modulus.

Side laps are formed, sealed, fastened or seam locked as required.

The proper number, type, and spacing of attachment clips and fasteners are installed.

Installer adheres to specified and detailed application parameters.

Associated flashings and sheet metal are installed in a timely manner in accord with the specified requirements.

3.7 INFORMATION CARD

For each roof, furnish a typewritten information card for facility records and a card laminated in plastic and framed for interior display at roof access point, or a photoengraved 1 mm (0.032) inch thick aluminum card for exterior display. Card shall be 215 mm by 275 mm (8 1/2 by 11 inches) minimum. Information card shall identify facility name and number; location; contract number; approximate roof area; detailed roof system description, including deck type, roof panel manufacturer and product name, type underlayment(s), date of completion; installing contractor identification and contact information; manufacturer warranty expiration, warranty reference number, and contact information. The card shall be a minimum size of 215 mm by 275 mm (8 1/2 by 11 inches). Install card at roof top or access location as directed by the Contracting Officer and provide a paper copy to the Contracting Officer.

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
NON-STRUCTURAL METAL ROOF SYSTEM

FACILITY DESCRIPTION_____

BUILDING NUMBER:_____

CORPS OF ENGINEERS CONTRACT NUMBER:_____

CONTRACTOR

CONTRACTOR:_____

ADDRESS:_____

POINT OF CONTACT:_____

TELEPHONE NUMBER:_____

OWNER

OWNER:_____

ADDRESS:_____

POINT OF CONTACT:_____

TELEPHONE NUMBER:_____

CONSTRUCTION AGENT

CONSTRUCTION AGENT:_____

ADDRESS:_____

POINT OF CONTACT:_____

TELEPHONE NUMBER:_____

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
NON-STRUCTURAL METAL ROOF SYSTEM
(continued)

THE NON-STRUCTURAL METAL ROOF SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY _____ FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE. THE NON-STRUCTURAL METAL ROOFING SYSTEM COVERED UNDER THIS WARRANTY SHALL INCLUDE, BUT SHALL NOT BE LIMITED TO, THE FOLLOWING: THE ENTIRE ROOFING SYSTEM, MANUFACTURER SUPPLIED FRAMING AND STRUCTURAL MEMBERS, METAL ROOF PANELS, FASTENERS, CONNECTORS, ROOF SECUREMENT COMPONENTS, AND ASSEMBLIES TESTED AND APPROVED IN ACCORDANCE WITH UL 580. IN ADDITION, THE SYSTEM PANEL FINISHES, SLIP SHEET, INSULATION, VAPOR RETARDER, ALL ACCESSORIES, COMPONENTS, AND TRIM AND ALL CONNECTIONS ARE INCLUDED. THIS INCLUDES ROOF PENETRATION ITEMS SUCH AS VENTS, CURBS, SKYLIGHTS; INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS; EAVES, RIDGE, HIP, VALLEY, RAKE, GABLE, WALL, OR OTHER ROOF SYSTEM FLASHINGS INSTALLED AND ANY OTHER COMPONENTS SPECIFIED WITHIN THIS CONTRACT TO PROVIDE A WEATHERTIGHT ROOF SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THE SPECIFICATIONS THAT ARE PART OF THE NON-STRUCTURAL METAL ROOFING SYSTEM.

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

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

_____

(Company President) (Date)

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
NON-STRUCTURAL METAL ROOFING SYSTEM
(continued)

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

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).

2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.

3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.

4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.

5. FAILURE OF ANY PART OF THE NON-STRUCTURAL METAL ROOF DUE TO ACTIONS BY THE OWNER TO INHIBIT FREE DRAINAGE OF WATER FROM THE ROOF AND GUTTERS AND DOWNSPOUTS OR ALLOW PONDING WATER TO COLLECT ON THE ROOF SURFACE. CONTRACTOR'S DESIGN SHALL INSURE FREE DRAINAGE FROM THE ROOF AND NOT ALLOW PONDING WATER.

6. THIS WARRANTY APPLIES TO THE NON-STRUCTURAL METAL ROOFING SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.

7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR;
**

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
NON-STRUCTURAL METAL ROOF SYSTEM
(continued)

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

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

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

-- End of Section --

SECTION 07 60 00

FLASHING AND SHEET METAL
01/07

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; equivalent European or Indian standards and publications may be used in lieu of as accepted by the Contracting Officer.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.2/D1.2M	(2003; Errata 2004) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A 167	(1999; R 2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 308/A 308M	(2003) Standard Specification for Steel Sheet, Terne (Lead-Tin Alloy) Coated by the Hot Dip Process
ASTM A 653/A 653M	(2007) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 101	(2002) Standard Specification for Lead-Coated Copper Sheet and Strip for Building Construction
ASTM B 209	(2006) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 209M	(2006) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B 221	(2006) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B 221M	(2006) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B 32	(2004) Standard Specification for Solder Metal

ASTM B 370	(2003) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B 69	(2001a; R 2005) Standard Specification for Rolled Zinc
ASTM D 1784	(2006a) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 226	(2006) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 41	(2005) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 4586	(2000; R 2006) Asphalt Roof Cement, Asbestos-Free

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA Arch. Manual	(2003, 6th Ed) Architectural Sheet Metal Manual

1.2 GENERAL REQUIREMENTS

Finished sheet metalwork will form a weather tight construction without waves, warps, buckles, fastening stresses or distortion, which allows for expansion and contraction. Sheet metal mechanic is responsible for cutting, fitting, drilling, and other operations in connection with sheet metal 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 roofing operations.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Covering on flat, sloped, or curved surfaces

Gutters

Downspouts

Expansion joints

Gravel stops and fascias

Splash pans

Flashing for roof drains

Base flashing

Counterflashing

Flashing at roof penetrations

Reglets

Scuppers

Copings

Drip edge

Conductor heads

Open valley flashing

Eave flashing

Indicate thicknesses, dimensions, fastenings and 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 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 immediately before installation.

PART 2 PRODUCTS: ALL PRODUCT STANDARDS LISTED BELOW MAY USE EQUIVALENT EUROPEAN OR INDIAN STANDARDS AS DETERMINED BY AND ACCEPTED BY THE CONTRACTING OFFICER.

2.1 MATERIALS

Do not use lead, lead-coated metal, or galvanized steel. Use any metal listed by SMACNA Arch. Manual for a particular item, unless otherwise specified or indicated. Conform to the requirements specified and to the thicknesses and configurations established in SMACNA Arch. Manual for the materials. 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.

Furnish sheet metal items in 2400 to 3000 mm lengths. Single pieces less than 2400 mm long may be used to connect to factory-fabricated inside and outside corners, and at ends of runs. Factory fabricate corner pieces with minimum 300 mm 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 Exposed Sheet Metal Items

Must be of the same material. Consider the following as exposed sheet metal: gutters, including hangers; downspouts; gravel stops and fascias; cap, valley, steeped, base, and eave flashings and related accessories.

2.1.2 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.

2.1.3 Steel Sheet, Zinc-Coated (Galvanized)

ASTM A 653/A 653M or equivalent as accepted by the Contracting Officer.

2.1.3.1 Finish

Exposed exterior items of zinc-coated steel sheet must have a baked-on, factory-applied color coating of polyvinylidene fluoride or other equivalent fluorocarbon coating applied after metal substrates have been cleaned and pretreated. Provide finish coating dry-film thickness of 0.020 to 0.033 mm and color as approved by Contracting Officer from manufacturer’s standard list submitted by the contractor.

2.1.4 Zinc Sheet and Strip

ASTM B 69, Type I, a minimum of 0.61 mm thick.

2.1.5 Stainless Steel

ASTM A 167, Type 302 or 304, 2D Finish, fully annealed, dead-soft temper.

2.1.6 Terne-Coated Steel

Minimum of 350 by 500 mm with minimum of 18 kilogram coating per double base box. ASTM A 308/A 308M.

2.1.7 Aluminum Alloy Sheet and Plate

ASTM B 209M, color as approved by Contracting Officer from manufacturer’s standard list submitted by the contractor.

2.1.7.1 Alclad

When fabricated of aluminum, fabricate the items Alclad 3003, Alclad 3004, Alclad 3005, clad on both sides unless otherwise indicated.

a. Gutters, downspouts, and hangers

b. Fascias

c. Flashing

2.1.7.2 Finish

Exposed exterior sheet metal items of aluminum must have a baked-on, factory-applied color coating of polyvinylidene fluoride (PVF2) or other equivalent fluorocarbon coating applied after metal substrates have been cleaned and pretreated. Provide finish coating dry-film thickness of 0.020 to 0.033 mm, and color as selected by Contracting Officer from manufacturer’s standard list submitted by the contractor.

2.1.8 Aluminum Alloy, Extruded Bars, Rods, Shapes, and Tubes

ASTM B 221M.

2.1.9 Solder

ASTM B 32, 95-5 tin-antimony.

2.1.10 Polyvinyl Chloride Reglet

ASTM D 1784, Type II, Grade 1, Class 14333-D, 1.9 mm minimum thickness.

2.1.11 Bituminous Plastic Cement

ASTM D 4586, Type I.

2.1.12 Roofing Felt
ASTM D 226 Type I.

2.1.13 Asphalt Primer

ASTM D 41.

2.1.14 Fasteners

Use the same metal or a metal compatible with the item fastened. Use stainless steel fasteners to fasten 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 13 mm 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 Arch. Manual, Architectural Sheet Metal Manual or similar standard. 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 450 mm. Confine nailing of flashing to one edge only. Space nails evenly not over 75 mm on center and approximately 13 mm from edge unless otherwise specified or indicated. Face nailing will not be 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.

3.1.3 Cleats

Provide cleats for sheet metal 450 mm and over in width. Space cleats evenly not over 300 mm on center unless otherwise specified or indicated. Unless otherwise specified, provide cleats of 50 mm wide by 75 mm 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. Pretin 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 1.0 mm 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 Flat-lock Seams

Finish not less than 20 mm wide.

3.1.5.2 Lap Seams

Finish soldered seams not less than 25 mm wide. Overlap seams not soldered, not less than 75 mm.

3.1.5.3 Loose-Lock Expansion Seams

Not less than 75 mm wide; provide minimum 25 mm movement within the joint. Completely fill the joints with the specified sealant, applied at not less than 3 mm thick bed.

3.1.5.4 Standing Seams

Not less than 25 mm high, double locked without solder.

3.1.5.5 Flat Seams

Make seams in the direction of the flow.

3.1.6 Soldering

Where soldering is specified, apply to copper, terne-coated stainless steel, zinc-coated steel, and stainless steel items. Pretin 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 one mm or less in thickness with specified sealants. Do not solder aluminum.

3.1.7 Welding and Mechanical Fastening

Use welding for aluminum of thickness greater than one mm. Aluminum one mm or less in thickness must be butted and the space backed with formed flashing plate; or lock joined, mechanically fastened, and filled with sealant as recommended by the aluminum manufacturer.

3.1.7.1 Welding of Aluminum

Use welding of the inert gas, shield-arc type. For procedures, appearance and quality of welds, and the methods used in correcting welding work, conform to AWS D1.2/D1.2M.

3.1.7.2 Mechanical Fastening of Aluminum

Use No. 12, aluminum alloy, sheet metal screws or other suitable aluminum alloy or stainless steel fasteners. Drive fasteners in holes made with a No. 26 drill in securing side laps, end laps, and flashings. Space fasteners 300 mm maximum on center. Where end lap fasteners are required to improve closure, locate the end lap fasteners not more than 50 mm from the end of the overlapping sheet.

3.1.8 Protection from Contact with Dissimilar Materials

3.1.8.1 Copper or Copper-bearing Alloys

Paint with heavy-bodied bituminous paint surfaces in contact with dissimilar metal, or separate the surfaces by means of moisture proof building felts.

3.1.8.2 Aluminum

Do not allow aluminum surfaces in direct contact with other metals except stainless steel, zinc, or zinc coating. Where aluminum contacts another metal, paint the dissimilar metal with a primer followed by two coats of aluminum paint. Where drainage from a dissimilar metal passes over aluminum, paint the dissimilar metal with a non-lead pigmented paint.

3.1.8.3 Metal Surfaces

Paint surfaces in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.1.8.4 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.

3.1.9 Expansion and Contraction

Provide expansion and contraction joints at not more than 9750 mm intervals for aluminum and at not more than 12 meter 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 fascias by expansion and contraction joints spaced not more than 3600 mm apart.

3.1.10 Base Flashing

Extend up vertical surfaces of the flashing not less than 200 mm and not less than 100 mm under the roof covering. Where finish wall coverings form a counter-flashing, extend the vertical leg of the flashing up behind the applied wall covering not less than 150 mm. Overlap the flashing strips with the previously laid flashing not less than 75 mm. Fasten the strips 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 inch 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. Extend the metal flashing over crickets at the up-slope side of chimneys, curbs, and similar vertical surfaces extending through sloping roofs, the metal flashings. Extend the metal flashings onto the roof covering not less than 115 mm at the lower side of chimneys, and similar vertical surfaces extending through the roof decks. Install and fit the flashings so as to be completely weather tight. Provide factory-fabricated base flashing for interior and exterior corners. Do not use metal base flashing on built-up roofing.

3.1.11 Counter-flashing

Except where indicated or specified otherwise, insert counter-flashing in reglets located from 230 to 250 mm above roof decks, extend down vertical surfaces over upturned vertical leg of base flashings not less than 75 mm. Fold the exposed edges of counter-flashings 13 mm. Where stepped counter-flashings are required, they may be installed in short lengths a minimum 8 inch by 8 inch or may be of the preformed one-piece type. Provide end laps in counter-flashings not less than 75 mm and make it weather tight with plastic cement. Do not make lengths of metal counter-flashings exceed 3000 mm. Form the flashings to the required shapes before installation. Factory-form the corners not less than 300 mm from the angle. Secure the flashings in the reglets with lead wedges and space not more than450 mm apart; on chimneys and short runs, place wedges closer together. Fill caulked-type reglets or raked joints which receive counter-flashing with caulking compound. Turn up the concealed edge of counter-flashings built into masonry or concrete walls not less than 6 mm and extend not less than 50 mm into the walls. Install counter-flashing to provide a spring action against base flashing. Where bituminous base flashings are provided, extend down the counter flashing as close as practicable to the top of the cant strip.

Factory form counter flashing to provide spring action against the base flashing.

3.1.12 Metal Reglets

Provide factory fabricated caulked type or friction type reglets with a minimum opening of 6 mm and a depth of 30 mm, as approved.

3.1.12.1 Caulked Reglets

Provide with rounded edges and metal strap brackets or other anchors for securing to the concrete forms. Provide reglets with a core to protect them from injury during the installation. Provide built-up mitered corner pieces for internal and external angles. Wedge the flashing in the reglets with lead wedges every 450 mm, caulked full and solid with an approved compound.

3.1.12.2 Friction Reglets

Provide with flashing receiving slots not less than 16 mm deep, 25 mm jointing tongues, and upper and lower anchoring flanges installed at 24 inch maximum snap-lock receiver. Insert the flashing the full depth of the slot and lock by indentations made with a dull-pointed tool, wedges, and filled with a sealant. For friction reglets, install flashing snaplock receivers at 24 inch on center maximum. When the flashing has been inserted the full depth, caulk the slot and lock and fill with sealant.

3.1.13 Polyvinyl Chloride Reglets Temporary Construction Installation

Rigid polyvinyl chloride reglets ASTM D 1784, Type II, Grade 1, Class 14333-D, 0.075 inch minimum thickness may be provided in lieu of metal reglets for temporary construction.

3.1.14 Metal Drip Edge

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 75 mm and secure with compatible nails spaced not more than250 mm on center along upper edge.

3.1.15 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 20 by 5 mm of material compatible with gutter. Fabricate gutters in sections not less than 2400 mm. Lap the sections a minimum of 25 mm in the direction of flow or provide with concealed splice plate 150 mm minimum. Join the gutters, other than aluminum, by riveted and soldered joints. Join aluminum gutters with riveted sealed 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 on adjustable hangers spaced not more than 750 mm on center by continuous cleats and or by cleats spaced not less than 36 inch apart. Adjust gutters to slope uniformly to

outlets, with high points occurring midway between outlets. Fabricate hangers and fastenings from metals.

3.1.16 Downspouts

Space supports for downspouts according to the manufacturer's recommendation for the masonry or steel substrate. Types, shapes and sizes are indicated. Provide complete including elbows and offsets. Provide downspouts in approximately 3000 mm lengths. Provide end joints to telescope not less than 13 mm 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 25 mm away from walls. Fasten to the walls at top, bottom, and at an intermediate point not to exceed 1500 mm on center with leader straps or concealed rack-and-pin type fasteners. Form straps and fasteners of metal compatible with the downspouts.

3.1.16.1 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. Set precast splash blocks of 4000 psi concrete with 6 percent air content on solid support true to line and grade for drainage. Splash blocks shall be precast at manufacturer's plant or 4000 psi concrete with 6 percent air content, have smooth surfaces true to line and face, and be free from defects and sharp rises. Provide splash pans as specified.

3.1.17 Eave Flashing

One piece in width, applied in 2400 to 3000 mm lengths with expansion joints spaced as specified in paragraph entitled "Expansion and Contraction." Provide a 20 mm continuous fold in the upper edge of the sheet to engage cleats spaced not more than 250 mm on center. Locate the upper edge of flashing not less than 450 mm 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 25 mm flat locked joints with cleats that are 250 mm on center.

3.1.18 Sheet Metal Covering on Flat or Sloped Surfaces

Except as specified or indicated otherwise, cover and flash all minor flat, sloped, or curved surfaces such as crickets, bulkheads, and small decks with metal sheets of the material used for flashing; maximum size of sheets, 375 by 455 mm. Fasten sheets to sheathing with metal cleats. Lock seams and solder. Lock aluminum seams as recommended by aluminum manufacturer. Provide an underlayment of roofing felt for all sheet metal covering.

3.1.19 Flashing at Roof Penetrations and Equipment Supports

Provide metal flashing for all pipes, ducts, and conduits projecting through the roof surface and for equipment supports, guy wire anchors, and similar items supported by or attached to the roof deck.

3.1.20 Single Pipe Vents

See Table I, footnote (d). Set flange of sleeve in bituminous plastic cement and nail 75 mm on center. Bend the top of sleeve over and extend down into the vent pipe a minimum of 50 mm. Set metal housing with a metal sleeve having a 100 mm roof flange in bituminous plastic cement and nailed 75 mm on center. Extend sleeve a minimum of 200 mm above the roof deck and lapped a minimum of 75 mm by a metal hood secured to the vent pipe by a draw band. Seal the area of hood in contact with vent pipe with an approved sealant.

3.1.21 Stepped Flashing

Stepped flashing shall be installed where sloping roofs surfaced with shingles abut vertical surfaces. Separate pieces of base flashing shall be placed in alternate shingle courses.

3.1.22 Copings

Provide coping using copper sheets 2400 or 3000 mm long joined by a 20 mm locked and soldered seam. Terminate outer edges in edge strips. Install with sealed joints as indicated.

3.2 PAINTING

Field-paint sheet metal for separation of dissimilar materials.

3.2.1 Aluminum Surfaces

Shall be solvent cleaned and given one coat of zinc-molybdate primer and one coat of aluminum paint.

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. Furnish 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	Aluminum, mm	Stainless Steel, mm	Terne-Coated Stainless Steel, mm	Zinc-Coated Steel, mm
Building Expansion Joints				
Cover.....	0.81	0.38	0.38	0.6
Waterstop-bellows or flanged, U-type.....	-	0.38	0.38	-
Covering on minor flat, pitched or curved surfaces.....	1.02	0.46	0.46	-
Downspouts and leaders.....	0.81	0.38	0.38	0.6
Downspout clips and anchors.....	-	1.02 clip	-	-	-
	-	3.175 anchor	-	-	-
Downspout straps, 50 mm.....	1.52	1.27	-	-
Strainers, wire diameter or gage....	3.66 diameter	2.77 diameter	-	
Flashings:				
Base.....	1.02	0.46	0.46	0.6
Cap (Counter-flashing)	0.81	0.38	0.38	0.5
Eave.....	-	0.38	0.38	0.6
Spandrel beam.....	-	0.25	0.25	-
Bond barrier.....	-	0.38	0.38	-
Stepped.....	0.81	0.38	0.38	-
Roof drain.....				
Pipe vent sleeve(d)				
Gravel stops and fascias:				
Extrusions.....	1.91	-	-	-
Sheets, corrugated.....	0.81	0.38	0.38	-

Sheets, smooth.....	1.27	0.46	0.46	0.6
Edge strip.....	1.27	0.635	-	-
Gutters:				
Gutter section.....	0.81	0.38	0.38	0.6
Continuous cleat.....	0.81	0.38	0.38	0.6
Hangers, dimensions.....	25 mm x 2 mm (c)	25 mm x 1 mm	-	-
Joint Cover plates... See Table II)	0.81	0.38	0.38	0.6
Reglets (c).....	-	0.25	0.25	-
Splash pans.....	1.02	0.46	0.46	-

(a) Brass.

(b) May be lead weighing 19.6 kilograms per square meter.

(c) May be polyvinyl chloride.

(d) 12.25 kilogram minimum lead sleeve with 100 mm flange. Where lead sleeve is impractical, refer to paragraph entitled "Single Pipe Vents" for optional material.

-- End of Section --

SECTION 07 84 00

FIRESTOPPING
04/06

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; European and Indian standards may be used in lieu of as determined or accepted by the Contracting Officer.

ASTM INTERNATIONAL (ASTM)

ASTM E 1966	(2001) Fire-Resistive Joint Systems

FM GLOBAL (FM)

FM AS 4991	(2001) Approval of Firestop Contractors
FM P7825a	(2005) Approval Guide Fire Protection

UNDERWRITERS LABORATORIES (UL)

UL 1479	(2003) Fire Tests of Through-Penetration Firestops
UL 2079	(2004) Tests for Fire Resistance of Building Joint Systems
UL 723	(2003; Rev thru May 2005) Standard for Test for Surface Burning Characteristics of Building Materials
UL Fire Resistance	(2007) Fire Resistance Directory Set

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Firestopping Materials.

Detail drawings including manufacturer's descriptive data, typical details conforming to UL Fire Resistance or other details certified

by another nationally recognized testing laboratory, installation instructions or UL listing details for a firestopping assembly in lieu of fire-test data or report or recognized European or Indian standard as accepted by the contracting officer. For those firestop applications for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgment, derived from similar UL system designs or other tests, shall be submitted for review and approval prior to installation. Submittal shall indicate the firestopping material to be provided for each type of application. When more than a total of 5 penetrations and/or construction joints are to receive firestopping, provide drawings that indicate location, "F" and "T" ratings, and type of application.

SD-07 Certificates

Firestopping Materials.

Certificates attesting that fire stopping material comply with the specified requirements. In lieu of certificates, drawings showing UL classified materials as part of a tested assembly may be provided. Drawings showing evidence of testing by an alternate internationally recognized independent laboratory may be substituted (the contracting officer has final authority for determination of acceptance of international standards).

Installer Qualifications.

Documentation of training and experience.

Inspection.

Contractor shall provide certification stating that firestopping work has been inspected and found to be applied according to the manufacturer's recommendations and the specified requirements.

1.3 GENERAL REQUIREMENTS

Firestopping shall consist of furnishing and installing tested and listed firestop systems, combination of materials, or devices to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls, partitions, floors, and ceiling-floor assemblies, including through-penetrations and construction joints and gaps. Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; firestopping material shall not interfere with the required movement of the joint. Gaps requiring firestopping include gaps between the top of the fire-rated walls and the roof or floor deck above.

1.4 DELIVERY AND STORAGE

Materials shall be delivered in the original unopened packages or containers showing name of the manufacturer and the brand name. Materials shall be stored off the ground and shall be protected from damage and exposure to elements. Damaged or deteriorated materials shall be removed from the site.

1.5 INSTALLER QUALIFICATIONS

The Contractor shall engage an experienced Installer who is:

a. FM Research approved in accordance with FM AS 4991, or

b. Certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary staff, training, and a minimum of 3 years experience in the installation of manufacturer's products per specified requirements (written certification is required if requested by the Contracting Officer). A manufacturer's willingness to sell its firestopping products to the Contractor or to an installer engaged by the Contractor does not in itself confer qualification on the buyer. The Installer shall have been trained by a direct representative of the manufacturer (not distributor or agent) in the proper selection and installation procedures.

1.6 COORDINATION

The specified work shall be coordinated with other trades. Firestopping materials, at penetrations of pipes and ducts, shall be applied prior to insulating, unless insulation meets requirements specified for firestopping. Firestopping materials at building joints and construction gaps shall be applied prior to completion of enclosing walls or assemblies. Cast-in-place firestop devices shall be located and installed in place before concrete placement. Pipe, conduit or cable bundles shall be installed through cast-in-place device after concrete placement but before area is concealed or made inaccessible.

PART 2 PRODUCTS

2.1 FIRESTOPPING MATERIALS

Firestopping materials shall consist of commercially manufactured, asbestos-free, noncombustible products FM P7825a approved, or UL listed, or accepted equivalent, for use with applicable construction and penetrating items, complying with the following minimum requirements:

2.1.1 Fire Hazard Classification

Material shall have a flame spread of 25 or less, and a smoke developed rating of 50 or less, when tested in accordance with ASTM E 84 or UL 723 or certification of flame spread by an equivalent standard. Material shall be an approved firestopping material as listed in UL Fire Resistance or by a recognized testing laboratory as determined by the Contracting Officer

2.1.2 Toxicity

Material shall be nontoxic to humans at all stages of application or during fire conditions.

2.1.3 Fire Resistance Rating

Firestop systems shall be UL Fire Resistance listed or FM P7825a or equivalent, approved with "F" rating at least equal to fire-rating of fire wall or floor in which penetrated openings are to be protected, except that "F" rating may be 3 hours in through-penetrations of 4 hour fire rated wall

or floor. Firestop systems shall also have "T" rating where required. In lieu of UL ratings, contractor may provide documentation of fire rating as accepted by the contracting officer (this applies to 1, 2, 3 or 4 hour fire resistance ratings). In no instances will firestopping matieral be installed without this acceptance.

2.1.3.1 Through-Penetrations

Firestopping materials for through-penetrations, as described in paragraph GENERAL REQUIREMENTS, shall provide "F" and "T" fire resistance ratings in accordance with ASTM E 814 or UL 1479 or equivalent. Fire resistance ratings shall be as follows:

a. Penetrations of Fire Resistance Rated Walls and Partitions: F Rating = Rating of wall or partition being penetrated.

b. Penetrations of Fire Resistance Rated Floors, Floor-Ceiling Assemblies and the ceiling membrane of Roof-Ceiling Assemblies: F Rating = 1 hour, T Rating = 1 hour.

2.1.3.2 Construction Joints and Gaps

Fire resistance ratings of construction joints and gaps such as those between floor slabs or roof decks shall be the same as the construction in which they occur. Construction joints and gaps shall be provided with firestopping materials and systems that have been tested per ASTM E 119, ASTM E 1966 or UL 2079 to meet the required fire resistance rating. Systems installed at construction joints shall meet the cycling requirements of ASTM E 1399 or UL 2079 or equivalent standard

PART 3 EXECUTION

3.1 PREPARATION

Areas to receive firestopping shall be free of dirt, grease, oil, or loose materials which may affect the fitting or fire resistance of the firestopping system. For cast-in-place firestop devices, formwork or metal deck to receive device prior to concrete placement shall be sound and capable of supporting device. Surfaces shall be prepared as recommended by the manufacturer.

3.2 INSTALLATION

Firestopping material shall completely fill void spaces regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping systems for filling floor voids 100 mm or more in any direction shall be capable of supporting the same load as the floor is designed to support or shall be protected by a permanent barrier to prevent loading or traffic in the firestopped area. Firestopping shall be installed in accordance with manufacturer's written instructions. Tested and listed firestop systems shall be provided in the following locations, except in floor slabs on grade:

a. Penetrations of duct, conduit, tubing, cable and pipe through floors and through fire-resistance rated walls, partitions, and ceiling-floor assemblies.

b. Penetrations of vertical shafts such as pipe chases, elevator shafts, and utility chutes.

c. Gaps at the intersection of floor slabs and curtain walls, including inside of hollow curtain walls at the floor slab.

d. Gaps at perimeter of fire-resistance rated walls and partitions, such as between the top of the walls and the bottom of roof decks.

e. Construction joints in floors and fire rated walls and partitions. All construction joints must meet the fire rating of the wall as shown on the contract plans.

f. Other locations where required to maintain fire resistance rating of the construction.

3.2.1 Insulated Pipes and Ducts

Thermal insulation shall be cut and removed where pipes or ducts pass through firestopping, unless insulation meets requirements specified for firestopping. Thermal insulation shall be replaced with a material having equal thermal insulating and firestopping characteristics.

3.3 INSPECTION

For all projects, the firestopped areas shall not be covered or enclosed until inspection is complete and approved by the contractor and accepted by the Contracting officer. The contractor shall inspect the applications initially to ensure adequate preparations (clean surfaces suitable for application, etc.) and periodically during the work to assure that the completed work has been accomplished according to the manufacturer's written instructions and the specified requirements. The Contractor shall submit written reports indicating locations of and types of penetrations and types of firestopping used at each location; type shall be recorded by UL listed printed numbers.

-- End of Section --

SECTION 07 92 00

JOINT SEALANTS
01/07

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; the contractor may provide European or Indian equivalent standards in lieu of as accepted/determined by the Contracting Officer.

ASTM INTERNATIONAL (ASTM)

ASTM C 1311	(2002) Standard Specification for Solvent Release Agents
ASTM C 509	(2006) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C 834	(2005) Latex Sealants
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM D 1056	(2000) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1667	(2005) Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
ASTM D 2452	(2003) Standard Test Method for Extrudability of Oil- and Resin-Base Caulking Compounds
ASTM D 2453	(2003) Standard Test Method for Shrinkage and Tenacity of Oil- and Resin-Base Caulking Compounds

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sealants

Primers

Bond breakers

Backstops

Manufacturer's descriptive data including storage requirements, shelf life, curing time, instructions for mixing and application, and primer data (if required). Provide a copy of the Material Safety Data Sheet for each solvent, primer or sealant material.

SD-07 Certificates

Sealant

Certificates of compliance stating that the materials conform to the specified requirements.

1.3 ENVIRONMENTAL CONDITIONS

Apply sealant when the ambient temperature is between 4 and 32 degrees C.

1.4 DELIVERY AND STORAGE

Deliver materials to the job site in unopened manufacturers' external shipping containers, with brand names, date of manufacture, color, and material designation clearly marked thereon. Label elastomeric sealant containers to identify type, class, grade, and use. Carefully handle and store materials to prevent inclusion of foreign materials or subjection to sustained temperatures exceeding 32 degrees C or less than 4 degrees C.

1.5 QUALITY ASSURANCE

1.5.1 Compatibility with Substrate

Verify that each of the sealants are compatible for use with joint substrates.

1.5.2 Joint Tolerance

Provide joint tolerances in accordance with manufacturer's printed instructions.

1.6 SPECIAL WARRANTY

Guarantee sealant joint against failure of sealant and against water penetration through each sealed joint for five years.

PART 2 PRODUCTS

2.1 SEALANTS

Provide sealant that has been tested and found suitable for the substrates to which it will be applied.

2.1.1 Interior Sealant

Provide ASTM C 920, Type S or M, Grade NS, Class 12.5, Use NT or equivalent as determined/accepted by the Contracting Officer. Location(s) and color(s) of sealant for the following:

	LOCATION	COLOR
a.	Small voids between walls or partitions and adjacent casework, shelving, door frames, built-in or surface-mounted equipment and fixtures, and similar items.	As selected
b.	Perimeter of frames at doors, windows, and access panels which adjoin exposed interior concrete and masonry surfaces.	As selected
c.	Joints of interior masonry walls and partitions which adjoin columns, pilasters, concrete walls, and exterior walls unless otherwise detailed.	As selected
d.	Interior locations, not otherwise indicated or specified, where small voids exist between materials specified to be painted.	As selected
e.	Joints between ablution trough and ceramic tile; joints between shower receptors and ceramic tile; joints formed where nonplaner tile surfaces meet.	As selected
f.	Joints formed between tile floors and tile base cove; joints between tile and dissimilar materials; joints occurring where substrates change.	As selected
g.	Behind escutcheon plates at valve pipe penetrations and showerheads in showers.	As selected

2.1.2 Exterior Sealant

For joints in vertical surfaces, provide ASTM C 920, Type S or M, Grade NS, Class 25, Use NT or equivalent as determined/accepted by the Contracting Officer. For joints in horizontal surfaces, provide ASTM C 920, Type S or M, Grade P, Class 25, Use T. Provide location(s) and color(s) of sealant as follows:

	LOCATION	COLOR
a.	Joints and recesses formed where frames and subsills of windows, doors, louvers, and vents adjoin masonry, concrete, or metal frames. Use sealant at both exterior and interior surfaces of exterior wall penetrations.	Match adjacent surface color Match adjacent surface color
b.	Joints between new and existing exterior	Match adjacent

	masonry walls.	surface color
c.	Masonry joints where shelf angles occur.	Match adjacent surface color
d.	Expansion and control joints.	Match adjacent surface color
e.	Interior face of expansion joints in exterior concrete or masonry walls where metal expansion joint covers are not required.	Match adjacent surface color
f.	Voids where items pass through exterior walls.	Match adjacent surface color
g.	Metal reglets, where flashing is inserted into masonry joints, and where flashing is penetrated by coping dowels.	Match adjacent surface color
h.	Metal-to-metal joints where sealant is indicated or specified.	Match adjacent surface color
i.	Joints between ends of fascias, copings, and adjacent walls.	Match adjacent surface color

2.1.3 Floor Joint Sealant

ASTM C 920, Type S or M, Grade P, Class 25, Use NT or equivalent as determined/accepted by the Contracting Officer.. Provide location(s) and color(s) of sealant as follows:

	LOCATION	COLOR
a.	Seats of metal thresholds for exterior doors.	Gray
b.	Control and expansion joints in floors, slabs, ceramic tile, and walkways.	Gray

2.1.4 Preformed Sealant

Provide preformed sealant of polybutylene or isoprene-butylene based pressure sensitive weather resistant tape or bead sealant capable of sealing out moisture, air and dust when installed as recommended by the manufacturer. At temperatures from minus 34 to plus 71 degrees C, the sealant must be non-bleeding and no loss of adhesion.

2.2 PRIMERS

Provide a nonstaining, quick-drying type and consistency recommended by the sealant manufacturer for the particular application.

2.3 BOND BREAKERS

Provide the type and consistency recommended by the sealant manufacturer to prevent adhesion of the sealant to backing or to bottom of the joint.

2.4 BACKSTOPS

Provide glass fiber roving or neoprene, butyl, polyurethane, or polyethylene foams free from oil or other staining elements as recommended by sealant manufacturer. Provide 25 to 33 percent oversized backing for closed cell and 40 to 50 percent oversized backing for open cell material, unless otherwise indicated. Make backstop material compatible with sealant. Do not use oakum and other types of absorptive materials as backstops.

2.4.1 Rubber

As recommended by the manufacturer.

2.4.2 Synthetic Rubber

As recommended by the manufacture

2.4.3 Neoprene

Conform to ASTM D 1056, closed cell expanded neoprene cord Type 2, Class C, Grade 2C2 for Neoprene backing or equivalent as determined/accepted by the Contracting Officer..

2.4.4 Butyl Rubber Based

Provide Butyl Rubber Based Sealants of single component, solvent release, color as selected by contracting officer from manufacturer’s standard listing submitted by contractor,.

2.5 CAULKING

As recommended by the manufacturer.

2.6 CLEANING SOLVENTS

Provide type(s) recommended by the sealant manufacturer except for aluminum and bronze surfaces that will be in contact with sealant.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Clean surfaces from dirt frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter that would tend to destroy or impair adhesion. Remove oil and grease with solvent. Surfaces must be wiped dry with clean cloths. When resealing an existing joint, remove existing calk or sealant prior to applying new sealant. For surface types not listed below, contact sealant manufacturer for specific recommendations.

3.1.1 Steel Surfaces

Remove loose mill scale by sandblasting or, if sandblasting is impractical or would damage finish work, scraping and wire brushing. Remove protective coatings by sandblasting or using a residue-free solvent.

3.1.2 Aluminum Surfaces

Remove temporary protective coatings from surfaces that will be in contact with sealant. When masking tape is used as a protective coating, remove tape and any residual adhesive just prior to sealant application. For removing protective coatings and final cleaning, use nonstaining solvents recommended by the manufacturer of the item(s) containing aluminum or bronze surfaces.

3.1.3 Concrete and Masonry Surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials, remove materials by sandblasting or wire brushing. Laitance, remove efflorescence and loose mortar from the joint cavity.

3.1.4 Wood Surfaces

Keep wood surfaces to be in contact with sealants free of splinters and sawdust or other loose particles.

3.2 SEALANT PREPARATION

Do not add liquids, solvents, or powders to the sealant. Mix multi-component elastomeric sealants in accordance with manufacturer's instructions.

3.3 APPLICATION

3.3.1 Joint Width-To-Depth Ratios

a. Acceptable Ratios:

JOINT WIDTH	JOINT DEPTH Minimum	JOINT DEPTH Maximum
For metal, glass, or other nonporous surfaces:		
6 mm (minimum)	6 mm	6 mm
over 6 mm	1/2 of width	Equal to width
For wood, concrete, masonry or stone		
6 mm (minimum)	6 mm	6 mm
Over 6 mm to 13 mm	6 mm	Equal to width
Over 13 mm to 50 mm	50 mm	16 mm
Over 50 mm	(As recommended by sealant manufacturer)	

b. Unacceptable Ratios: Where joints of acceptable width-to-depth ratios have not been provided, clean out joints to acceptable depths and grind or cut to acceptable widths without damage to the adjoining work. Grinding is not required on metal surfaces.

3.3.2 Masking Tape

Place masking tape on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Remove masking tape within 10 minutes after joint has been filled and tooled.

3.3.3 Backstops

Install backstops dry and free of tears or holes. Tightly pack the back or bottom of joint cavities with backstop material to provide a joint of the depth specified. Install backstops in the following locations:

a. Where indicated.

b. Where backstop is not indicated but joint cavities exceed the acceptable maximum depths specified in paragraph entitled, "Joint Width-to-Depth Ratios".

3.3.4 Primer

Immediately prior to application of the sealant, clean out loose particles from joints. Where recommended by sealant manufacturer, apply primer to joints in concrete masonry units, wood, and other porous surfaces in accordance with sealant manufacturer's instructions. Do not apply primer to exposed finish surfaces.

3.3.5 Bond Breaker

Provide bond breakers to the back or bottom of joint cavities, as recommended by the sealant manufacturer for each type of joint and sealant used, to prevent sealant from adhering to these surfaces. Carefully apply the bond breaker to avoid contamination of adjoining surfaces or breaking bond with surfaces other than those covered by the bond breaker.

3.3.6 Sealants

Provide a sealant compatible with the material(s) to which it is applied. Do not use a sealant that has exceeded shelf life or has jelled and cannot be discharged in a continuous flow from the gun. Apply the sealant in accordance with the manufacturer's printed instructions with a gun having a nozzle that fits the joint width. Force sealant into joints to fill the joints solidly without air pockets. Tool sealant after application to ensure adhesion. Make sealant uniformly smooth and free of wrinkles. Upon completion of sealant application, roughen partially filled or unfilled joints, apply sealant, and tool smooth as specified. Apply sealer over the sealant when and as specified by the sealant manufacturer.

3.4 PROTECTION AND CLEANING

3.4.1 Protection

Protect areas adjacent to joints from sealant smears. Masking tape may be used for this purpose if removed 5 to 10 minutes after the joint is filled.

3.4.2 Final Cleaning

Upon completion of sealant application, remove remaining smears and stains and leave the work in a clean and neat condition.

a. Masonry and Other Porous Surfaces: Immediately scrape off fresh sealant that has been smeared on masonry and rub clean with a solvent as recommended by the sealant manufacturer. Allow excess sealant to cure for 24 hour then remove by wire brushing or sanding.

b. Metal and Other Non-Porous Surfaces: Remove excess sealant with a solvent-moistened cloth.

-- End of Section --

SECTION 08 11 13

STEEL DOORS AND FRAMES

07/06

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; European or Indian publications and standards may be used in lieu of as determined/accepted by the Contracting Officer.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2006; Errata 2006) Structural Welding Code Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 653/A 653M	(2007) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 879/A 879M	(2006) Standard Specification for Steel Sheet, zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
ASTM A 924/A 924M	(2006) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM C 578	(2006) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 591	(2005) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 612	(2004) Mineral Fiber Block and Board Thermal Insulation
ASTM E 283	(2004) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA A115	(2006) (Complete Set - Spec dates Vary) Specifications for Door and Frame Preparation for Hardware (Incl A115.1 (1990), A115.2 (1987), A115.4 (1994), A115.5 (1992), A115.6 (1993), A115.12 (1994), A115.13 (1991), A115.14 (1994), A115.15 (1994), A115.16 (1990), A115.17 (1994), A115.18 (1994)

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM HMMA HMM	(1999; R 2000) Hollow Metal Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 105	(2006) Installation of Smoke Door Assemblies
NFPA 252	(2003) Standard Methods of Fire Tests of Door Assemblies
NFPA 80	(2007) Standard for Fire Doors and Other Opening Protectives

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR 111	(2000) Recommended Selection and Usage Guide for Standard Steel Doors, Frames and Accessories
SDI/DOOR A250.11	(2001) Recommended Erection Instructions for Steel Frames
SDI/DOOR A250.6	(2003) Hardware on Steel Doors (Reinforcement - Application)
SDI/DOOR A250.8	(2003) Recommended Specification for Standard Steel Doors and Frames

UNDERWRITERS LABORATORIES (UL)

UL 10B	(1997; Rev thru Oct 2001) Fire Tests of Door Assemblies

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors; G

Frames; G

Accessories

Weatherstripping

Show elevations, construction details, metal gages, hardware provisions, method of glazing, and installation details.

Schedule of doors;

Schedule of frames;

Submit door and frame locations.

SD-03 Product Data

Doors;

Frames;

Accessories

Weatherstripping

Submit manufacturer's descriptive literature for doors, frames, and accessories. Include data and details on door construction, panel internal reinforcement, insulation, and door edge construction. When "custom hollow metal doors" are provided in lieu of "standard steel doors," provide additional details and data. All fire rated doors, frames and appurtenances require manufacturer’s certification as a submittal.

SD-04 Samples

Factory-applied enamel finish;

Where colors are not indicated, submit manufacturer's standard colors and patterns for selection.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver doors, frames, and accessories undamaged and with protective wrappings or packaging. Strap frames in bundles. Provide temporary steel spreaders securely fastened to the bottom of each welded frame. Store doors and frames on platforms under cover in clean, dry, ventilated, and accessible locations, with 6 mm airspace between doors. Remove damp or wet packaging immediately and wipe affected surfaces dry. Replace damaged materials with new.

PART 2 PRODUCTS (EUROPEAN OR INDIAN DOOR STANDARDS LISTED HEREIN MAY BE USED IN LIEU OF THE SDI STANDARDS AS DETERMINED/ACCEPTED BY THE CONTRACTING OFFICER).

2.1 STANDARD STEEL DOORS

SDI/DOOR A250.8, except as specified otherwise. Prepare doors to receive door hardware. Undercut where indicated. Exterior doors shall have top edge closed flush and sealed to prevent water intrusion. Doors shall be 44.5 mm thick, unless otherwise indicated.

2.2 INSULATED STEEL DOOR SYSTEMS

Insulated steel doors shall have a core of polyurethane foam and an R factor of 10.0 or more (based on a k value of 0.16); face sheets, edges, and frames of galvanized steel not lighter than 0.7 mm thick, 1.5 mm thick, and 1.5 mm respectively; magnetic weatherstripping; nonremovable-pin hinges; thermal-break aluminum threshold; and vinyl door bottom. Doors and frames shall receive phosphate treatment, rust-inhibitive primer, and baked acrylic enamel finish. Doors shall have been tested in accordance with SDI/DOOR A250.4 and shall have met the requirements for Level C. Prepare doors to receive specified hardware. Doors shall be 44.5 mm thick. Provide insulated steel doors and frames at exterior doors to all buildings.

2.3 ACCESSORIES

2.3.1 Moldings

Provide moldings around glass of interior and exterior doors and louvers of interior doors. Provide nonremovable moldings on outside of exterior doors and on corridor side of interior doors. Other moldings may be stationary or removable. Secure inside moldings to stationary moldings, or provide snap-on moldings. Muntins shall interlock at intersections and shall be fitted and welded to stationary moldings.

2.4 STANDARD STEEL FRAMES

SDI/DOOR A250.8, Level 2, except as otherwise specified. Form frames to sizes and shapes indicated, with welded corners. Provide steel frames for doors, unless otherwise indicated.

2.4.1 Welded Frames

Continuously weld frame faces at corner joints. Mechanically interlock or continuously weld stops and rabbets. Grind welds smooth.

Weld frames in accordance with the recommended practice of the Structural Welding Code Sections 1 through 6, AWS D1.1/D1.1M and in accordance with the practice specified by the producer of the metal being welded.

2.4.2 Mullions

Mullions shall be closed or tubular construction and be a member with heads and jambs butt-welded thereto or knock-down for field assembly. Bottom of door mullions shall have adjustable floor anchors and spreader connections. No transoms are allowed.

2.4.3 Stops and Beads

Form stops and beads from 0.9 mm thick steel. Provide for glazed and other openings in standard steel frames. Secure beads to frames with oval-head, countersunk Phillips self-tapping sheet metal screws or concealed clips and fasteners. Space fasteners approximately 300 to 400 mm on center. Miter

molded shapes at corners. Butt or miter square or rectangular beads at corners.

2.4.4 Anchors

Provide anchors to secure the frame to adjoining construction. Provide steel anchors, zinc-coated or painted with rust-inhibitive paint, not lighter than 1.2 mm thick.

2.4.4.1 Wall Anchors

Provide at least three anchors for each jamb. For frames which are more than 2285 mm in height, provide one additional anchor for each jamb for each additional 760 mm or fraction thereof.

a. Masonry: Provide anchors of corrugated or perforated steel straps or 5 mm diameter steel wire, adjustable or T-shaped;

c. Completed openings: Secure frames to previously placed concrete or masonry with expansion bolts in accordance with SDI/DOOR 111; and

2.4.4.2 Floor Anchors

Provide floor anchors drilled for 10 mm anchor bolts at bottom of each jamb member. Where floor fill occurs, terminate bottom of frames at the indicated finished floor levels and support by adjustable extension clips resting on and anchored to the structural slabs.

2.5 FIRE AND SMOKE DOORS AND FRAMES

NFPA 80 and NFPA 105 and this specification. The requirements of NFPA 80 and NFPA 105 shall take precedence over details indicated or specified. European (EN) or British Standards (BS) may be used in lieu of the NFPA requirements for fire and smoke rated doors, frames, glazing and other appurtenances.

2.5.1 Door and Frame Certification

Contractor must provide recognized testing laboratory (UL, FM or equivalent) certification to the Contracting Officer of fire rating.

2.5.2 Oversized Doors

For fire doors and frames which exceed the size for which testing and labeling are available, furnish certificates stating that the doors and frames are identical in design, materials, and construction to a door which has been tested and meets the requirements for the class indicated.

2.5.3 Astragal on Fire and Smoke Doors

On pairs of labeled fire doors, conform to NFPA 80 and UL requirements. On smoke control doors, conform to NFPA 105.

2.6 WEATHERSTRIPPING

As specified in Section 08 71 00 DOOR HARDWARE.

2.7 HARDWARE PREPARATION

Provide minimum hardware reinforcing gages as specified in SDI/DOOR A250.6. Drill and tap doors and frames to receive finish hardware. Prepare doors and frames for hardware in accordance with the applicable requirements of SDI/DOOR A250.8 and SDI/DOOR A250.6. For additional requirements refer to BHMA A115. Drill and tap for surface-applied hardware at the project site. Build additional reinforcing for surface-applied hardware into the door at the factory. Locate hardware in accordance with the requirements of SDI/DOOR A250.8, as applicable. Punch door frames to receive a minimum of two rubber or vinyl door silencers on lock side of single doors and one silencer for each leaf at heads of double doors. Set lock strikes out to provide clearance for silencers.

2.8 FINISHES

2.8.1 Electrolytic Zinc-Coated Anchors and Accessories

Provide electrolytically deposited zinc-coated steel in accordance with ASTM A 879/A 879M, Commercial Quality, Coating Class A. Phosphate treat and factory prime zinc-coated surfaces as specified in SDI/DOOR A250.8.

2.8.2 Factory-Applied Enamel Finish

Coatings shall meet test procedures and acceptance criteria in accordance with SDI/DOOR A250.3. After factory priming, apply two coats of medium-gloss enamel to exposed surfaces. Separately bake or oven-dry each coat. Drying time and temperature requirements shall be in accordance with the coating manufacturer's recommendations. Color(s) of finish coat shall be as selected by Contracting Officer from manufacturers standard listing submitted by contractor and shall match approved color sample(s).

2.9 GLAZING

Vision panel requirements shall be as shown and as specified in Section 08 81 00.

2.10 FABRICATION AND WORKMANSHIP

Finished doors and frames shall be strong and rigid, neat in appearance, and free from defects, waves, scratches, cuts, dents, ridges, holes, warp, and buckle. Molded members shall be clean cut, straight, and true, with joints coped or mitered, well formed, and in true alignment. Dress exposed welded and soldered joints smooth. Design door frame sections for use with the wall construction indicated. Corner joints shall be well formed and in true alignment. Conceal fastenings where practicable. On wraparound frames for masonry partitions, provide a throat opening 3 mm larger than the actual masonry thickness. Design other frames in exposed masonry walls or partitions to allow sufficient space between the inside back of trim and masonry to receive calking compound.

2.10.1 Grouted Frames

Frames to be installed in exterior walls are to be filled with mortar or grout. Fill the stops with strips of rigid insulation to keep the grout out of the stops and to facilitate installation of stop-applied head and jamb seals.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Frames

Set frames in accordance with SDI/DOOR A250.11. Plumb, align, and brace securely until permanent anchors are set. Anchor bottoms of frames with expansion bolts or powder-actuated fasteners. Build in or secure wall anchors to adjoining construction. Where frames require ceiling struts or overhead bracing, anchor frames to the struts or bracing. Backfill frames with mortar. Coat inside of frames with corrosion-inhibiting bituminous material. For frames in exterior walls, ensure that stops are filled with rigid insulation before grout is placed.

3.1.2 Doors

Hang doors in accordance with clearances specified in SDI/DOOR A250.8. After erection and glazing, clean and adjust hardware.

3.1.3 Fire and Smoke Doors and Frames

Install fire doors and frames, including hardware, in accordance with NFPA 80. Install fire rated smoke doors and frames in accordance with NFPA 80 and NFPA 105.

3.2 PROTECTION

Protect doors and frames from damage. Repair damaged doors and frames prior to completion and acceptance of the project or replace with new, as directed. Wire brush rusted frames until rust is removed. Clean thoroughly. Apply an all-over coat of rust-inhibitive paint of the same type used for shop coat.

3.3 CLEANING

Upon completion, clean exposed surfaces of doors and frames thoroughly. Remove mastic smears and other unsightly marks.

3.4 SCHEDULE

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

PRODUCTS	INCH-POUND	METRIC
Door thickness	1-3/4 inch	44.5 mm
Steel channels	16 gage	1.5 mm
Steel Sheet	23 gage	0.7 mm
	16 gage	1.5 mm
	20 gage	0.9 mm
	18 gage	1.2 mm
Anchor bolts	3/8 inch	10 mm

-- End of Section --

SECTION 08 14 00

WOOD DOORS

07/06

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; European or Indian publications and standards may be used in lieu of as determined/accepted by the Contracting Officer.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 252	(2007) Standard Methods of Fire Tests of Door Assemblies
NFPA 80	(2010) Standard for Fire Doors and Other Opening Protectives

UNDERWRITERS LABORATORIES (UL)

UL 10B	(2008; Rev thru Apr 2009) Fire Tests of Door Assemblies

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors;GA
Submit drawings or catalog data showing each type of door unit; descriptive data of head and jamb weather-stripping with installation instructions shall be included]. Drawings and data shall indicate door type and construction, sizes, thickness, methods of assembly.

SD-03 Product Data

Doors;
Accessories;
Frames:

SD-04 Samples

Doors

Prior to the delivery of wood doors, submit a sample section of each type of door which shows the stile, rail, veneer, finish, and core construction.

Door finish colors;

Submit a minimum of two color selection samples for selection by the Contracting Officer.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver doors to the site in an undamaged condition and protect against damage and dampness. Stack doors flat under cover. Support on blocking, a minimum of 100 mm (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 or two years warranty if contractor manufactured.

PART 2 PRODUCTS

2.1 DOORS

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

2.1.1 Flush Doors

No hollow core doors are allowed; all doors must be of solid wood construction..

2.2 ACCESSORIES

2.2.4 Additional Hardware Reinforcement

Provide the minimum lock blocks to secure the specified hardware. The measurement of top, bottom, and intermediate rail blocks are a minimum 125 mm by full core width. Comply with the manufacturer's labeling requirements for reinforcement blocking, but not mineral material similar to the core.

2.3 FABRICATION

2.3.1 Marking

Stamp each door with a brand, stamp, or other identifying mark indicating quality and construction of the door as provided by the manufacturer or contractor.

2.3.2 Preservative Treatment

Treat doors scheduled for restrooms, janitor closets and other possible wet locations including exterior doors with a water-repellent preservative treatment

2.3.3 Adhesives and Bonds

. Provide a nonstaining adhesive on doors with a natural finish.

2.3.4 Prefitting

Provide factory prefinished and 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, bevelling edges, mortising, and drilling for hardware and providing necessary beaded openings for glass and louvers. Provide the door manufacturer with the necessary hardware samples, and frame and hardware schedules to coordinate the work.

2.3.5 Finishes

2.3.5.1 Field Painting

provide field painting.

2.3.5.2 Color

Provide door finish colors as selected by the Contracting Officer from the color selection samples.

2.3.6 Water-Resistant Sealer

Provide manufacturer's standard water-resistant sealer compatible with the specified finishes.

PART 3 EXECUTION

3.1 INSTALLATION

Before installation, seal top and bottom edges of doors with the approved water-resistant sealer. Seal cuts made on the job immediately after cutting using approved water-resistant sealer. Fit, trim, and hang doors with a 2 mm (1/16 inch) minimum, 3 mm (1/8 inch) maximum clearance at sides and top, and a 5 mm (3/16 inch) minimum, 6 mm (1/4 inch) maximum clearance over thresholds. Provide 10 mm 3/8 inch minimum, 11 mm (7/16 inch) maximum

clearance at bottom where no threshold occurs. Bevel edges of doors at the rate of 3 mm in 50 mm 1/8 inch in 2 inch. Door warp shall not exceed 6 mm .

3.1.2 Prehung Doors

Install doors in accordance with the manufacturer's instructions and details. Provide fasteners for stops and casing trim within 75 mm (3 inch)of each end and spaced 279 mm (11 inch) on center maximum. Provide side and head jambs joined together with a dado or notch of 5 mm 3/16 inch minimum depth.

-- End of Section --

SECTION 08 34 63

DETENTION HOLLOW METAL FRAMES, DOORS, AND DOOR FRAMES
04/06

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; European or Indian publications and standards may be used in lieu of as determined/accepted by the Contracting Officer.

ASTM INTERNATIONAL (ASTM)

ASTM A 1011/A 1011M	(2006b) Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
ASTM A 366/A 366M	(1997e1) Standard Specification for Commercial Steel, Sheet, Carbon,(0.15 Maximum Percent Cold-Rolled
ASTM A 653/A 653M	(2007) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM HMMA 863	(2004) Guide Specifications for Detention Security Hollow Metal Doors and Frames

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detention hollow metal doors and frames; G

Submit details at not less than 1/4 full size for each frame type, and elevations of door design type at 1:50 minimum, show conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections. Indicate fabrication, erection, anchorage, and accessory items.

Submit a schedule listing the location of each door and frame using indicated reference numbers for details and openings shown.

SD-03 Product Data

Detention hollow metal doors and frames

Submit manufacturer's material and fabrication specifications.

SD-06 Test Reports

Door fabrication

Prior to fabrication, submit test report for reinforced flush door of the type to be provided on this project.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver hollow metal work with packaging to provide protection during transit and job storage as recommended by the manufacturer. Door frames shall be provided with steel spreader angles, temporarily attached to the bottom of both jambs, one on each side of the opening to serve as a brace during shipping and handling. Inspect hollow metal work upon delivery for damage. Store hollow metal units on raised platforms in vertical positions with blocking between units to allow air circulation. Keep stored material covered and protected from damage and rust. Do not cover with plastic or unvented canvas.

1.4 HARDWARE COORDINATION CONFERENCE

Conduct a conference for hardware and hollow metal work prior to submittals for the purpose of coordinating the interface of materials that are furnished by the participants listed. Require that a representative of the entity responsible for each of the following functions attend the conference. Notify the following participants a minimum of 5 working days before the conference:

a. Contractor

b. Hollow metal supplier and installer

c. Detention hollow metal supplier and installer

d. Hardware supplier

e. Hardware installer

f. Detention hardware supplier

g. Detention hardware installer

h. Remote control operator and locking device supplier and installer

PART 2 PRODUCTS

2.1 MATERIALS: EUROPEAN OR INDIAN EQUIVALENT STANDARDS MAY BE USED IN LIEU OF THE ASTM STANDARDS LISTED BELOW AS ACCEPTED/DETERMINED BY THE CONTRACTING OFFICER.

2.1.1 Hot-Rolled Carbon Steel

ASTM A 1011/A 1011M, commercial quality, 14 gage and thicker.

2.1.2 Cold-Rolled Carbon Steel

ASTM A 366/A 366M, commercial quality, stretcher level sheets, 12 gage.

2.1.3 Galvanized Steel

ASTM A 653/A 653M, CQ, mill phosphatized tested by ASTM G 60.

2.2 DETENTION HOLLOW METAL DOORS AND FRAMES

2.2.1 Door Fabrication

a. Provide doors fabricated of cold rolled, pickled and oiled stretcher leveled steel sheets with clean smooth surfaces. Gages shall be as indicated for each type of door. Form molded members straight with joints coped or mitered, and in true alignment. Welded joints on exposed surfaces shall be dressed smooth, to be invisible. Doors shall be custom made full flush design, internally reinforced, sound deadened and insulated, 50 mm thick to receive detention locks, of the elevations, types and sizes shown on the approved shop drawings and schedules.

b. Face sheets shall be mild steel fully welded on edges with continuous inner-reinforcements full height and width. Provide internally 10 gage steel channel banding around complete door perimeter, spot welded to face sheet 75 mm on center. Inner reinforcements shall be truss design with triangular form, or interlocking channels with "Z" bar stiffeners, the shape of which cannot be altered without changing the length of the sides. Flat apexes shall be resistance spot welded on 70 mm centers horizontally and 75 mm centers vertically. Insulate each flute of reinforcement with 96 kg/cubic meter density rock wool.

c. Bevel vertical door edges 3 mm in 50 mm and internally reinforced full length with 3 mm thick steel channels spot welded not over 75 mm on center inside both door faces. Close top and bottom door edges with continuous recessed 10 gage channels extending the full width of the door and welded 75 mm on center maximum to both faces and continuously welded to the vertical door edge channels to form a single perimeter frame inside the door. Top and bottom edges of doors shall be finished flush, except for provisions for weatherproofing. Mortise, reinforce, drill and tap door edges to receive templated specified hardware in accordance with the approved hardware schedule and the hardware manufacturer's recommendations for the proper installation of hardware and detention equipment.

d. Clearances shall be coordinated with frame and in accordance with NAAMM HMMA 863, Part 2, Section 2.02.

e. Doors shall be free from warpage, wind or buckle. Bends shall be of minimum radius for the gage of metal used.

f. The removable glass stop shall consist of 10 gage angle securely fastened to the frame using machine screws (6 mm #20UNRC: 25 mm at 150 mm on center and no more than 100 mm from corners). Exposed screw heads shall be button head type.. The finished glass stop shall be tight fitting and mitered at the corner joints. There shall be a minimum 25 mm glass engagement.

2.2.2 Door and View Window Frame Fabrication

a. Custom-made, fully assembled, factory-welded units of the size and shapes shown on the approved shop drawings. "Knock-down" frames will not be accepted. Coordinate frame dimension to thickness of door or glass.

b. Strong, rigid, neat in appearance, and free from defects. Frame members shall be clean cut, straight, and of uniform profile.

c. Form frames to provide mitered trim and butted stops. Join head and jamb members by continuous welds occupying the full depth and width of the frame. Grind exposed welds smooth and flush.

d. When frames are for door light or food pass, fabricate members as closed tubular shapes having no visible seams or joints on exposed surfaces. Grind exposed welds smooth and flush.

e. Frames over 1200 mm wide installed in masonry partitions shall have a channel stiffener not less than 13 gage welded into the head at the factory.

f. Protect cutouts and reinforcements with pressed steel mortar guards on the inside of the frame.

g. Floor anchors formed of not less than 12 gage steel shall be securely welded to the bottom of each jamb.

h. Frames for installation in masonry walls shall be provided with non-removable adjustable jamb anchors constructed of not less than 14 gage material. Provide jamb anchors at 400 mm on center.

i. Welded frames that are to be installed in previously prepared masonry openings shall be 12 mm smaller in width and 6 mm smaller in height than the masonry opening to provide 6 mm clearance on all sides.

j. When shipping limitations dictate, frames for large openings shall be fabricated in sections designed for field welded splicing. Welds shall be ground smooth and primed for painting. Sections shall be assembled at the factory to ensure proper fit and be clearly marked for field reassembly.

2.2.3 Door Reinforcement for Hardware

a. Mortise, reinforce, drill, and tap doors at the factory for mortised hardware in accordance with the approved hardware schedule and templates. Doors to receive surface-mounted hardware shall have inner reinforcing plates for drilling and tapping to be performed in the field.

b. For each mortised hinge, provide a reinforcing plate measuring 5 by 38 by 250 mm that is continuously welded inside the edge channel. The top hinge preparation shall be additionally braced by a channel, welded to the back of the hinge reinforcing plate and inside the edge reinforcing channel.

c. Where detention locks are scheduled, provide reinforced pocket to receive locks. The secure side of the door shall be finished flush with a 5 mm backup plate to protect lock. Form the pocket perimeter of 12 gage channels on three sides with the door edge channel completing the perimeter frame. Do not cut the door edge channel except for passage of the lock bolt. Provide a 5 mm thick steel mounting and protection plate to cover the lock pocket and extend at least 20 mm on three sides beyond the cutout. Secure the lock to the protection plate in accordance with the lock manufacturer's instructions. Secure the cover plate to the door by at least six 6 mm security-type machine screws. Make provisions so that removal of the lock is impossible when the lock bolt is extended.

d. Reinforcements for door pulls shall be 5 mm steel welded inside door. Reinforcement size shall be 38 by 250 mm for loop type pull and 150 by 175 mm for flush type pull. Minimum 12 gage reinforcing shall be welded inside the door for all other surface hardware items.

2.2.4 Frame Reinforcement for Hardware

a. Mortise, reinforce, drill, and tap frames at the factory for templated mortised hardware, in accordance with the approved hardware schedules and templates. Where surface-mounted hardware is to be applied, frames shall have reinforcing plates completely drilled and tapped for installation in the field.

b. For each mortised hinge, provide a 7 gage, off-set reinforcing plate that is factory drilled and tapped and measures 38 by 250 mm. Top hinge reinforcement shall be additionally braced by a 7 gage backup angle welded to the reinforcement and to the inside of the frame trim.

c. All other mortised and surface-mounted hardware reinforcements shall be not less than 12 gage.

2.2.5 Factory Finishing

a. After fabrication, dress, fill, and sand tool marks and surface imperfections to make faces and vertical edges smooth, level, and free of irregularities.

b. Surfaces shall be chemically treated and cleansed of rust, oil, and impurities and given a phosphate treatment to ensure paint adhesion.

c. Paint exposed surfaces of doors, and both inside and outside of frames with a minimum of one-mil thickness of rust inhibitive primer which shall be dried and completely cured to develop hardness before shipment.

2.3 ACCESS PANELS

Provide steel access panels of sizes and locations as indicated and where required for access to utilities, equipment, and controls, if required by the contract plans.

a. Doors shall be 10 gage steel, flanged 32 mm on four sides, with welded corners.

b. Frame shall be composed of steel angles measuring 5 by 50 by 50 mm. Weld and grind joints smooth.

c. Provide detention type hinges with non-removable pin, three per frame. Weld to door and frames.

d. Weld steel stop angles measuring 3 by 25 by 25 mm to frame on all four sides.

e. Masonry anchors shall be welded at factory, 3 by 25 by 150 mm, minimum four per panel. Provide expansion shields at concrete openings, factory countersunk for 10 mm flathead machine screw, minimum two per jamb.

f. Factory finish with prime coat of rust-inhibitive, baked-on enamel.

g. Provide locks at panels within the security perimeter and points of egress from ducts and tunnels terminating outside the security perimeter. Lock case and cover shall be malleable iron and steel. Bolt shall be high strength bronze and project 20 mm from case when retracted and have a throw of not less than 16 mm. Locks shall have five tumblers, each actuated by phosphor bronze springs. Locks shall operate from one side only. Attach to panel with detention type screws. Locks shall be keyed alike. Enter coded keys into keying system.

2.4 OPENING PROVISION

Speaking ports, view ports, food passes shall be manufactured as indicated.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Door Schedule

Refer to door schedule on drawings for location of doors, door frames, and door hardware.

3.1.2 Frames

Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After completing wall construction, remove temporary braces and spreaders. Do not use any part of the frame as lintels or load-carrying members. Anchor frame to masonry with flat head security type machine screws into expansion shields or attached to a pre-set rough buck anchored to the masonry in the same way. Install five anchors on each jamb for doors up to and including 2250 mm in height and six on each jamb for taller doors.

3.1.3 Doors

Fit hollow metal doors accurately in frames. Provide metal shims where necessary.

3.1.4 Access Panels (if required)

Prepare openings as required to receive frame. Use fasteners as specified and required by type of surrounding construction. Ensure that frames are properly seated into opening with steel shims and that doors are true, in alignment, and completely flush in appearance. Maintain 3 mm maximum clearance between door and frame.

3.2 ADJUSTMENT AND CLEANING

Remove and replace defective work which is warped, bowed, or otherwise damaged. Adjust hollow metal work for smooth operation. Touch up scratches and bare edges in the field with a rust inhibiting primer prior to painting.

-- End of Section --

SECTION 08 52 00

WOOD WINDOWS
07/06

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; European or Indian equivalent publications and standards may be used in lieu of as determined/accepted by the Contracting Officer.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 101	(2005) Standard Specification for Windows, Doors, and Unit Skylights
AAMA 2603	(2002) Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels
AAMA 2604	(2005) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels

ASTM INTERNATIONAL (ASTM)

ASTM D 1784	(2006a) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 3656	(2004) Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns

SCREEN MANUFACTURERS ASSOCIATION (SMA)

SMA 1004	(1987; R 1998) Aluminum Tubular Frame Screens for Windows

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Wood windows;G

Indicate elevations of units, full-size sections, fastenings, methods of installation and anchorage, method of glazing, locations of operating hardware, mullion details, method and material for weatherstripping, bar and muntin layouts if any, method of attaching insect screens, details of installation, and connections with other work.

SD-08 Manufacturer's Instructions

Wood windows

Submit manufacturer's written instructions for installation.

1.3 DELIVERY AND STORAGE

Deliver windows to site in sealed undamaged cartons or in palletized multiple units. Protect from damage, dampness and extreme temperature or humidity changes. Store under cover in well-ventilated enclosed space. Do not store in a building under construction until concrete, masonry, and plaster are dry. Replace defective or damaged windows.

PART 2 PRODUCTS

2.1 WOOD WINDOWS

Wood windows shall consist of complete units including sash, glass, frame, weatherstripping, insect screen, and hardware. maximum air infiltration shall not exceed 0.00016 cu m per second of sash crack when tested under uniform static air pressure difference of 75 pascals, provide hardware for various window types as indicated below. Plexiglass and glazing materials shall conform to Section 08 81 00 "GLAZING". Wood members which will receive transparent finish shall be in one piece, not finger-jointed.

2.1.1 Awning Windows (Top Hinged)

Awning window ventilators in same bay shall operate separately. Provide two or more hinges, pivots, or sash-supporting arms for each operative sash to allow easy operation, substantial support and cleaning of both sides of sash from inside. Provide latches for securing each sash if operating devices do not include locking features. Provide operating devices for controlling position of sash, including full open, tight close, and intermediate firm hold. Operating devices shall include rotary operators of worm-gear type with wear-resistant and impact-resistant gears or lever operators of lever handle, off-set arm type. Venting sash shall have corrosion resistant steel hinges connected to top and bottom rails of sash. When lever operators are

used, operating arms shall be adjustable so that even sash edge contact can be maintained. Provide compression-type weatherstripping.

2.2 ACCESSORIES

2.2.1 Adhesives

Comply with applicable regulations regarding toxic and hazardous materials, GS-36, and as specified in Section 07 92 00 JOINT SEALANTS.

2.2.2 Fasteners

Fabricated from 100 percent re-melted steel.

2.3 FINISHES

2.3.1 Paint

Furnish windows with factory-primed surfaces which will be exempt from first paint coat application required in Section 09 90 00 PAINTS AND COATINGS.

2.4 INSECT SCREENS

ASTM D 3656, Class 2, 18 by 14 mesh, color grey. Aluminum frames to meet SMA 1004.

2.5 SASH POLES AND SPECIAL OPERATORS

For windows having operating hardware or locking or latching devices located more than 1800 mm above the floor, provide suitably designed operators or locking or latching devices necessary for convenient and proper window operation.

2.5.1 Pole Operators

Poles shall be of proper length to permit window operation from 1500 mm above the floor. Provide one pole operator for each room, and one pole hanger for each pole. Locate hangers where directed.

2.5.2 Extension Crank Operators

Provide removable handles for crank-operated rotary-type operators located more than 1800 mm above the floor. Provide one removable handle for each room.

2.5.3 Sash Poles

Seamless aluminum tube, 1.59 mm minimum wall thickness, 25 mm diameter, 3 m long, with cast aluminum hook and protective cover or tip on the lower end. Finish shall match windows.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Wood Windows

Install in accordance with the approved installation instructions. Securely anchor windows in place. Install and seal windows in a manner that will prevent entrance of water and wind.

3.1.2 Insect Screen

Install screen panels in accord with manufacturer's instructions.

3.2 ADJUSTMENTS

Make final adjustment for proper operation of ventilating unit after glazing. Make adjustments to operating sash or ventilators to assure smooth operation. Units shall be weathertight when locked closed. Verify products are properly installed, connected, and adjusted.

3.3 CLEANING

Clean windows on both exterior and interior in accordance with manufacturer's recommendations.

3.4 WASTE MANAGEMENT

Separate corrugated cardboard and protective materials in accordance with the Waste Management Plan and reuse or recycle. Place materials defined as hazardous or toxic waste in designated containers and dispose of properly. Close and seal tightly all partly used sealant containers and store protected in well ventilated fire-safe area at moderate temperature. Place used sealant tubes and containers in areas designated for hazardous materials and dispose of properly.

-- End of Section --

SECTION 08 56 63

DETENTION AND SECURITY WINDOWS
04/06

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; European or Indian publications and standards may be used in lieu of as determined/accepted by the Contracting Officer.

ASME INTERNATIONAL (ASME)

ASME B18.6.3	(2003) Machine Screws and Machine Screw Nuts
ASME B18.6.4	(1998; R 2005) Thread Forming and Threaded Cutting Tapping Screws and Metallic Drive Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A 1011/A 1011M	(2006b) Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 167	(1999; R 2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 239	(1995; R 2004) Standard Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles
ASTM A 627	(2003) Standard Specification for Tool-Resisting Steel Bars, Flats, and Shapes for Detention and Correctional Facilities
ASTM A 629	(1988; R 1994e1) Standard Specification for Tool-Resisting Steel Flat Bars and Shapes for Security Applications
ASTM A 653/A 653M	(2007) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

STEEL WINDOW INSTITUTE (SWI)

SWI AGSW (2002) Architect's Guide to Steel Windows

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Window units

Indicate the elevations of windows, half-size sections, thicknesses and gages of metal, fastenings, proposed method of anchoring, the size and spacing of anchors, details of construction, method of glazing, mullion details, casings, sills, trim, other related items, and installation details.

SD-03 Product Data

Window units

Fasteners

Accessories

Include finishes.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver windows to project site in an undamaged condition. Store windows and components at the site on edge, out of contact with the ground, and under a weather-tight covering.

PART 2 PRODUCTS

2.1 MATERIALS: EUROPEAN OR INDIAN STANDARDS MAY BE USED IN LIEU OF THE LISTED MATERIAL STANDARDS AS DETERMINED/ACCEPTED BY THE CONTRACTING OFFICER.

2.1.1 Steel Bars

SWI AGSW.

2.1.2 Sheet Steel

ASTM A 1011/A 1011M.

2.1.3 Zinc-Coated Sheet Steel

ASTM A 653/A 653M.

2.1.4 Zinc-Coated Steel

ASTM A 90/A 90M, ASTM A 123/A 123M or ASTM A 153/A 153M.

2.1.5 Corrosion Resisting Sheet Steel

ASTM A 167.

2.1.6 Screws and Bolts

ASTM B 766, ASME B18.6.3, or ASME B18.6.4, as applicable.

2.2 WINDOW UNITS

Units shall conform to the SWI AGSW or recognized standards, except as modified herein.

2.3 FABRICATION

Form permanent joints by welding or by mechanically fastening as specified for each type window. Use joints of strength required to maintain the structural value of members connected. Weld joints solid, remove excess metal, and dress smooth on exposed and contact surfaces. Closely fit joints formed with mechanical fastenings and make permanently watertight. Assemble frames at the plant, and ship as a unit with hardware unattached.

2.3.1 Window Sections

Where fixed window sections adjoin, provide a fixed sash, fabricated from similar frame members and of the manufacturer's standard type suitable for the purpose. Roll weathering surfaces integrally to provide two-point, parallel-surface contact with an overlap at both inside and outside points of closure.

2.3.2 Drainage Holes

Provide drips and weep holes, as required, to return water to outside, minimum of two per window.

2.3.3 Fasteners

Use flat or oval head spanner, twist-off or safety head screws and bolts with standard threads on windows, trim and accessories. Self tapping sheet-metal screws are not acceptable.

2.3.4 Fastener Finish

Fabricate windows with hot-dipped galvanized finish, using stainless steel or hot-spun galvanized steel fasteners. Use heavily cadmium plated steel fasteners for windows with painted finish or electrogalvanized in accordance with ASTM A 239. Finish exposed heads of fasteners to match finish of windows.

2.3.5 Frames

Form frames from low carbon steel not less than 12 U.S. gage. Frames shall be one piece, channel shaped sections, at each jamb and between jamb at head and sill. Cope or miter and weld frame members at corners full depth of the frame for maximum strength and weathertightness; dress exposed welds smooth. Provide frame members with dimensions and profiles indicated. Provide 20 by 57 mm, tool resistant steel flats conforming to ASTM A 629, penetrated by 22 mm tool-resistant steel rounds conforming to ASTM A 627 in frame members.

2.4 PROVISIONS FOR GLAZING

Design for outside single glazing with metal beads and glazing compound as specified in Section 08 81 00 GLAZING.

2.5 SCREENS

Provide manufacturer's standard screens for window units with movable sash, galvanized frame.

2.6 ACCESSORIES

Provide windows complete with necessary hardware, fastenings, clips, fins, anchors, glazing beads, and other appurtenances necessary for complete installation of windows.

2.7 ANCHORS

Use hot-dip, zinc-coated steel anchors of the type indicated or specified. Use cadmium or zinc-coated nuts, bolts, and other fasteners for ferrous material.

2.8 SHOP PRIMED FINISH

After fabrication, clean surfaces of windows, fins, mullions, cover plates and screen frames, provide a hot-dip galvanized, phosphate-treated and shop primed finish. . Windows shall receive finish paint coats as specified in Section 09 90 00 PAINTS AND COATINGS.

PART 3 EXECUTION

3.1 INSTALLATION

Install windows in accordance with the manufacturer's printed instructions and details, except as specified otherwise in this section. Build in windows as the work progresses. Set windows at indicated elevation, location, and reveal. Set plumb, square, level, and in alignment. Brace, strut, and stay to prevent distortion and misalignment.

3.2 ANCHORS AND FASTENINGS

Place anchorage as wall construction progresses. Build in anchors or bolt anchors and fastenings to the jambs of openings and weld securely to the windows or frames and to the adjoining construction. Space anchors not more than 400 mm apart on jambs, and install a minimum of four anchors on each side of each opening. Anchors and fastenings shall have sufficient strength to hold the member firmly in position.

3.3 SEALANTS

Section 07 92 00 JOINT SEALANTS.

3.4 CLEANING

Clean metal surfaces of windows, inside and outside, of mortar, plaster, paint, and other foreign matter to present a neat appearance and to prevent fouling of weathering surfaces. Clean and touch-up abraded surfaces of steel windows. Replace stained, discolored, or abraded windows that cannot restored to their original condition with new windows.

-- End of Section --

SECTION 08 71 00

DOOR HARDWARE
10/07

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; European or Indian publications and standards may be used in lieu of as determined/accepted by the Contracting Officer. BHMA standards listed below must be used or demonstrated by the contractor; no substitutions are allowed.

ASTM INTERNATIONAL (ASTM)

ASTM F 883	(2004) Padlocks

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA A156.1	(2006) Butts and Hinges
BHMA A156.13	(2005) Mortise Locks & Latches, Series 1000
BHMA A156.15	(2006) Closer Holder Release Devices
BHMA A156.16	(2002) Auxiliary Hardware
BHMA A156.18	(2006) Materials and Finishes
BHMA A156.2	(2003) Bored and Preassembled Locks and Latches
BHMA A156.21	(2006) Thresholds
BHMA A156.22	(2005) Door Gasketing and Edge Seal Systems
BHMA A156.3	(2001) Exit Devices
BHMA A156.4	(2000) Door Controls - Closers
BHMA A156.5	(2001) Auxiliary Locks & Associated Products
BHMA A156.6	(2005) Architectural Door Trim
BHMA A156.7	(2003) Template Hinge Dimensions
BHMA A156.8	(2005) Door Controls - Overhead Stops and Holders

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2009) Life Safety Code, 2009 Edition

NFPA 80	(2007) Standard for Fire Doors and Other Opening Protectives

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR A250.8	(2003) Recommended Specification for Standard Steel Doors and Frames

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Hardware schedule;

Keying system

SD-03 Product Data

Hardware items;

SD-08 Manufacturer's Instructions

Installation

1.3 HARDWARE SCHEDULE

Prepare and submit hardware schedule in the following form:

Hardware Item	Quantity	Size	Reference Publication Type No.	Finish	Mfr. Name and Catalog No.	Key Control Symbols	UL Mark (If fire rated and listed)	BHMA Finish Designation

1.4 KEY BITTING CHART REQUIREMENTS

Submit key bitting charts to the Contracting Officer prior to completion of the work. Include:

a. Complete listing of all keys (AA1, AA2, etc.).

b. Complete listing of all key cuts (AA1-123456, AA2-123458).

c. Tabulation showing which key fits which door.

d. Copy of floor plan showing doors and door numbers.

e. Listing of 20 percent more key cuts than are presently required in each master system.

1.5 QUALITY ASSURANCE

1.5.1 Hardware Manufacturers and Modifications

Provide, as far as feasible, locks, hinges, and closers of one lock, hinge, or closer manufacturer's make. Modify hardware as necessary to provide features indicated or specified.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver hardware in original individual containers, complete with necessary appurtenances including fasteners and instructions. Mark each individual container with item number as shown in hardware schedule. Deliver permanent keys and removable cores to the Contracting Officer, either directly or by certified mail. Deliver construction master keys with the locks.

PART 2 PRODUCTS

2.1 TEMPLATE HARDWARE

Provide hardware to be applied to metal or to prefinished doors manufactured to template. Promptly furnish template information or templates to door and frame manufacturers. Conform to BHMA A156.7 for template hinges. Coordinate hardware items to prevent interference with other hardware.

2.2 HARDWARE FOR FIRE DOORS AND EXIT DOORS (NOTE: EUROPEAN (EN) OR BRITISH (BS) FIRE RATED DOOR STANDARDS MAY BE USED AS DETERMINED/ACCEPTED BY THE CONTRACTING OFFICER)

Provide all hardware necessary to meet the requirements of NFPA 80 for fire doors and NFPA 101 for exit doors, as well as to other requirements indicated, even if such hardware is not specifically mentioned under paragraph entitled "Hardware Schedule." Provide certification of compliance with fire rating standards used.

2.3 HARDWARE ITEMS

Clearly and permanently mark with the manufacturer's name or trademark, hinges, pivots, locks, latches, exit devices, bolts and closers where the identifying mark will be visible after the item is installed. For closers with covers, the name or trademark may be beneath the cover.

2.3.1 Hinges

BHMA A156.1, size as indicated. Construct loose pin hinges for exterior doors and reverse-bevel interior doors so that pins will be non-removable when door is closed. Other antifriction bearing hinges may be provided in lieu of ball-bearing hinges. There shall be at least 3 hinges at each door. Each hinge shall be at least 200/16/5 MM, secured with threaded pins.

2.3.2 Locks and Latches

2.3.2.1 Mortise Locks and Latches

BHMA A156.13, Series 1000, Operational Grade 1, Security Grade 2. Provide mortise locks with escutcheons not less than 178 by 57 mm with a bushing at least 6 mm long. Cut escutcheons to suit cylinders and provide trim items with straight, beveled, or smoothly rounded sides, corners, and edges. Install knobs and roses of mortise locks with screwless shanks and no exposed screws.

2.3.2.2 Bored Locks and Latches

BHMA A156.2, Series 4000, Grade 1.

2.3.2.3 Auxiliary Locks

BHMA A156.5, Grade 1.

2.3.4 Exit Devices

BHMA A156.3, Grade 1. Provide adjustable strikes for rim type and vertical rod devices. Provide open back strikes for pairs of doors with mortise and vertical rod devices. Provide escutcheons, not less than 178 by 57 mm.

2.3.4 Cylinders and Cores

Provide cylinders and cores for new locks, including locks provided under other sections of this specification. Provide cylinders and cores with six pin tumblers. Provide cylinders from products of one manufacturer, and

provide cores from the products of one manufacturer. Rim cylinders, mortise cylinders, and knobs of bored locksets have interchangeable cores which are removable by special control keys. Stamp each interchangeable core with a key control symbol in a concealed place on the core.

2.3.5 Keying System

Provide a master keying system. Provide a construction master keying system. Provide key cabinet as specified.

2.3.6 Lock Trim

Cast, forged, or heavy wrought construction and commercial plain design.

2.3.6.1 Lever Handles

Provide lever handles in lieu of knobs. Conform to the minimum requirements of BHMA A156.13 for mortise locks of lever handles for exit devices. Provide lever handle locks with a breakaway feature (such as a weakened spindle or a shear key) to prevent irreparable damage to the lock when force in excess of that specified in BHMA A156.13 is applied to the lever handle. Provide lever handles return to within 13mm.

2.3.7 Keys

Furnish one file key, one duplicate key, and one working key for each key change and for each master keying system. Furnish one additional working key for each lock of each keyed-alike group. Furnish two additional keys for each sleeping room. Furnish 2 construction master keys, and 2 control keys for removable cores. Furnish a quantity of key blanks equal to 20 percent of the total number of file keys. Stamp each key with appropriate key control symbol and "U.S. property - Do not duplicate." Do not place room number on keys.

2.3.8 Closers

BHMA A156.4, Series C02000, and Series C02061, Grade 1, with PT 4C. Provide with brackets, arms, mounting devices, fasteners, full size covers, except at storefront mounting, and other features necessary for the particular application. Size closers in accordance with manufacturer's recommendations, or provide multi-size closers, Sizes 1 through 6, and list sizes in the Hardware Schedule. Provide manufacturer's 10 year warranty. All fire rated doors require closers.

2.3.8.1 Identification Marking

Engrave each closer with manufacturer's name or trademark, date of manufacture, and manufacturer's size designation located to be visible after installation.

2.3.9 Overhead Holders

BHMA A156.8.

2.3.10 Closer Holder-Release Devices

BHMA A156.15.

2.3.11 Door Protection Plates

BHMA A156.6. Door protection plates shall be stainless steel with smooth sanded surface, grain 240. Plates shall be fastened with glue and stainless steel screws.

2.3.11.1 Sizes of Mop Plates

Fifty mm less than door width for single doors; 25 mm less than door width for pairs of doors. Provide 150 mm mop plates.

2.3.11.2 Sizes of Kick Plates

Kick plates shall be full width of the door and 300 MM high (50 mm above bottom edge of door). Kick plates shall be provided on both sides of the doors.

2.3.12 Door Stops and Silencers

BHMA A156.16. Silencers Type L03011. Provide three silencers for each single door, two for each pair. Door stops shall be heavy-duty stainless steel post with skid nose made of white nylon. Length of stops shall be sufficient to prevent door handles from striking wall.

2.3.13 Thresholds

Thresholds are marble as shown on the contract drawings.

2.3.14 Weather Stripping Gasketing

BHMA A156.22. Provide the type and function designation where specified in paragraph entitled "Hardware Schedule". Provide a set to include head and jamb seals, sweep strips, and, for pairs of doors, astragals Provide weather stripping with one of the following:

2.3.14.1 Extruded Aluminum Retainers

Extruded aluminum retainers not less than 1.25 mm wall thickness with vinyl, neoprene, silicone rubber, or polyurethane inserts. Provide clear anodized aluminum.

2.3.14.2 Interlocking Type

Zinc or bronze not less than 0.45 mm thick.

2.3.14.3 Spring Tension Type

Spring bronze or stainless steel not less than 0.20 mm thick.

2.3.15 Rain Drips

Extruded aluminum, not less than 2.03 mm thick, clear anodized. Set drips in sealant and fasten with stainless steel screws.

2.3.15.1 Door Rain Drips

Approximately 38 mm high by 16 mm projection. Align bottom with bottom edge of door.

2.3.15.2 Overhead Rain Drips

Approximately 38 mm high by 64 mm projection, with length equal to overall width of door frame. Align bottom with door frame rabbet.

2.3.16 Special Tools

Provide special tools, such as spanner and socket wrenches and dogging keys, required to service and adjust hardware items.

2.4 FASTENERS

Provide fasteners of proper type, quality, size, quantity, and finish with hardware. Provide stainless steel or nonferrous metal fasteners that are exposed to weather. Provide fasteners of type necessary to accomplish a permanent installation.

2.5 FINISHES

BHMA A156.18. Provide hardware in heavy duty commercial grade stainless steel unless specified otherwise.

2.6 KEY CABINET AND CONTROL SYSTEM

BHMA A156.5, Type required to yield a capacity (number of hooks) 50 percent greater than the number of key changes used for door locks.

PART 3 EXECUTION

3.1 INSTALLATION

Install hardware in accordance with manufacturers' printed installation instructions. Fasten hardware to wood surfaces with full-threaded wood screws or sheet metal screws. Provide machine screws set in expansion shields for fastening hardware to solid concrete and masonry surfaces. Provide toggle bolts where required for fastening to hollow core construction. Provide through bolts where necessary for satisfactory installation.

3.1.1 Weather Stripping Installation

Handle and install weather stripping to prevent damage. Provide full contact, weather-tight seals. Operate doors without binding.

3.1.1.1 Stop-Applied Weather Stripping

Fasten in place with color-matched sheet metal screws not more than 225 mm on center after doors and frames have been finish painted.

3.1.1.2 Interlocking Type Weather Stripping

Provide interlocking, self-adjusting type on heads and jambs and flexible hook type at sills. Nail weather stripping to door 25 mm on center and to heads and jambs at 100 mm on center.

3.1.1.3 Spring Tension Type Weather Stripping

Provide spring tension type on heads and jambs. Provide bronze nails with bronze, stainless steel nails with stainless steel. Space nails not more than 38 mm on center.

3.1.2 Threshold Installation

Thresholds are marble and shall be installed as per the contract drawings..

3.2 HARDWARE LOCATIONS

SDI/DOOR A250.8, unless indicated or specified otherwise.

a. Kick and Armor Plates: Push side of single-acting doors. Both sides of double-acting doors.

3.3 KEY CABINET AND CONTROL SYSTEM

Locate where directed by Contracting Officer. Tag one set of file keys and one set of duplicate keys. Place other keys in appropriately marked envelopes, or tag each key. Furnish complete instructions for setup and use of key control system. On tags and envelopes, indicate door and room numbers or master or grand master key.

3.4 FIELD QUALITY CONTROL

After installation, protect hardware from paint, stains, blemishes, and other damage until acceptance of work. Submit notice of testing 15 days before scheduled, so that testing can be witnessed by the Contracting Officer. Adjust hinges, locks, latches, bolts, holders, closers, and other items to operate properly. Demonstrate that permanent keys operate respective locks, and give keys to the Contracting Officer. Correct, repair, and finish, as directed, errors in cutting and fitting and damage to adjoining work.

3.5 HARDWARE SETS

Refer to Architectural Drawings for Hardware Sets.

-- End of Section --

SECTION 08 81 00

GLAZING
07/06

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; European or Indian publications and standards may be used in lieu per determination/acceptance by the Contracting Officer.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2004) Safety Glazing Materials Used in Buildings

ASTM INTERNATIONAL (ASTM)

ASTM C 1184	(2005) Standard Specification for Structural Silicone Sealants
ASTM C 509	(2006) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C 669	(2000) Glazing Compounds for Back Bedding and Face Glazing of Metal Sash
ASTM C 864	(2005) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM D 2287	(1996; R 2001) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM D 4802	(2002) Poly(Methyl Methacrylate) Acrylic Plastic Sheet
ASTM E 119	(2007) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E 2010	(2001) Positive Pressure Fire Tests of Window Assemblies

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(2004) Glazing Manual

GANA Sealant Manual	(1990) Sealant Manual
GANA Standards Manual	(2001) Tempering Division's Engineering Standards Manual

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2004) Procedure for Determining Fenestration Product U-Factors
NFRC 200	(2004) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 252	(2003) Standard Methods of Fire Tests of Door Assemblies
NFPA 257	(2006) Fire Test for Window and Glass Block Assemblies
NFPA 80	(2007) Standard for Fire Doors and Other Opening Protectives

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 4-010-01	(2009 (July) DOD Minimum Antiterrorism Standards for Buildings

UNDERWRITERS LABORATORIES (UL)

UL 752	(2005; Rev thru Dec 2006) Bullet-Resisting Equipment
UL MEAPD	(2003) Mechanical Equipment and Associated Products Directory

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation

Drawings showing complete details of the proposed setting methods, mullion details, edge blocking, size of openings, frame details, materials, and types and thickness of plastic glazing.

SD-03 Product Data

Glass GA

Plastic Glazing

Glazing Accessories

Manufacturer's descriptive product data, handling and storage recommendations, installation instructions, and cleaning instructions.

SD-04 Samples

Plastic Sheet

Glazing Compound

Glazing Tape

Sealant

Two 203 x 254 mm samples of each of the following: plastic sheet and insulating glass units.

SD-07 Certificates

Plastic Glazing

Certificates stating that the plastic glazing meets the specified requirements. Labels or manufacturers marking affixed to the glass will be accepted in lieu of certificates.

Glazing Accessories

SD-08 Manufacturer's Instructions

Setting and sealing materials

Plastic Glazing setting

Submit plastic glazing manufacturer's recommendations for setting and sealing materials and for installation of each type of glazing material specified. Include cleaning instructions for plastic sheets.

1.3 SYSTEM DESCRIPTION

Glazing systems shall be fabricated and installed watertight and airtight to withstand thermal movement and wind loading without plastic glazing breakage, gasket failure, deterioration of glazing accessories, and defects in the work. Glazed panels shall comply with the safety standards, as indicated in accordance with ANSI Z97.1. Glazed panels shall comply with indicated wind/snow loading in accordance with ASTM E 1300.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver products to the site in unopened containers, labeled plainly with manufacturers' names and brands. Store plastic glazing and setting materials in safe, enclosed dry locations and do not unpack until needed for installation. Handle and install materials in a manner that will protect them from damage.

1.5 ENVIRONMENTAL REQUIREMENTS

Do not start glazing work until the outdoor temperature is above 4 degrees and rising, unless procedures recommended by the plastic glazing manufacturer and approved by the Contracting Officer are made to warm the glass and rabbet surfaces. Provide ventilation to prevent condensation of moisture on glazing work during installation. Do not perform glazing work during damp or rainy weather.

1.6 WARRANTY

1.6.1 Warranty for Plastic Glazing Units

For five year period following acceptance of the work: Warranty Type I, category A (UV stabilized) sheets against breakage.

For ten year period following acceptance of the work: Warranty Type IV, against yellowing and loss of light transmission.

PART 2 PRODUCTS

2.1 MIRRORS

2.1.1 Glass Mirrors see section 10 28 13

2.1.2 One-Way Laminated Vision Glass (Transparent Mirrors)

Type I, Class 1, Quality q1, 6 mm thick, coated on one face with a hard, adherent film of chromium or other approved coating of equal durability. Glass shall transmit not less than 5 percent or more than 11 percent of total incident visible light and shall reflect from the front surface of the coating not less than 45 percent of the total incident visible light.

2.2 PLASTIC GLAZING

2.2.1 Plexiglas G - Acrylic Sheet

ASTM D 4802 (or equivalent), Category A-1, Finish 1 (architectural glazing clear and smooth on both sides), Finish 3 (abrasion resistant mylar coated for guard tower), Type UVF ultraviolet stabilized, heat resistant, 8 mm thick.

2.3 SETTING AND SEALING MATERIALS

Provide as specified in the GANA Glazing Manual, IGMA TM-3000, IGMA TB-3001, or equivalent and manufacturer's recommendations, unless specified otherwise herein. Do not use metal sash putty, nonskinning compounds, nonresilient preformed sealers, or impregnated preformed gaskets. Materials exposed to view and unpainted shall be gray or neutral color.

2.3.1 Putty and Glazing Compound

Putty shall be linseed oil type conforming to CID A-A-378 for face-glazing primed wood sash or equivalent.

2.3.2 Sealants

Provide elastomeric and structural sealants.

2.3.2.1 Elastomeric Sealant

ASTM C 920, Type S, Grade NS, Class 12.5, Use G or equivalent. Use for channel or stop glazing metal sash. Sealant shall be chemically compatible with setting blocks, edge blocks, and sealing tapes, and with plastic sheet. Color of sealant shall be white.

2.3.2.2 Structural Sealant

ASTM C 1184, Type S or equivalent.

2.3.3 Joint Backer

Joint backer shall have a diameter size at least 25 percent larger than joint width; type and material as recommended in writing by glass and sealant manufacturer.

2.3.4 Preformed Channels

Neoprene, vinyl, or rubber, as recommended by the glass manufacturer for the particular condition. Channels shall be chemically compatible with plastic sheet.

2.3.5 Sealing Tapes

Preformed, semisolid, PVC-based material of proper size and compressibility for the particular condition, complying with ASTM D 2287 or equivalent. Use only where glazing rabbet is designed for tape and tape is recommended by the glass or sealant manufacturer. Provide spacer shims for use with compressible tapes. Tapes shall be chemically compatible with the product being set.

2.3.6 Setting Blocks and Edge Blocks

Closed-cell neoprene setting blocks shall be dense extruded type conforming to ASTM C 509 and ASTM D 395, Method B, Shore A durometer between 70 and 90. Edge blocking shall be Shore A durometer of 50 (+ or - 5) or equivalent. Silicone setting blocks shall be required when blocks are in contact with silicone sealant. Profiles, lengths and locations shall be as required and recommended in writing by plastic glazing manufacturer. Block color shall be black.

2.3.7 Glazing Gaskets

Neoprene or DPDM glazing gaskets shall be extruded with continuous integral locking projection designed to engage into plastic glazing holding members to provide a watertight seal during dynamic loading, building movements and

thermal movements. Glazing gaskets for a single glazed opening shall be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets shall be in lengths or units recommended by manufacturer to ensure against pull-back at corners. Glazing gasket profiles shall be as indicated on drawings.

2.3.7.1 Fixed Glazing Gaskets

Fixed glazing gaskets shall be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C 509, Type 2, Option 1 or equivalent.

2.3.7.2 Wedge Glazing Gaskets

Wedge glazing gaskets shall be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to ASTM C 864, Option 1, Shore A durometer between 65 and 75 or equivalent.

2.3.8 Accessories

Provide as required for a complete installation, including glazing points, clips, shims, angles, beads, and spacer strips. Provide non-corroding metal accessories. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers.

2.4 MIRROR ACCESSORIES

2.4.1 Mirror Frames

Mirrors shall be provided with mirror frames (J-mold channels) fabricated of one-piece roll-formed Type 304 stainless steel with No. 4 brushed satin finish and concealed fasteners which will keep mirrors snug to wall. Frames shall be 32 x 6 x 6 mm (1-1/4 x 1/4 x 1/4 inch) continuous at top and bottom of mirrors. Concealed fasteners of type to suit wall construction material shall be provided with mirror frames.

PART 3 EXECUTION

3.1 PREPARATION

Preparation, unless otherwise specified or approved, shall conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, or equivalent and manufacturer's recommendations. Determine the sizes to provide the required edge clearances by measuring the actual opening to receive the plastic glazing. Grind smooth in the shop plastic glazing edges that will be exposed in finish work. Leave labels in place until the installation is approved, except remove applied labels on heat-absorbing plastic glazing as soon as plastic glazing is installed. Securely fix movable items or keep in a closed and locked position until glazing compound has thoroughly set.

3.2 PLASTIC GLAZING SETTING

Shop glaze or field glaze items to be glazed using plastic glazing of the quality and thickness specified or indicated. Glazing, unless otherwise specified or approved, shall conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000 or

equivalent, and manufacturer's recommendations. Handle and install glazing materials in accordance with manufacturer's instructions. Use channel frames, beads or stops which are furnished with items to be glazed to secure the plastic glazing in place and allow glazing to expand and contract freely. The channel frame shall be deep enough for the plastic glazing to contract freely and stay within the frame. Tapes and sealants that adhere to both plastic glazing and the frame shall be sufficiently extensible to accommodate thermal expansion of both. Verify products are properly installed, connected, and adjusted.

3.2.1 Plastic Sheet

Conform to manufacturer's recommendations for edge clearance, channel frames, type of sealant and tape, and method of installation.

3.3 CLEANING

Clean glass surfaces and remove labels, paint spots, putty, and other defacement as required to prevent staining. Glass shall be clean at the time the work is accepted. Clean plastic sheet in accordance with manufacturer's instructions.

3.4 PROTECTION

Plastic glazing work shall be protected immediately after installation. Glazed openings shall be identified with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Upon removal, separate protective materials for reuse or recycling. Plastic glazing units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities shall be removed and replaced with new units.

-- End of Section --

SECTION 09 22 37.00 10

LATHING AND PLASTERING
04/06

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; European or Indian publications and standards may be used in lieu per acceptance/determination of the Contracting Officer.

ASTM INTERNATIONAL (ASTM)

ASTM A 580/A 580M	(2006) Standard Specification for Stainless Steel Wire
ASTM A 853	(2004) Standard Specification for Steel Wire, Carbon, for General Use
ASTM B 164	(2003) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM C 1002	(2004) 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 C 1032	(2006) Standard Specification for Woven Wire Plaster Base
ASTM C 150	(2005) Standard Specification for Portland Cement
ASTM C 206	(2003) Standard Specification for Finishing Hydrated Lime
ASTM C 61/C 61M	(2000) Gypsum Keene's Cement
ASTM C 841	(2003) Installation of Interior Lathing and Furring
ASTM C 847	(2006) Standard Specification for Metal Lath
ASTM C 897	(2000) Aggregate for Job-Mixed Portland Cement-Based Plasters
ASTM C 926	(2006) Application of Portland Cement-Based Plaster

ASTM C 933 (2005) Welded Wire Lath

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings; G

Drawings including installation details

SD-03 Product Data

Lathing Installation;

Manufacturer's pre-printed descriptive data, catalog cuts, and installation instructions for plastering materials and accessories.

SD-04 Samples

Portland Cement Plaster

One 1 m square sample panel of each specified finish.

SD-07 Certificates

Qualifications

Manufacturer's experience in specified work.

1.3 QUALIFICATIONS

Manufacturer shall specialize in manufacturing the types of material specified, and shall have a minimum of 5 years of documented successful experience. Applicator shall specialize in the type of lath and plaster work required to meet requirements, with a minimum of 3 years of documented experience.

1.4 DELIVERY, STORAGE AND HANDLING

Materials shall be delivered to project site in the original containers bearing the name of manufacturer, contents, and brand name. Plaster, cement, and lime shall be stored off the ground under weathertight cover and away from sweating walls and other damp surfaces until ready for use. Accessories shall be stored off the ground in a weathertight structure for protection. Damaged or deteriorated materials shall be removed from project site.

1.5 ENVIRONMENTAL CONDITIONS

A temperature between 4 and 27 degrees C shall be evenly maintained in the building for a period of not less than 1 week prior to application of plaster, and for a period of at least 1 week after the gypsum plaster is set, in accordance with ASTM C 842 or standard practices. Interior spaces shall be ventilated in accordance with ASTM C 842 or standard practices immediately after applying plaster.

PART 2 PRODUCTS

2.1 METAL LATH

2.1.1 Expanded Metal Lath

Expanded metal lath shall conform to ASTM C 847 or equivalent. Lath shall be self-furring lath or flat rib lath, expanded from cold-rolled carbon sheet steel of commercial quality, coated with rust-inhibitive paint after fabrication, 1.8 kg/square meter, with backing.

2.2 CEMENT PLASTER MATERIALS

2.2.1 Portland Cement

Portland cement shall conform to ASTM C 150 or equivalent, white portland cement Type II with 13 mm chopped alkali-resistant fiberglass strands or polypropylene fibers, minimum 680 g per sack of cement.

2.2.2 Aggregates

The unit weight of aggregates shall be determined in accordance with ASTM C 29/C 29M or equivalent. Portland cement based plaster aggregates shall c-conform to ASTM C 897, except that the gradation of natural or manufactured sand for portland-cement plaster shall be as follows:

Sieve Size (mm)	Sand, Percentage by Weight Retained on Each Sieve Maximum	Minimum
4.75	0	--
2.36	8	2
1.18	38	22
0.60	78	52
0.30	97	65
0.15	100	97

2.2.3 Water

Water shall be clean, fresh, potable, and free from injurious amounts of oils, acids, alkalis and organic matter injurious to the plaster and to any metal in the system.

2.2.4 Lime

Lime shall conform to ASTM C 206 or equivalent, Type S-Special hydrated finishing lime suitable for use in scratch brown and finish coats of portland-cement plaster.

2.3 WALL OPENING FRAMES

Steel frames for wall openings for doors, pass-through openings, and access panels shall be as specified in Section 08 11 13 STEEL DOORS AND FRAMES or Section 05 50 00 METAL: MISCELLANEOUS AND FABRICATIONS. Wood frames, wood bucks, and blocking for wall openings for doors, pass-through openings, and access panels shall be as specified in Section 06 10 00 ROUGH CARPENTRY.

PART 3 EXECUTION

3.1 PREPARATION

Project conditions shall be verified as ready to receive the work. Field measurements shall be verified for compliance with approved detail drawings and manufacturer's published recommendations. Beginning of installation means installer accepts existing conditions.

3.2 LATHING INSTALLATION

3.2.1 Metal Lath on Vertical Surfaces

Metal lath shall be applied with the long dimension across the supports, with true even surfaces, and without sags or buckles in accordance with ASTM C 841. or equivalent Metal lath on vertical surfaces shall be oriented to provide maximum mechanical bond with plaster and the upper sheet shall be attached to overlap the lower sheet. When paper-backed lath is used, the upper sheet shall be attached to overlap the lower sheet. The lath shall be secured to supports at intervals not exceeding 150 mm. Nails or staples shall be used for securing lath to wood supports. Tie wires, rings, clips, or other approved fasteners having equivalent holding power of the tie wires shall be used for securing the plaster base to metal supports and to concrete or masonry. Side-laps or junction of sides of plaster base shall be tied or otherwise secured at intervals not exceeding 225 mm between supports, in addition to being secured to supports.

3.2.2 Metal Lath on Ceilings

Metal lath on ceilings shall be in accordance with ASTM C 841 or equivalent. Lath on unrestrained ceilings shall not be turned down at junction with wall or tied to wall lath or furring. Lath on restrained ceilings shall be

turned down at junction with wall, or shall be applied to cornerite or corner bead.

3.2.3 Side and End Laps

Side and end laps of metal plaster bases shall be performed in accordance with ASTM C 841 or equivalent for flat lath and ribbed lath.

3.2.4 Chases and Recesses

Chases and recesses shall be lathed for plastering. Openings over 300 mm wide shall be bridged with furring channels spaced 300 mm on centers. Openings 300 mm wide and less do not need to be bridged. Lath shall extend 75 mm beyond the edges of opening. Lath shall be securely fastened by nailing or tying. Lath shall be securely fastened with nails, screws or wire ties.

3.3 OPENINGS

Reinforcement shall be provided at corners of openings in plastered areas extending 300 mm or more in any dimension by securing striplath diagonally at corners. Striplath shall be at least 150 mm wide by 400 mm long. Shorter lengths shall be used to preclude lapping striplath. Striplath shall be secured to lathing without extending fastenings into or around supporting members. Where plaster is applied directly to concrete or masonry surfaces, striplath shall be secured to the concrete or masonry.

3.3.1 Steel Frames

Steel frames shall be securely attached through built-in anchors to the nearest stud on each side of opening with tie wire, bolts, screws, or welding or bracing where bracing is specified. Steel frames shall be grouted solid with plaster grout and a groove shall be formed within the frame returns to receive lath and plaster.

3.3.2 Ceiling Openings

Framing shall be provided for ceiling openings and supplemental supporting members for items mounted in ceiling or attached to ceiling suspension system. Frames for openings shall be secured to lath support members. Frames provided with expanded metal flanges shall be secured to lath. Intermediate structural members shall be provided for attachment or suspension of support members.

3.3.3 Openings in Hollow Partitions

Hollow partition door openings shall be additionally braced by tying together each set of double-jamb studs with not less than four solid metal column clips evenly spaced along each jamb.

3.3.4 Openings in Partitions Not To Structure

Partitions not extending to the structural ceiling or structural supports or frame shall be strengthened at openings with angle bracing from each jamb location anchored to the structural ceiling or supports.

3.3.5 Cross Bracing

Cross bracing between partitions or similar bracing may be substituted for angle bracing as approved. Minor frames such as those required for access panels may be provided with expanded metal flanges which shall be attached to lath.

3.4 INSTALLATION OF TRIM, MOLDINGS, AND ACCESSORIES

Trim, moldings, and accessories shall be installed in standard lengths level and plumb to straight lines and as indicated on drawings. Fastenings shall be spaced not over 300 mm on centers for single-flanged accessories and not over 600 mm on centers on each flange of double-flanged accessories. Items shall be mitered or coped at corners, or prefabricated corners shall be used. Joints in straight runs shall be formed with splice or tie plates.

3.4.1 Base Screeds

Base screeds shall be installed approximately 75 mm above finished floor elevation unless indicated otherwise.

3.4.2 Corner Beads

Corner beads shall be installed in standard lengths at external plastered corners, and shall be secured to furring members or supports.

3.4.3 Cornerites

Cornerites shall be installed at internal angles formed by abutting surfaces of gypsum lath or metal lath not turned down at horizontal corners or returned around vertical corners. Cornerites shall be secured to lathed surfaces. Cornerites shall be secured to concrete or masonry where plaster is applied directly to concrete or masonry surfaces. Cornerites shall not be installed at unrestrained ceilings.

3.4.4 Casing Beads

Casing beads shall be installed at the joints of dissimilar base materials in the same plane and at exposed edges of plaster including junctions of walls and ceilings except that beads shall not be installed at restrained ceilings abutting plastered surfaces. At the perimeter of unrestrained suspended ceilings, the casing bead shall be secured to the ceiling to provide a 10 mm opening between the abutting surfaces. The opening shall be sealed prior to plastering with sealant as specified in Section 07 92 00 JOINT SEALANTS.

3.4.5 Expansion and Control Joint Beads

Expansion joint beads shall be installed as control joints in plasterwork at the locations indicated. Plaster base shall not be run continuous through control joints. Additional supports shall be installed as required to support the beads.

3.4.6 Trim

Trim shall be installed where indicated and as required to complete the plaster work.

3.5 PLASTER THICKNESS AND SURFACE EVENNESS

Plaster thickness and surface evenness shall be controlled by grounds or screeds of metal, wood, or plaster. Wood grounds are specified under Section 06 10 00 ROUGH CARPENTRY. Plaster thickness shall be as shown.

3.6.1 Grounds and Screeds

Grounds shall be used for securing trim items, and for finished corners and terminations. Screeds shall be installed for base screeds when wood or metal grounds are not required. Temporary screeds shall be installed when permanent screeds or grounds cannot be used. On completion of approved base coats, temporary screeds shall be removed and voids immediately filled with plaster.

3.6.2 Plaster Screeds

Plaster screeds shall be used within the plastered areas to supplement wood and metal grounds and screeds.

3.7 PLASTER GROUT

Plaster grout shall be scratch-coat material mixed to a non-fluid consistency. Plaster grout shall be used to fill steel door frames and partition bases. Heads and jambs of frames shall be filled solid with grout, and 13 mm deep grooves shall be formed in the grout, while plastic, to receive gypsum lath.

3.8 PROPORTIONS AND MIXING

3.8.1 Portland Cement Plaster Base Coat

Base coat shall be proportioned and mixed in accordance with ASTM C 926.

3.8.2 Portland Cement-Plaster Finish

The finish coat shall be proportioned and mixed in accordance with ASTM C 926 or equivalent.

3.9 MACHINE APPLICATION

A plastering machine may be used for the application of scratch and brown coats. Plaster for machine application shall be a special plaster compounded and packaged by the manufacturer for this purpose. Slump cone equipment shall be present on the jobsite when base-coat plastering begins, and until completion. Testing of the mix shall be the responsibility of the Contractor, but equipment shall be available for use by the Government. Additional water shall not be added to the mix to allow pumping through extended hose lines to the plastering nozzle. The amount of water added to each batch of plaster shall be that quantity which results in a plaster slump of not more than 75 mm for gypsum and 65 mm for portland cement using a standard plaster slump cone or 150 mm for gypsum and 125 mm for portland cement using a concrete slump cone. Application of plaster shall conform to the provisions of ASTM C 842 or equivalent.

3.10 QUALITY CONTROL

Fluidity or stiffness of plaster shall be tested with a standard 50 x 100 x 150 mm plaster slump testing cone or by a 100 x 200 x 300 mm concrete slump testing cone. Method of making slump test shall be as follows:

a. Place cone on center of dry base plate located on a level, firm surface. Hold cone tightly against plate.

b. Fill the cone with plaster obtained from the hose or nozzle, without air on the nozzle, puddling with tamping rod during the operation to eliminate air bubbles or voids.

c. Screed plaster level with top of cone.

d. Lift cone straight up from base plate in a slow and uniform motion, and place it on the base plate next to plaster sample.

e. Lay a straightedge across top of cone, being careful not to disturb or jostle the plate, and measure the slump in mm from the bottom of the straightedge to the top of the plaster sample.

3.11 APPLICATION OF FINISHES

The finish coat may be omitted back of projecting bases, wainscots, structural-glass wall finish, cabinets, chalkboards, tackboards, bulletin boards, acoustic treatments, fixed equipment, and other locations where indicated. Finish coats shall not be applied above wainscots until wainscots have been installed. Plaster shall have a smooth-trowelfinish.

3.11.1 Portland Cement-Based Plaster

Two-coat portland cement-based plaster shall be applied in accordance with ASTM C 926 or equivalent. The final coat shall be finished to a true and even surface free from rough areas, checks, or blemishes. Nominal plaster finish thickness shall be as shown (two 10-mm layers).

3.12 PATCHING

Plaster showing oversanding, cracks, blisters, pits, checks, discoloration or other defects is not acceptable. Defective plaster work shall be removed and replaced with new plaster at the expense of Contractor. Patching of defective work will be permitted only when approved by the Contracting Officer. Patching shall match existing work in texture and color.

3.13 SAMPLES OF COMPLETED WORK

Samples of completed work may be taken by the Contracting Officer at any time for laboratory inspection and tests to determine conformance.

-- End of Section --

SECTION 09 24 23

STUCCO
04/06

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; European or Indian publications or standards may be used in lieu as per acceptance/determination of the Contracting Officer.

ASTM INTERNATIONAL (ASTM)

ASTM A 185/A 185M	(2006; E 2006) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM C 1032	(2006) Standard Specification for Woven Wire Plaster Base
ASTM C 1063	(2006) Standard Practice for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster
ASTM C 150	(2005) Standard Specification for Portland Cement
ASTM C 206	(2003) Standard Specification for Finishing Hydrated Lime
ASTM C 841	(2003) Installation of Interior Lathing and Furring
ASTM C 847	(2006) Standard Specification for Metal Lath
ASTM C 897	(2000) Aggregate for Job-Mixed Portland Cement-Based Plasters
ASTM C 926	(2006) Application of Portland Cement-Based Plaster
ASTM C 933	(2005) Welded Wire Lath
ASTM D 1784	(2006a) 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" designation; submittals not having a "G" designation are for information only. When

used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Lath

Drawings showing details of construction for reinforcement, , and grounds; including manufacturer's installation instructions for stucco materials, and locations where each mix and coating thickness will be used.

SD-03 Product Data

Materials

Detailed description of the proposed job-mix proportions for base and finish coats; including identification of thickness of coats.

SD-04 Samples

Colored Stucco Finish Coat

Samples including both a fabricated portion of unit of work and color samples.

Sample Panel

Sample panel, as specified.

1.3 DELIVERY AND STORAGE

Packaged materials shall be delivered to the site in the original packages and containers with labels intact and seals unbroken. Cementitious materials shall be kept dry and stored off the ground under cover away from damp surfaces until ready to be used. Aggregate shall be covered to prevent the absorption or loss of moisture.

1.4 ENVIRONMENTAL CONDITIONS

Stucco shall not be applied when the ambient temperature is 4 degrees C or lower, or when a drop in temperature below 4 degrees C is expected within 48 hours after application.

1.5 SAMPLE PANEL

The Contractor shall submit: One 300 mm square stucco panel showing finish texture and color and exposed reinforcement at the edges, one 300 mm square of reinforcement, and a 300 mm length of each accessory proposed, and prior to proceeding with stucco work.

PART 2 PRODUCTS

2.1 PORTLAND CEMENT

Portland cement shall conform to ASTM C 150 or equivalent, White portland cement, Type I.

2.2 COLORED STUCCO FINISH COAT

Colored stucco finish coat shall be a mill mixed product using white portland cement and requiring only the addition of and mixing with water for application. Color shall be selected by the Contracting Officer from the color board provided by the contractor.

2.3 LIME

Lime shall conform to ASTM C 206, Type S.

2.4 SAND

Sand aggregate for job-mixed base coat and job-mixed finish coat stucco shall conform to ASTM C 897 or equivalent.

2.5 ACCESSORIES

Accessories shall be roll-formed galvanized steel, except that cornerite and strip lath shall be formed from steel sheets with manufacturer's standard galvanized coating. Welded wire corner reinforcements shall be zinc coated, galvanized 1.4 mm steel wire conforming to ASTM A 185/A 185Mo r equivalent . Furring shall 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 shall be as shown and shall be manufacturers standard products with shop applied protective coating.

2.7 METAL LATH

Metal lath shall conform to ASTM C 847, types and weights in accordance with the various spacing shown in ASTM C 841. Lath for vertical application on steel and wood framing supports shall be expanded metal or welded or woven wire and shall have paper backing with a minimum vapor permeance of 287.2 mg per Pa per second per square meter. Woven wire lath shall be a maximum 38 x 38 mm mesh wire of not less than 1.37 mm nominal diameter and shall conform to ASTM C 1032. Welded wire lath shall conform to ASTM C 933, with openings not to exceed 50 x 50 mm. Expanded metal or wire lath shall be fabricated in a manner to provide not less than 6 mm keying between wire and paper backing and keying shall be obtained by a uniform series of slots in a perforated face paper woven between the wires.

2.8 WATER

Water shall be clean, fresh, potable, and free from amounts of oils, acids, alkalis and organic matter that would be injurious to the stucco.

PART 3 EXECUTION

3.1 FRAMING

Framing shall be installed as indicated.

3.2 CONTROL JOINTS

Control joints shall be located as indicated on the drawings. Prefabricated control joint members shall be installed prior to the application of the stucco. Control joints shall be cleared of all stucco within the control area after stucco application and prior to final stucco set.

3.3 LATH

Lath shall be installed in accordance with ASTM C 841 or ASTM C 1063 or equivalent except as otherwise specified. Metal and wire lath shall be applied straight, without buckles and with joints staggered. End laps of metal lath shall be not less than 25 mm. When paper-backed lath is used, the paper shall be split from the lath at all lap areas to provide a paper to paper and lath to lath lap. Horizontal joints shall be shiplapped. Lath shall be interrupted at all control joints.

3.3.1 Steel and Wood Supports

Metal lath without integral backing over vertical open or solid wood and steel backing frame construction shall be applied only after a backing of shiplapped waterproofed building paper or other approved material has been applied to the area to receive the stucco. Lath shall be secured to the wood frames with nails or staples spaced not over 150 mm on centers along each support; and where sheets of lath are lapped, fasteners shall be driven so as to hold both lapped edges securely in place. Lath shall be secured to steel frames in accordance with ASTM C 841 or ASTM C 1063 or equivalent , as applicable.

3.3.2 On Concrete and Masonry

Lath shall be fastened every 200 mm vertically and every 400 mm horizontally. Where wood supports adjoin masonry or concrete in the same direction, casing bead, control joints, or reinforcement shall be provided as indicated.

3.3.3 Over Metal Lintels and Flashings

Lath over metal lintels shall be extended vertically over the angles to a height of not less than 150 mm and horizontally across the underside of the lintels and shall be secured in an approved manner. Lath over metal flashings shall lap the flashings not less than 50 mm and shall be extended vertically for a height of not less than 150 mm.

3.3.4 Special Shapes, Profiles, and Contours

Special shapes, profiles, and contours shall be formed with wood, metal or aluminum furring and reinforcing.

3.5 PREPARATION OF SURFACES

Preparation of surfaces for application of stucco to solid bases such as stone, masonry or concrete shall conform to the applicable requirements of ASTM C 926 or equivalent.

3.6 PROPORTIONS AND MIXING

Proportions and mixing for job-mixed base coat and finish coat shall conform to the applicable requirements of ASTM C 926. or equivalent Mixing of mill-mixed finish coat shall be in accordance with the manufacturer's directions.

3.7 STUCCO APPLICATION

Stucco shall be applied in two coats to a thickness of not less than 20 mm 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 shall conform to the applicable requirements of ASTM C 926 or equivalent and the following:

3.7.1 Workmanship

Items or features of the work in connection with or adjoining the stucco shall be in place, plumb, straight, and true prior to beginning the stucco work. Metal and wire lath, where required, shall be in place and positioned to provide a good key at back of lath. Where lath is applied over copper, the copper shall be given a heavy coat of bituminous paint. Masonry surfaces to receive stucco shall be evenly dampened immediately prior to application of stucco. Each stucco coat shall 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 shall be made at a break, opening, or other natural division of the surface. Edges to be joined shall be dampened slightly to produce a smooth confluence. Exterior corners of stucco shall be slightly rounded. Stucco on soffit surfaces shall be pitched forward to form a drip.

Stucco showing over sanding, cracks, blisters, pits, checks, discoloration or other defects is not acceptable. Defective plaster work shall be removed and replaced with new plaster at the expense of the Contractor. Patching of defective work will be permitted only when approved by the Contracting Officer. Patching shall match existing work in texture and color. All exterior color finish shall be integral with the stucco finish.

3.7.2 Scratch Coat

Scratch coat shall be applied not less than 10 mm thick under sufficient pressure to form good keys and to completely embed the reinforcement. Before the scratch coat has set, it shall be lightly scratched in one direction and vertical surfaces shall be scratched in the horizontal direction only. The scratch coat shall be fog cured for a minimum of 7 days.

3.7.3 Finish Coat

Surfaces of the brown coat (10 mm layer thickness) shall be dampened 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 shall have a trowel-textured finish and shall conform to the approved sample. The finish coat shall be fog cured for a minimum of 48 hours. Care shall be taken to prevent staining.

3.7.4 Surface Tolerance

When a 3 m straightedge is placed at any location on the finished surface of the stucco, excluding rough-textured finish, the surface shall not vary more than 3 mm from the straightedge.

3.8 CURING AND PROTECTION

Fog curing shall be accomplished by applying a fine mist of water to the stucco. Care shall be exercised during fog curing to avoid erosion damage to the stucco surfaces. A solid stream of water shall not be used. Frequency of fogging shall be not less than three times daily. When directed the Contractor shall protect the stucco from the direct rays of the sun during severe drying conditions using canvas, cloth or other approved sheet material.

3.9 PATCHING AND POINTING

Loose, cracked, damaged or defective work shall be replaced or patched as directed. Patching shall match existing work in texture and color and shall be finished flush.

-- End of Section --

SECTION 09 66 16

TERRAZZO TILE
05/09

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; European or Indian publications and standards may be used in lieu as per acceptance/determination of the Contracting Officer.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108.10	(2005) Installation of Grout in Tile work
ANSI A118.4	(2005) Latex - Portland Cement Mortar
ANSI A118.6	(2005) Standard Cement Grouts
ANSI A118.8	(2005) Polymer Modified Cement Grouts

ASTM INTERNATIONAL (ASTM)

ASTM C 33/C 33M	(2008) Standard Specification for Concrete Aggregates
ASTM C 150	(2007) Standard Specification for Portland Cement
ASTM C 293	(2008) Standard Test Method for Flexural Strength of Concrete
ASTM C 501	(1984; R 2002) Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser
ASTM D 56	(2005) Flash Point by Tag Closed Cup Tester

NATIONAL TERRAZZO & MOSAIC ASSOCIATION (NTMA)

NTMA Info Guide	(2000) Terrazzo Information Guide

TILE COUNCIL OF AMERICA (TCA)

TCA Hdbk	(2007) Handbook for Ceramic Tile Installation

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that

will review the submittal for the Government. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Terrazzo Tile; G

Drawings indicating pattern, size, style, and color of tiles.

SD-03 Product Data

Installation

The manufacturer's printed installation instructions for the conditions indicated.

SD-04 Samples

Terrazzo Tile

Two 150 by 150 mm minimum samples of each color and pattern of terrazzo tile to be used.

SD-07 Certificates

Terrazzo Tile
Adhesive

Certificates indicating that the materials conform to the specified requirements and flooring manufacturer's approval of adhesive, grout and cleaners.

1.3 QUALITY ASSURANCE

Installer shall possess, to the satisfaction of the Contracting Officer, the technical qualifications, experience, trained personnel, and facilities to properly install the specified items.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the jobsite in the manufacturer's original unopened containers marked with the manufacturer's brand name, color, and pattern. Store materials delivered and placed in indoor storage protected from damage, weather, humidity and temperature variation, dirt and dust, or other contaminants. Temperature of storage area shall not be lower than 10 degrees C or higher than 32 degrees C.

1.5 SITE CONDITIONS

Do not install tiles until other work that could cause damage to the finished work has been completed. A temperature of not less than 21 degrees C shall be maintained in areas where tile is to be installed for a period of not less than 48 hours before, during and after laying of tiles. Tiles shall be brought into installation areas and allowed to condition at not less than 21 degrees C for a period of 48 hours prior to installation.

After installation of tiles, a minimum temperature of 13 degrees C shall be maintained.

1.6 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials which are the standard products of a manufacturer regularly engaged in the manufacture of the material and that essentially duplicate products that have been in satisfactory use at least 2 years prior to bid opening.

2.2 TERRAZZO TILE

Terrazzo tile shall be of the indicated or as directed colors as per manufacturer's or NTMA color plates and shall consist of marble or granite chips embedded in a portland cement matrix. Tiles shall be 50 mm thick and nominal 250 by 250 mm. Tiles shall have a polished finish with uniform color distribution of chips. Marble chips shall be graded to 6 mm maximum size. Granite chips shall be manufacturer's standard gradation. Tile shall have the following properties (per ASTM or equivalent):

TERRAZZO TILE PROPERTIES

PROPERTY	TEST METHOD	VALUE
Compressive Strength	ASTM C 140	62 MPa minimum
Flexural Strength	ASTM C 293	6.5 MPa minimum
Water Absorption	ASTM C 140	4.5 percent maximum
Abrasive Wear	ASTM C 501	Index 28
Coefficient of Friction	ASTM C 1028	0.6 dry, 0.5 wet
Flame Spread	ASTM E 84	Class A
Critical Radiant Flux	ASTM E 648	Class I

Sizing Tolerances:

1. All units to conform to shop drawings with a 1/16" tolerance in dimension.

Precast Surfaces and Edges:

1. All exposed edges to be ground and polished with a minimum of 1/16" bevel.

2. All finished surfaces to be ground and polished, free of holes and to have overall uniformity in matrix and aggregate.

3. All precast terrazzo finished surfaces to be sealed with a sealer approved by manufacturer.

2.3 MATERIALS: EQUIVALENT MATERIAL STANDARDS MAY BE USED AS PER ACCEPTANCE/DETERMINATION BY THE CONTRACTING OFFICER.

2.3.1 Portland Cement

ASTM C-150, White.

2.3.2 Aggregates

ASTM C-33, ASTM C-131

2.3.3 Coloring

Pigments used shall be inorganic, resistant to alkalinity, and used per manufacturer's recommendations

2.3.4 Bond Coat Thinset Mortar

Exceed requirements of ANSI A118.4-2005 Latex-Portland Cement Mortar. Use Medium-Bed, Latex-Portland Cement Mortar for tiles larger than 12″ x 12″.

2.3.5 Grouting Materials

1. Heat Resistant Grout type: Polymer Modified Sand-Portland Cement Grout – Comply with ANSI A118.7 Polymer Modified Cement Grouts

   a. Liquid Latex Admixture: Liquid Latex added as a replacement for part or all of the mixing water in dry grout mix as specified or recommended by latex manufacturer

   b. Factory prepared cementitious grout mixture including a redispersible, latex/polymer powder to which only water is added at the job site

2. Heat Resistant Grout type: Standard Sand-Portland Cement grout – Exceed ANSI A118.6-2005 Standard Cement Grouts

2.3.6 Reinforcement and Hardware

1. To conform with NTMA and Manufacturer's design.
2. Reinforce precast with deformed rods or wire mesh or both as recommended by precast terrazzo manufacturer.

2.3.7 Cleaner

Liquid neutral chemical cleaner, with pH factor between 7 and 8, of formulation recommended by manufacture for type of precast terrazzo used and complying with NTMA requirements.

2.3.8 Sealer

Colorless, slip and stain-resistant penetrating sealer with pH factor between 7 and 8 that does not affect color or physical properties of precast

terrazzo surface. High flash point (ASTM D56): 100 degrees C, Minimum, flame spread: Class A over noncombustible surfaces.

2.4 MIXES

2.4.1 Aggregate

Natural, sound, crushed marble chips or granite chips without excessive flats or flakes, complying with NTMA requirements.

2.4.2 Matrix Pigments

Pure mineral or synthetic pigments, resistant to alkalis and non-fading.

2.4.3 Monolithic Wet Cast

Terrazzo tile shall have 70 percent coverage of the precast terrazzo face with marble or granite aggregate.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify (in the field), dimensions, defects in existing work and deviations beyond allowable tolerances for substrate and advise the Contracting Officer of any discrepancy before performing the work.

3.2 GENERAL

Except as required for installation of new tile, nothing shall be kept on new tile for at least 24 hours after installation.

3.3 SUBSTRATE PREPARATION

Fill holes and cracks with mortar. Substrate shall be plumb, level and true with square corners, free of curing compounds, grease, dirt, loose particles and other foreign matter that would prevent adhesion. Projecting irregularities shall be chipped or ground smooth. Depressions shall be filled and uneven surfaces leveled; maximum variation from plane shall be 3 mm in 3m. Base shall then be rinsed and allowed to dry prior to applying setting mortar.

3.4 INSTALLATION

3.4.1 Tile Laying

Install tile in accordance with TCA Handbook, ANSI A108.3 and the manufacturer's approved installation instructions, except as specified herein. Tile shall be laid as indicated or symmetrical about center lines of vertical surfaces. Joints shall be a minimum of 3 mm to 4.5 mm, and in alignment. Tile shall be cut to fit snugly at pipes and other vertical surfaces. Joints at pipes shall be sealed with adhesive. Entire surface of finished tile countertop and vertical surfaces shall be smooth, straight, and free from mortar, buckles, waves, or projecting tile edges upon completion. Mortar on finished tile is cause for rejection by the

Contracting Officer. Damaged or rejected tiles shall be removed and replaced.

3.4.2 Precast Terrazzo Finishing Guidelines

Grouting: Comply with ANSI A108.10-2005 Installation of Grout in Tile work.

3.4.3 Finishing

Apply grout release prior to grouting with cementitious grout. After the grout has set, remove the grout release, clean the floor thoroughly with a neutral ph cleaner and apply the final seal with a product compatible with cement terrazzo and following the sealer manufacturer’s guidelines.

3.5 MOISTURE TEST

After concrete/CMU/firebrick surfaces have been cleaned, small patches of setting mortar to be used shall be spread in several locations on top of encasement and vertical surfaces to receive tile and allowed to dry overnight. If the setting mortar can be peeled easily from the surfaces, the surface is not sufficiently dry. The steps shall be repeated until the setting mortar adheres properly. Tiles shall not be applied until setting mortar adheres tightly to the substrate.

3.6 CLEANING

Upon completion of the installation and after setting mortar has cured, tile surface shall be thoroughly cleaned in accordance with the manufacturer's recommendations.

3.7 PROTECTION

The terrazzo tile work shall be covered and protected from damage until completion of the work of all other trades. Defects which develop, such as loose, broken, or curled tiles, shall be removed and replaced. Submit Manufacturer's Maintenance Instructions.

-- End of Section --

SECTION 09 90 00

PAINTS AND COATINGS
10/06

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; European or Indian publications and standards may be used in lieu as per determination/acceptance by the Contracting Officer.

ASME INTERNATIONAL (ASME)

ASME A13.1	(1996; R 2002) Scheme for the Identification of Piping Systems

ASTM INTERNATIONAL (ASTM)

ASTM C 669	(2000) Glazing Compounds for Back Bedding and Face Glazing of Metal Sash
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM D 2092	(2001e1) Standard Guide for Preparation of Zinc-Coated (Galvanized) Steel Surfaces for Painting
ASTM D 235	(2002) Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)
ASTM D 2824	(2006) Aluminum-Pigmented Asphalt Roof Coatings, Non-Fibered, Asbestos Fibered, and Fibered without Asbestos
ASTM D 4214	(1998) Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D 4263	(1983; R 2005) Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D 4444	(1992; R 2003) Use and Calibration of Hand-Held Moisture Meters
ASTM F 1869	(2004) Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

MASTER PAINTERS INSTITUTE (MPI)

MPI 1	(2004) Aluminum Paint
MPI 10	(2004) Exterior Latex, Flat, MPI Gloss Level 1
MPI 101	(2004) Epoxy Anti-Corrosive Metal Primer
MPI 107	(2004) Rust Inhibitive Primer (Water-Based)
MPI 108	(2004) High Build Epoxy Coating, Low Gloss
MPI 11	(2004) Exterior Latex, Semi-Gloss, MPI Gloss Level 5
MPI 113	(2004) Exterior Pigmented Elastomeric Coating (Water Based)
MPI 116	(2004) Epoxy Block Filler
MPI 119	(2004) Exterior Latex, Gloss
MPI 13	(2004) Exterior Solvent-Based Semi-Transparent Stain
MPI 134	(2004) Galvanized Primer (Waterbased)
MPI 138	(2004) Interior High Performance Latex, MPI Gloss Level 2
MPI 139	(2004) Interior High Performance Latex, MPI Gloss Level 3
MPI 140	(2004) Interior High Performance Latex, MPI Gloss Level 4
MPI 141	(2004) Interior High Performance Latex MPI Gloss Level 5
MPI 147	(2004) Institutional Low Odor / VOC Interior Latex, Semi-Gloss, MPI Gloss Level 5
MPI 151	(2006) Interior W.B. Light Industrial Coating, MPI Gloss Level 3
MPI 153	(2006) Interior W.B. Light Industrial Coating, Semi-Gloss, MPI Gloss Level 5
MPI 154	(2006) Interior W.B. Light Industrial Coating, Gloss, MPI Gloss Level 6
MPI 16	(2004) Exterior Latex-Based Solid Hide Stain
MPI 161	(2006) Exterior W.B. Light Industrial Coating, MPI Gloss Level 3
MPI 163	(2006) Exterior W.B. Light Industrial Coating, Semi-Gloss, MPI Gloss Level 5

MPI 164	(2006) Exterior W.B. Light Industrial Coating, Gloss, MPI Gloss Level 6
MPI 19	(2004) Inorganic Zinc Rich Primer
MPI 2	(2004) Aluminum Heat Resistant Enamel (up to 427 C and 800 F
MPI 21	(2004) Heat Resistant Enamel, Gloss (up to 205 degrees C and 400 degrees F), MPI Gloss Level 6
MPI 22	(2004) Aluminum Paint, High Heat (up to 590 degrees C and 1100 degrees F.
MPI 23	(2004) Surface Tolerant Metal Primer
MPI 26	(2004) Cementitious Galvanized Metal Primer
MPI 27	(2004) Exterior / Interior Alkyd Floor Enamel, Gloss
MPI 31	(2004) Polyurethane, Moisture Cured, Clear Gloss
MPI 39	(2004) Interior Latex-Based Wood Primer
MPI 4	(2004) Interior/Exterior Latex Block Filler
MPI 42	(2004) Latex Stucco and Masonry Textured Coating
MPI 44	(2004) Interior Latex, MPI Gloss Level 2
MPI 45	(2004) Interior Alkyd Primer Sealer
MPI 46	(2004) Interior Enamel Undercoat
MPI 47	(2004) Interior Alkyd, Semi-Gloss, MPI Gloss Level 5
MPI 48	(2004) Interior Alkyd, Gloss, MPI Gloss Level 6
MPI 49	(2004) Interior Alkyd, Flat, MPI Gloss Level 1
MPI 5	(2004) Exterior Alkyd Wood Primer
MPI 50	(2004) Interior Latex Primer Sealer
MPI 51	(2004) Interior Alkyd, Eggshell, MPI Gloss Level 2
MPI 52	(2004) Interior Latex, MPI Gloss Level 3
MPI 54	(2004) Interior Latex, Semi-Gloss, MPI Gloss Level 5

MPI 56	(2004) Interior Oil Modified Urethane Clear Gloss
MPI 57	(2004) Interior Oil Modified Urethane Clear Satin
MPI 59	(2004) Interior/Exterior Floor Enamel, Low Gloss
MPI 6	(2004) Exterior Latex Wood Primer
MPI 60	(2004) Interior/Exterior Latex Floor Paint, Low Gloss
MPI 68	(2004) Interior/Exterior Latex Floor Enamel, Gloss
MPI 7	(2004) Exterior Oil Wood Primer
MPI 71	(2004) Polyurethane, Moisture Cured, Clear, Flat
MPI 72	(2004) Polyurethane, Two Component, Pigmented, Gloss
MPI 77	(2004) Epoxy Gloss
MPI 79	(2004) Alkyd Anti-Corrosive Metal Primer
MPI 8	(2004) Exterior Alkyd, Flat, MPI Gloss Level I
MPI 9	(2004) Exterior Alkyd, Gloss, MPI Gloss Level 6
MPI 90	(2004) Interior Wood Stain, Semi-Transparent
MPI 94	(2004) Exterior Alkyd, Semi-Gloss, MPI Gloss Level 5
MPI 95	(2004) Quick Drying Primer for Aluminum

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS SP-01	(2000) Environmentally Preferable Product Specification for Architectural and Anti-Corrosive Paints

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Guide 6	(2004) Guide for Containing Debris Generated During Paint Removal Operations
SSPC Guide 7	(2004; E 2004) Guide for the Disposal of Lead-Contaminated Surface Preparation Debris
SSPC PA 1	(2000; E 2004) Shop, Field, and Maintenance Painting

SSPC PA Guide 3	(1982; E 1995) A Guide to Safety in Paint Application
SSPC Paint 18	(1982; E 2004) Paint Specification No. 18 Chlorinated Rubber Intermediate Coat Paint
SSPC QP 1	(1998; E 2004) Standard Procedure for Evaluating Painting Contractors (Field Application to Complex Industrial Structures)
SSPC SP 1	(1982; E 2004) Solvent Cleaning
SSPC SP 10	(2000; E 2004) Near-White Blast Cleaning
SSPC SP 12	(2002) Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating
SSPC SP 2	(1982; E 2004) Hand Tool Cleaning
SSPC SP 3	(2004e1) Power Tool Cleaning
SSPC SP 6	(2000; E 2004) Commercial Blast Cleaning
SSPC SP 7	(2000; E 2004) Brush-Off Blast Cleaning
SSPC VIS 1	(2002) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning
SSPC VIS 3	(2004) Visual Standard for Power-and Hand-Tool Cleaned Steel
SSPC VIS 4	(1998; E 2000) Guide and Reference Photographs for Steel Surfaces Prepared by Waterjetting

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2003) Safety -- Safety and Health Requirements

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-PRF-680	(Rev B) Degreasing Solvent
MIL-STD-101	(Rev B) Color Code for Pipelines & for Compressed Gas Cylinders

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev B; Am 1) Colors Used in Government Procurement

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

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

The current MPI, "Approved Product List" which lists paint by brand, label, product name and product code as of the date of contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use a subsequent MPI "Approved Product List", however, only one list may be used for the entire contract and each coating system is to be from a single manufacturer. All coats on a particular substrate must be from a single manufacturer. No variation from the MPI Approved Products List is acceptable.

Samples of specified materials may be taken and tested for compliance with specification requirements.

In keeping with the intent of Executive Order 13101, "Greening the Government through Waste Prevention, Recycling, and Federal Acquisition", products certified by SCS as meeting SCS SP-01 shall be given preferential consideration over registered products. Products that are registered shall be given preferential consideration over products not carrying any EPP designation.

SD-02 Shop Drawings

Piping identification

Submit color stencil codes

SD-03 Product Data

Coating

Manufacturer's Technical Data Sheets

Sealant

SD-04 Samples

Color

Submit manufacturer's samples of paint colors. Cross reference color samples to color scheme as indicated.

SD-07 Certificates

Applicator's qualifications

Qualification Testing laboratory for coatings

SD-08 Manufacturer's Instructions

Application instructions

Mixing

Detailed mixing instructions, minimum and maximum application temperature and humidity, potlife, and curing and drying times between coats.

1.3 APPLICATOR'S QUALIFICATIONS

1.3.1 Contractor Qualification

Submit the name, address, telephone number, FAX number, and e-mail address of the contractor that will be performing all surface preparation and coating application. Submit evidence that key personnel have successfully performed surface preparation and application of coatings on a minimum of three similar projects within the past three years. List information by individual and include the following:

a. Name of individual and proposed position for this work.

b. Information about each previous assignment including:

Position or responsibility

Employer (if other than the Contractor)

Name of facility owner

Mailing address, telephone number, and telex number (if non-US) of facility owner

Name of individual in facility owner's organization who can be contacted as a reference

Location, size and description of structure

Dates work was carried out

Description of work carried out on structure

1.4 QUALITY ASSURANCE

1.4.1 Field Samples and Tests

The Contracting Officer may choose up to two coatings that have been delivered to the site to be tested at no cost to the Government. Take samples of each chosen product as specified in the paragraph "Sampling Procedures." Test each chosen product as specified in the paragraph "Testing Procedure." Products which do not conform, shall be removed from the job site and replaced with new products that conform to the referenced specification. Testing of replacement products that failed initial testing shall be at no cost to the Government.

1.4.1.1 Sampling Procedure

The Contracting Officer will select paint at random from the products that have been delivered to the job site for sample testing. The Contractor shall provide one liter samples of the selected paint materials. The samples shall be taken in the presence of the Contracting Officer, and labeled, identifying each sample. Provide labels in accordance with the paragraph "Packaging, Labeling, and Storage" of this specification.

1.4.1.2 Testing Procedure

Provide Batch Quality Conformance Testing for specified products, as defined by and performed by MPI. As an alternative to Batch Quality Conformance Testing, the Contractor may provide Qualification Testing for specified products above to the appropriate MPI product specification, using the third-party laboratory approved under the paragraph "Qualification Testing" laboratory for coatings. The qualification testing lab report shall include the backup data and summary of the test results. The summary shall list all of the reference specification requirements and the result of each test. The summary shall clearly indicate whether the tested paint meets each test requirement. Note that Qualification Testing may take 4 to 6 weeks to perform, due to the extent of testing required.

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that employees performing testing are qualified. If the Contractor chooses MPI to perform the Batch Quality Conformance testing, the above submittal information is not required, only a letter is required from the Contractor stating that MPI will perform the testing.

1.5 REGULATORY REQUIREMENTS

1.5.1 Lead Content

Do not use coatings having a lead content over 0.06 percent by weight of nonvolatile content.

1.5.2 Chromate Content

Do not use coatings containing zinc-chromate or strontium-chromate.

1.5.3 Asbestos Content

Materials shall not contain asbestos.

1.5.4 Mercury Content

Materials shall not contain mercury or mercury compounds.

1.5.5 Silica

Abrasive blast media shall not contain free crystalline silica.

1.5.6 Human Carcinogens

Materials shall not contain ACGIH 0100Doc and ACGIH 0100Doc confirmed human carcinogens (A1) or suspected human carcinogens (A2).

1.6 PACKAGING, LABELING, AND STORAGE

Paints shall be in sealed containers that legibly show the contract specification number, designation name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name and address of manufacturer. Pigmented paints shall be furnished in containers not larger than 20 liters. Paints and thinners shall be stored in accordance with the manufacturer's written directions, and as a minimum, stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors, and at temperatures between 4 to 35 degrees C. Do not store paint, polyurethane, varnish, or wood stain products with materials that have a high capacity to adsorb VOC emissions. Do not store paint, polyurethane, varnish, or wood stain products in occupied spaces.

1.7 SAFETY AND HEALTH

Apply coating materials using safety methods and equipment in accordance with the following:

Work shall comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN as specified in Appendix A of EM 385-1-1.

1.7.1 Safety Methods Used During Coating Application

Comply with the requirements of SSPC PA Guide 3.

1.7.2 Toxic Materials

To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

a. The applicable manufacturer's Material Safety Data Sheets (MSDS) or local regulation.

b. 29 CFR 1910.1000.

c. ACGIH 0100Doc, threshold limit values.

1.8 ENVIRONMENTAL CONDITIONS

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 3 degrees C above dew point;

b. Below 10 degrees C or over 35 degrees C, unless specifically pre-approved by the Contracting Officer and the product manufacturer. Under no circumstances shall application conditions exceed manufacturer recommendations.

1.8.2 Post-Application

Vacate space for as long as possible after application. Wait a minimum of 48 hours before occupying freshly painted rooms. Maintain one of the following ventilation conditions during the curing period, or for 72 hours after application:

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 13 degrees C and 29 degrees C 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.

1.9 COLOR SELECTION

Colors shall be selected by the Contracting Officer, from manufacturer’s standard list submitted by the contractor.

Tint each coat progressively darker to enable confirmation of the number of coats.

1.10 LOCATION AND SURFACE TYPE TO BE PAINTED

1.10.1 Painting Included

Where a space or surface is indicated to be painted, include the following unless indicated otherwise.

a. Surfaces behind portable objects and surface mounted articles readily detachable by removal of fasteners, such as screws and bolts.

b. New factory finished surfaces that require identification or color coding and factory finished surfaces that are damaged during performance of the work.

c. Existing coated surfaces that are damaged during performance of the work.

1.10.1.1 Exterior Painting

Includes new surfaces, existing coated surfaces, and existing uncoated surfaces, of the buildings and appurtenances. Also included are existing coated surfaces made bare by cleaning operations.

1.10.1.2 Interior Painting

Includes new surfaces of the buildings and appurtenances as indicated and existing coated surfaces made bare by cleaning operations. Where a space or surface is indicated to be painted, include the following items, unless indicated otherwise.

a. Exposed columns, girders, beams, joists, and metal deck; and

b. Other contiguous surfaces.

1.10.2 Painting Excluded

Do not paint the following unless indicated otherwise.

a. Surfaces concealed and made inaccessible by panel boards, 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, brass, and lead except existing coated surfaces.

e. Hardware, fittings, and other factory finished items.

1.10.3 Mechanical and Electrical Painting

Includes field coating of interior and exterior new surfaces.

a. Where a space or surface is indicated to be painted, include the following items unless indicated otherwise.

(1) Exposed piping, conduit, and ductwork;

(2) Supports, hangers, air grilles, and registers;

(3) Miscellaneous metalwork and insulation coverings.

b. Do not paint the following, unless indicated otherwise:

(1) New zinc-coated, aluminum, and copper surfaces under insulation

(2) New aluminum jacket on piping

(3) New interior ferrous piping under insulation.

1.10.4 Exterior Painting of Site Work Items

Field coat the following items:

New Surfaces

a. Exterior unpainted exposed steel

b. Exterior previously primed exposed steel

c. Exterior exposed steel damaged during construction

1.10.5 MISCELLANEOUS PAINTING

Lettering Building

Lettering shall be provided as scheduled on the drawings, shall be block type, and shall be black enamel. Samples shall be approved before application.

1.10.6 Definitions and Abbreviations

1.10.6.1 Qualification Testing

Qualification testing is the performance of all test requirements listed in the product specification. This testing is accomplished by MPI to qualify each product for the MPI Approved Product List, and may also be accomplished by Contractor's third party testing lab if an alternative to Batch Quality Conformance Testing by MPI is desired.

1.10.6.2 Batch Quality Conformance Testing

Batch quality conformance testing determines that the product provided is the same as the product qualified to the appropriate product specification. This testing shall only be accomplished by MPI testing lab.

1.10.6.3 Coating

A film or thin layer applied to a base material called a substrate. A coating may be a metal, alloy, paint, or solid/liquid suspensions on various substrates (metals, plastics, wood, paper, leather, cloth, etc.). They may be applied by electrolysis, vapor deposition, vacuum, or mechanical means such as brushing, spraying, calendering, and roller coating. A coating may be applied for aesthetic or protective purposes or both. The term "coating" as used herein includes emulsions, enamels, stains, varnishes, sealers, epoxies, and other coatings, whether used as primer, intermediate, or finish coat. The terms paint and coating are used interchangeably.

1.10.6.4 DFT or dft

Dry film thickness, the film thickness of the fully cured, dry paint or coating.

1.10.6.5 DSD

Degree of Surface Degradation, the MPI system of defining degree of surface degradation. Five (5) levels are generically defined under the Assessment sections in the MPI Maintenance Repainting Manual.

1.10.6.6 EPP

Environmentally Preferred Products, a standard for determining environmental preferability in support of Executive Order 13101.

1.10.6.7 EXT

MPI short term designation for an exterior coating system.

1.10.6.8 INT

MPI short term designation for an interior coating system.

1.10.6.9 micron / microns

The metric measurement for 0.001 mm or one/one-thousandth of a millimeter.

1.10.6.10 mil / mils

The English measurement for 0.001 in or one/one-thousandth of an inch, equal to 25.4 microns or 0.0254 mm. for this project, only metric units shall be used.

1.10.6.11 mm

The metric measurement for millimeter, 0.001 meter or one/one-thousandth of a meter.

1.10.6.12 MPI Gloss Levels

MPI system of defining gloss. Seven (7) gloss levels (G1 to G7) are generically defined under the Evaluation sections of the MPI Manuals. Traditionally, Flat refers to G1/G2, Eggshell refers to G3, Semigloss refers to G5, and Gloss refers to G6.

Gloss levels are defined by MPI as follows:

Gloss Level	Description	Units @ 60 degrees	Units @ 85 degrees
G1	Matte or Flat	0 to 5	10 max
G2	Velvet	0 to 10	10 to 35
G3	Eggshell	10 to 25	10 to 35
G4	Satin	20 to 35	35 min
G5	Semi-Gloss	35 to 70	
G6	Gloss	70 to 85	
G7	High Gloss		

Gloss is tested in accordance with ASTM D 523. Historically, the Government has used Flat (G1 / G2), Eggshell (G3), Semi-Gloss (G5), and Gloss (G6).

1.10.6.13 MPI System Number

The MPI coating system number in each Division found in either the MPI Architectural Painting Specification Manual or the Maintenance Repainting

Manual and defined as an exterior (EXT/REX) or interior system (INT/RIN). The Division number follows the CSI Master Format.

1.10.6.14 Paint

See Coating definition.

1.10.6.15 REX

MPI short term designation for an exterior coating system used in repainting projects or over existing coating systems.

1.10.6.16 RIN

MPI short term designation for an interior coating system used in repainting projects or over existing coating systems.

PART 2 PRODUCTS

2.1 MATERIALS: EQUIVALENCIES SHALL BE ACCEPTED/DETERMINED BY THE CONTRACTING OFFICER

Conform to the coating specifications and standards referenced in PART 3. Submit manufacturer's technical data sheets for specified coatings and solvents. Comply with applicable regulations regarding toxic and hazardous materials.

PART 3 EXECUTION

3.1 PROTECTION OF AREAS AND SPACES NOT TO BE PAINTED

Prior to surface preparation and coating applications, remove, mask, or otherwise protect, hardware, hardware accessories, machined surfaces, radiator covers, plates, lighting fixtures, public and private property, and other such items not to be coated that are in contact with surfaces to be coated. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Restore surfaces contaminated by coating materials, to original condition and repair damaged items.

3.2 SURFACE PREPARATION

Remove dirt, splinters, loose particles, grease, oil, disintegrated coatings, and other foreign matter and substances deleterious to coating performance as specified for each substrate before application of paint or surface treatments. Oil and grease shall be removed prior to mechanical cleaning. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

3.2.1 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 D 235. Allow surface to dry. Wiping shall immediately precede 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.

e. Previously painted surfaces specified to be repainted or damaged during construction shall be thoroughly cleaned of all grease, dirt, dust or other foreign matter.

f. Blistering, cracking, flaking and peeling or other deteriorated coatings shall be removed.

g. Chalk shall be removed so that when tested in accordance with ASTM D 4214, the chalk resistance rating is no less than 8.

h. Slick surfaces shall be roughened. Damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls shall be repaired with suitable material to match adjacent undamaged areas.

i. Edges of chipped paint shall be feather edged and sanded smooth.

j. Rusty metal surfaces shall be cleaned as per SSPC requirements. Solvent, mechanical, or chemical cleaning methods shall be used to provide surfaces suitable for painting.

k. New, proposed coatings shall be compatible with existing coatings.

3.2.2 Existing Coated Surfaces with Minor Defects

Sand, spackle, and treat minor defects to render them smooth. Minor defects are defined as scratches, nicks, cracks, gouges, spalls, alligatoring, chalking, and irregularities due to partial peeling of previous coatings. Remove chalking by sanding or blasting so that when tested in accordance with ASTM D 4214, the chalk rating is not less than 8.

3.2.3 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.

3.2.4 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.

3.3 PREPARATION OF METAL SURFACES

3.3.1 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, or SSPC SP 10. Brush-off blast remaining surface in accordance with SSPC SP 7. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.

b. Surfaces With More Than 20 Percent Rust, Mill Scale, and Other Foreign Substances: Clean entire surface in accordance with SSPC SP 6/SSPC SP 12 WJ-3.

c. Metal Floor Surfaces to Receive Nonslip Coating: Clean in accordance with SSPC SP 10.

3.3.2 Final Ferrous Surface Condition:

For tool cleaned surfaces, the requirements are stated in SSPC SP 2 and SSPC SP 3. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 3.

For abrasive blast cleaned surfaces, the requirements are stated in SSPC SP 7, SSPC SP 6, and SSPC SP 10. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 1.

For waterjet cleaned surfaces, the requirements are stated in SSPC SP 12. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 4.

3.3.3 Galvanized Surfaces

a. New or Existing Galvanized Surfaces With Only Dirt and Zinc Oxidation Products: Clean with solvent, or non-alkaline detergent solution in accordance with SSPC SP 1. If the galvanized metal has been passivated or stabilized, the coating shall be completely removed by brush-off abrasive blast. New galvanized steel to be coated shall not be "passivated" or "stabilized" If the absence of hexavalent stain inhibitors is not documented, test as described in

ASTM D 2092, Appendix X2, and remove by one of the methods described therein.

b. Galvanized with Slight Coating Deterioration or with Little or No Rusting: Water jetting to SSPC SP 12 WJ3 to remove loose coating from surfaces with less than 20 percent coating deterioration and no blistering, peeling, or cracking. Use inhibitor as recommended by the coating manufacturer to prevent rusting.

c. Galvanized With Severe Deteriorated Coating or Severe Rusting: Spot abrasive blast rusted areas as described for steel in SSPC SP 6, and waterjet to SSPC SP 12, WJ3 to remove existing coating.

3.3.4 Non-Ferrous Metallic Surfaces

Aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces.

a. Surface Cleaning: Solvent clean in accordance with SSPC SP 1 and wash with mild non-alkaline detergent to remove dirt and water soluble contaminants.

3.3.5 Terne-Coated Metal Surfaces

Solvent clean surfaces with mineral spirits, ASTM D 235. Wipe dry with clean, dry cloths.

3.3.6 Existing Surfaces with a Bituminous or Mastic-Type Coating

Remove chalk, mildew, and other loose material by washing with a solution of 0.20 liter trisodium phosphate, 0.1 liter household detergent, 1.6 liters 5 percent sodium hypochlorite solution and 4.8 liters of warm water.

3.4 PREPARATION OF CONCRETE AND CEMENTITIOUS SURFACE

3.4.1 Concrete and Masonry

a. Curing: Concrete, stucco and masonry surfaces shall be allowed to cure at least 30 days before painting, except concrete slab on grade, which shall be allowed to cure 90 days before painting.

b. Surface Cleaning: Remove the following deleterious substances.

(1) Dirt, Chalking, Grease, and Oil: Wash new and existing uncoated surfaces with a solution composed of 0.2 liter trisodium phosphate, 0.1 liter household detergent, and 6.4 liters 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 surfaces with a solution composed of 0.2 liter trisodium phosphate, 0.1 liter household detergent, 1.6 liters 5 percent sodium hypochlorite solution and 4.8 liters 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 0.4 square meter of surface, per workman, at one time.

c. Cosmetic Repair of Minor Defects: Repair or fill mortar joints and minor defects, including but not limited to spalls, in accordance with manufacturer's recommendations and prior to coating application.

d. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not to surfaces with droplets of water. Do not apply epoxies to damp vertical surfaces as determined by ASTM D 4263 or horizontal surfaces that exceed 3 lbs of moisture per 1000 square feet in 24 hours as determined by ASTM F 1869. In all cases follow manufacturers recommendations. Allow surfaces to cure a minimum of 30 days before painting.

3.4.2 Plaster, and Stucco

a. Surface Cleaning: Plaster and stucco shall be clean and free from loose matter; gypsum board shall be dry. Remove loose dirt and dust by brushing with a soft brush, rubbing with a dry cloth, or vacuum-cleaning prior to application of the first coat material. A damp cloth or sponge may be used if paint will be water-based.

b. Repair of Minor Defects: Prior to painting, repair joints, cracks, holes, surface irregularities, and other minor defects with patching plaster or spackling compound and sand smooth.

c. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not surfaces with droplets of water. Do not apply epoxies to damp surfaces as determined by ASTM D 4263. New plaster to be coated shall have a maximum moisture content of 8 percent, when measured in accordance with ASTM D 4444, Method A, unless otherwise authorized. In addition to moisture content requirements, allow new plaster to age a minimum of 30 days before preparation for painting.

3.5 PREPARATION OF WOOD AND PLYWOOD SURFACES

3.5.1 New, Existing Uncoated, and Existing Coated Plywood and Wood Surfaces:

a. Wood surfaces shall be cleaned of foreign matter.

Surface Cleaning: Surfaces shall be free from dust and other deleterious substances and in a condition approved by the Contracting Officer prior to receiving paint or other finish. Do not use water to clean uncoated wood. Scrape to remove loose coatings. Lightly sand to roughen the entire area of previously enamel-coated wood surfaces.

b. Removal of Fungus and Mold: Wash existing coated surfaces with a solution composed of 0.2 liter trisodium phosphate, 0.1 liter

household detergent, 1.6 liters 5 percent sodium hypochlorite solution and 4.8 liters of warm water. Rinse thoroughly with fresh water.

c. Moisture content of the wood shall not exceed 12 percent as measured by a moisture meter in accordance with ASTM D 4444, Method A, unless otherwise authorized.

d. Wood surfaces adjacent to surfaces to receive water-thinned paints shall be primed and/or touched up 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 1.3-kg-cut shellac varnish, plasticized with 0.14 liters of castor oil per liter. 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 before wood becomes dirty, warped, or weathered.

3.6 APPLICATION

3.6.1 Coating Application

Painting practices shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards. Apply coating materials in accordance with SSPC PA 1. SSPC PA 1 methods are applicable to all substrates, except as modified herein.

At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application.

Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. Use trigger operated spray nozzles for water hoses. Rollers for applying paints and enamels shall be 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.

Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

Thoroughly work coating materials into joints, crevices, and open spaces. Special attention shall be given to insure that all edges, corners,

crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces.

Each coat of paint shall be applied so dry film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete.

Touch up damaged coatings before applying subsequent coats. Interior areas shall be broom clean and dust free before and during the application of coating material.

a. Drying Time: Allow time between coats, as recommended by the coating manufacturer, to permit thorough drying, but not to present topcoat adhesion problems. Provide each coat in specified condition to receive next coat.

b. Primers, and Intermediate Coats: Do not allow primers or intermediate coats to dry more than 30 days, or longer than recommended by manufacturer, before applying subsequent coats. Follow manufacturer's recommendations for surface preparation if primers or intermediate coats are allowed to dry longer than recommended by manufacturers of subsequent coatings. Each coat shall cover surface of preceding coat or surface completely, and there shall be a visually perceptible difference in shades of successive coats.

c. Finished Surfaces: Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.

d. Thermosetting Paints: Topcoats over thermosetting paints (epoxies and urethanes) should be applied within the overcoating window recommended by the manufacturer.

3.6.2 Mixing and Thinning of Paints

Reduce paints to proper consistency by adding fresh paint, except when thinning is mandatory to suit surface, temperature, weather conditions, application methods, or for the type of paint being used. Obtain written permission from the Contracting Officer to use thinners. The written permission shall include quantities and types of thinners to use.

When thinning is allowed, paints shall be thinned immediately prior to application with not more than 0.125 L of suitable thinner per liter. The use of thinner shall not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed limits on volatile organic compounds. Paints of different manufacturers shall not be mixed.

3.6.3 Two-Component Systems

Two-component systems shall be mixed in accordance with manufacturer's instructions. Any thinning of the first coat to ensure proper penetration and sealing shall be as recommended by the manufacturer for each type of substrate.

3.6.4 Coating Systems

a. Systems by Substrates: Apply coatings that conform to the respective specifications listed in the following Tables:

Table

Division 3. Exterior Concrete Paint Table
Division 4. Exterior Concrete Masonry Units Paint Table
Division 5. Exterior Metal, Ferrous and Non-Ferrous Paint Table
Division 6. Exterior Wood Paint Table

Division 3. Interior Concrete Paint Table
Division 4. Interior Concrete Masonry Units Paint Table
Division 5. Interior Metal, Ferrous and Non-Ferrous Paint Table
Division 6. Interior Wood Paint Table
Division 9: Interior Plaster Paint Table

b. Minimum Dry Film Thickness (DFT): Apply paints, primers, varnishes, enamels, undercoats, and other coatings to a minimum dry film thickness of 0.038 mm each coat unless specified otherwise in the Tables. Coating thickness where specified, refers to the minimum dry film thickness.

c. Coatings for Surfaces Not Specified Otherwise: Coat surfaces which have not been specified, the same as surfaces having similar conditions of exposure.

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.

3.7 COATING SYSTEMS FOR METAL

Apply coatings of Tables in Division 5 for Exterior and Interior.

a. Apply specified ferrous metal primer on the same day that surface is cleaned, to surfaces that meet all specified surface preparation requirements at time of application.

b. Inaccessible Surfaces: Prior to erection, use one coat of specified primer on metal surfaces that will be inaccessible after erection.

c. Shop-primed Surfaces: Touch up exposed substrates and damaged coatings to protect from rusting prior to applying field primer.

d. Surface Previously Coated with Epoxy or Urethane: Apply MPI 101, 0.038 mm DFT immediately prior to application of epoxy or urethane coatings.

e. Pipes and Tubing: The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat, but shall be overcoated with the specified ferrous-metal primer prior to application of finish coats.

f. Exposed Nails, Screws, Fasteners, and Miscellaneous Ferrous Surfaces. On surfaces to be coated with water thinned coatings, spot prime exposed nails and other ferrous metal with latex primer MPI 107.

3.8 COATING SYSTEMS FOR CONCRETE AND CEMENTITIOUS SUBSTRATES

Apply coatings of Tables in Division 3, 4 and 9 for Exterior and Interior.

3.9 COATING SYSTEMS FOR WOOD AND PLYWOOD

a. Apply coatings of Tables in 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.

3.10 PIPING IDENTIFICATION

Piping Identification, Including Surfaces In Concealed Spaces: Provide in accordance with MIL-STD-101. Place stenciling in clearly visible locations. On piping not covered by MIL-STD-101, stencil approved names or code letters, in letters a minimum of 13 mm high for piping and a minimum of 50 mm high elsewhere. Stencil arrow-shaped markings on piping to indicate direction of flow using black stencil paint.

3.11 INSPECTION AND ACCEPTANCE

In addition to meeting previously specified requirements, demonstrate mobility of moving components, including swinging and sliding doors, cabinets, and windows with operable sash, for inspection by the Contracting Officer. Perform this demonstration after appropriate curing and drying times of coatings have elapsed and prior to invoicing for final payment.

3.12 PAINT TABLES

All DFT's are minimum values. .

3.12.1 EXTERIOR PAINT TABLES

DIVISION 3: EXTERIOR CONCRETE PAINT TABLE

A. New and uncoated existing concrete; vertical surfaces, including undersides of balconies and soffits but excluding tops of slabs:

1. Latex
   New; MPI EXT 3.1A-G5 (Semigloss)
   Primer: Intermediate: Topcoat:
   MPI 11 MPI 11 MPI 11
   System DFT: 88 microns

Primer as recommended by manufacturer. Topcoat: Coating to match adjacent surfaces.

DIVISION 4: EXTERIOR CONCRETE MASONRY UNITS PAINT TABLE

A. New concrete masonry on uncoated surface:

1. Latex
   New; MPI EXT 4.2A-G5 (Semigloss) / Existing; MPI REX 4.2A-G5 (Semigloss)
   Block Filler: Primer: Intermediate: Topcoat:
   MPI 4 N/A MPI 11 MPI 11
   System DFT: 275 microns

   Topcoat: Coating to match adjacent surfaces.

DIVISION 5: EXTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE

STEEL / FERROUS SURFACES

A. New Steel that has been hand or power tool cleaned to SSPC SP 2 or SSPC SP 3

1. Alkyd
   New; MPI EXT 5.1Q-G5 (Semigloss)
   Primer: Intermediate: Topcoat:
   MPI 23 MPI 94 MPI 94
   System DFT: 131 microns

EXTERIOR SURFACES, OTHER METALS (NON-FERROUS)

A. Surfaces adjacent to painted surfaces; Mechanical, Electrical, and miscellaneous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment. Match surrounding finish:

1. Waterborne Light Industrial Coating
   MPI EXT 5.1C-G5 (Semigloss)
   Primer: Intermediate: Topcoat:
   MPI 79 MPI 163 MPI 163
   System DFT: 125 microns

3.12.2 3.12.2 INTERIOR PAINT TABLES

DIVISION 3: INTERIOR CONCRETE PAINT TABLE

A. New Concrete, vertical surfaces, not specified otherwise:

1. Institutional
   New; MPI INT 3.1M-G5 (Semigloss) / Existing; MPI RIN 3.1L-G5 (Semigloss)
   Primer: Intermediate: Topcoat:
   MPI 50 MPI 147 MPI 147
   System DFT: 100 microns

B. New concrete in toilet areas, food-preparation areas, food-serving areas, restrooms, laundry areas, shower areas, areas requiring a high degree of sanitation, and other high-humidity areas not otherwise specified except floors:

1. Waterborne Light Industrial Coating
   New; MPI INT 3.1L-G5(Semigloss) / Existing; MPI RIN 3.1C-G5(Semigloss)
   Primer: Intermediate: Topcoat:
   MPI 153 MPI 153 MPI 153
   System DFT: 120 microns

DIVISION 5: INTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE

INTERIOR STEEL / FERROUS SURFACES

A. Metal, Mechanical, Electrical, surfaces adjacent to painted surfaces (match surrounding finish), and miscellaneous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment:

1. High Performance Architectural Latex
   MPI INT 5.1R-G5 (Semigloss)
   Primer: Intermediate: Topcoat:
   MPI 79 MPI 139 MPI 139
   System DFT: 125 microns</ENG>

B. Metal in toilets areas, food-preparation areas, food-serving areas, 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:

1. MPI INT 5.1E-G5 (Semigloss)
   Primer: Intermediate: Topcoat:
   MPI 79 MPI 47 MPI 47
   System DFT: 131 microns</ENG>

C. Ferrous metal in concealed damp spaces or in exposed areas having unpainted adjacent surface:

1. Aluminum Paint
   MPI INT 5.1M
   Primer: Intermediate: Topcoat:
   MPI 79 MPI 1 MPI 1
   System DFT: 106 microns

D. Miscellaneous non-ferrous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment. Match surrounding finish:

1. High Performance Architectural Latex
   MPI INT 5.4F-G5 (Semigloss)

Primer: Intermediate: Topcoat:
MPI 95 MPI 141 MPI 141
System DFT: 125 microns</ENG>

E. Hot metal surfaces including smokestacks subject to temperatures up to 205 degrees C (400 degrees F):

1. Heat Resistant Enamel
MPI INT 5.2A
Primer: Intermediate: Topcoat:
MPI 21 Surface preparation and number of coats per Manufacturer’s instructions.
System DFT: Per Manufacturer

F. Ferrous metal subject to high temperature, up to 400 degrees C (750 degrees F):

1. Inorganic Zinc Rich Coating
MPI INT 5.2C
Primer: Intermediate: Topcoat:
MPI 19 Surface preparation and number of coats per manufacturer's instructions.
System DFT: Per Manufacturer

G. New surfaces made bare cleaning to SSPC SP 10 subject to temperatures up to 593 degrees C (1100 degrees F):

1. High Heat Resistant Coating
MPI INT 5.2D
Primer: Intermediate: Topcoat:
MPI 22 Surface preparation and number of coats per manufacturer's instructions.
System DFT: Per Manufacturer

DIVISION 6: INTERIOR WOOD PAINT TABLE

A. New uncoated Wood and plywood not otherwise specified:

1. Institutional
New; MPI INT 6.3V-G5 (Semigloss)
Primer: Intermediate: Topcoat:
MPI 39 MPI 147 MPI 147

DIVISION 9: INTERIOR PLASTER SURFACES PAINT TABLE

A. New and previously painted Plaster not otherwise specified:

1. Institutional
New; MPI INT 9.2M-G5 (Semigloss) / Existing; MPI RIN 9.2M-G5 (Semigloss)
Primer: Intermediate: Topcoat:
MPI 50 MPI 147 MPI 147
System DFT: 100 microns

B. New and previously painted in toilet areas, food-preparation areas, food-serving areas, restrooms, laundry areas, shower areas, areas requiring a high degree of sanitation, and other high humidity areas not otherwise specified.

1. Waterborne Light Industrial Coating
    New; MPI INT 9.2L-G5(Semigloss) / Existing; MPI RIN 9.2L-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 50	MPI 153	MPI 153

    System DFT: 100 microns

-- End of Section --

SECTION 10 28 13

TOILET AND SHOWER ACCESSORIES
07/06

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; European or Indian publications and standards may be used in lieu per acceptance/determination of the Contracting Officer.

ASTM INTERNATIONAL (ASTM)

ASTM C 1036 (2006) Standard Specification for Flat Glass

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-03 Product Data

Finishes
Accessory Items

Manufacturer's descriptive data and catalog cuts indicating materials of construction, fasteners proposed for use for each type of wall construction, mounting instructions, operation instructions, and cleaning instructions.

SD-04 Samples

Finishes
Accessory Items

One sample of each accessory proposed for use. Incorporate approved samples into the finished work, provided they are identified and their locations noted.

SD-07 Certificates

Accessory Items

Certificate for each type of accessory specified, attesting that the items meet the specified requirements.

1.3 DELIVERY, STORAGE, AND HANDLING

Wrap toilet accessories for shipment and storage, then deliver to the jobsite in manufacturer's original packaging, and store in a clean, dry area protected from construction damage and vandalism.

1.4 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

Provide toilet accessories shall be provided where indicated in accordance with paragraph SCHEDULE. Provide each accessory item shall be complete with the necessary mounting plates of sturdy construction with corrosion resistant surface.

2.1.1 Anchors and Fasteners

Provide anchors and fasteners capable of developing a restraining force commensurate with the strength of the accessory to be mounted and suited for use with the supporting construction. Provide tamperproof design exposed fasteners with finish to match the accessory.

2.1.2 Finishes

Except where noted otherwise, provide the following finishes on metal:

Metal	Finish
Stainless steel	No. 4 satin finish
Carbon steel, copper alloy, and brass	Chromium plated, bright

2.2 ACCESSORY ITEMS

Conform to the requirements for accessory items specified below.

2.2.1 Mirrors, Glass (MG)

Provide Type I transparent flat type, Class 1-clear glass for mirrors, size as directed. Glazing Quality q1 6 mm thick conforming to ASTM C 1036. Coat glass on one surface with silver coating, copper protective coating, and mirror backing paint. Provide highly adhesive pure silver coating of a thickness which provides reflectivity of 83 percent or more of incident light when viewed through 6 mm thick glass, free of pinholes or other defects. Provide copper protective coating with pure bright reflective copper, homogeneous without sludge, pinholes or other defects, of proper thickness to prevent "adhesion pull" by mirror backing paint. Provide mirror backing paint with two coats of special scratch and abrasion-resistant paint and baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

2.2.3 Soap Holder (SH)

Provide surface mounted Type 304 stainless steel soap holder. Provide stainless steel separate supports. Provide one per shower stall and one per single use sink or lavatory.

2.2.4 Shelf, Metal, Heavy Duty (SMHD)

Furnish a minimum 18 gauge stainless steel heavy duty metal shelf with hemmed edges. Provide shelves over 750 mm with intermediate supports. Provide minimum of 16 gauge supports, welded to the shelf, and spaced no more than 750 mm apart. Provide one in janitor closet.

2.2.5 Shelf, Metal, Light Duty (SMLD)

Support light duty metal shelf between brackets or on brackets. Purpose of brackets is to prevent lateral movement of the shelf. Furnish 600 mm (24 inch) long shelf. Provide stainless steel shelf and brackets. Provide one over each lavatory.

2.2.6 Towel Bar (TB)

Provide stainless steel towel bar with a minimum thickness of 0.38 mm. Provide minimum 19 mm diameter bar, or 16 mm square. Provide satin finish. Provide one towel bar per shower stall.

2.2.7 Towel Pin (TP)

Provide towel pin with concealed wall fastenings, and a pin integral with or permanently fastened to wall flange with maximum projection of 100 mm. Provide satin finish. Provide two towel pins per shower stall.

2.2.9 Toilet Tissue Dispenser, Jumbo (TTDJ)

Provide surface mounted toilet tissue dispenser with 2 rolls of jumbo tissue. Fabricate cabinet of Type 304, 18 gauge stainless steel with Type 304, 20 gauge stainless steel door. Provide cover with key lock. Provide one dispenser per water closet.

2.2.10 Shower Curtain and Shower Rod

Provide 22 cm outside, 19 cm inside stainless steel. Aluminum shower curtain rod. Length of curtain rod shall be full width of shower, with stainless steel. Permanent mounting on each end for secure connection to wall. Provide rectangular opaque polyester shower curtain, measuring a minimum of 178 x 198 cm with stainless steel accessories. Provide one complete assembly per shower.

PART 3 EXECUTION

3.1 INSTALLATION

Provide the same finish for the surfaces of fastening devices exposed after installation as the attached accessory. Provide oval exposed screw heads. Install accessories at the location and height indicated. Protect exposed

surfaces of accessories with strippable plastic or by other means until the installation is accepted. After acceptance of accessories, remove and dispose of strippable plastic protection. Coordinate accessory manufacturer's mounting details with other trades as their work progresses. Use sealants for brackets, plates, anchoring devices and similar items in showers (a silicone or polysulphide sealant) as they are set to provide a watertight installation. After installation, thoroughly clean exposed surfaces and restore damaged work to its original condition or replace with new work.

3.1.1 Surface Mounted Accessories

Mount on concealed backplates, unless specified otherwise. Conceal fasteners on accessories without backplates. Install accessories with sheet metal screws or wood screws in lead-lined braided jute, teflon or neoprene sleeves, or lead expansion shields, or with toggle bolts or other approved fasteners as required by the construction. Install backplates in the same manner, or provide with lugs or anchors set in mortar, as required by the construction. Fasten accessories mounted on gypsum board and plaster walls without solid backing into the metal or wood studs or to solid wood blocking secured between wood studs, or to metal backplates secured to metal studs.

3.2 CLEANING

Clean material in accordance with manufacturer's recommendations. Do not use alkaline or abrasive agents. Take precautions to avoid scratching or marring exposed surfaces.

-- End of Section --

SECTION 10 35 13.13

STOVE WALL THIMBLES
09/09

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-04 Samples

Submit manufacturers' standard cut sheet for Stove Wall Thimbles showing the manufacturer's recommended color and finish selections.

Submit one sample, assembled sections of wall thimble to show corners, intersections, and other details of construction. Provide any graphics in drawing for approval.

PART 2 PRODUCTS

2.1 TYPE OF WALL THIMBLE

2.1.1 Two-Piece Wall Thimble

Two piece heavy duty galvanized steel wall thimble shall serve dual purpose of both a heat shield and fire-stop. Thimble shall easily slide together for installation from both sides of wall and be provided with trim plate. Inner pipe shall be 304 stainless steel. Provide temporary galvanized steel cap for exterior of building to seal building prior to installation of stove.

PART 3 EXECUTION

3.1 DELIVERY OF MATERIALS

Deliver materials to the project site in their original packages or containers bearing labels clearly identifying the manufacturer, brand name, and quality or grade.

Store materials in their original unbroken packages or containers in the area in which they will be installed. Unwrap, inspect, and install wall thimbles at indicated location.

Contractor must remove and dispose excess packing materials.

3.2 EXAMINATION

Comply with manufacture's requirements of wall conditions for location, sizes, and other conditions affecting installation of stove wall thimbles.

3.3 INSTALLATION

Install only in satisfactory conditions. Comply with manufacturer's written printed instructions for through wall thimble assembly. Set wall thimble at indicated height or as recommended by manufacturer for most effective draft. Coordinate construction of precast concrete cap and cradle to provide clearance for wall thimble. Grout annular space between thimble and precast concrete air-tight.

-- End of Section --

SECTION 10 35 23.13

PROPANE STOVE

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 Z21.72/CSA 11.2	(2006) Portable Type Gas Camp Stoves
ANSI Z83.11/CSA 1.8	(2009) Gas Food Service Equipment

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition
NFPA 96	(2008) Ventilation Control and Fire Protection of Commercial Cooking Operations

1.2 RELATED REQUIREMENTS

Sections 22 00 00 PLUMBING - GENERAL PURPOSE, 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS, 26 20 00 INTERIOR DISTRIBUTION SYSTEM, apply to this section, with additions and modifications specified herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-03 Product Data

Propane stove

SD-08 Manufacturer's Instructions

Propane stove

Exhaust hood

SD-10 Operation and Maintenance Data

Propane stove, Data Package 2; G

Submit in accordance with Section 01781 OPERATION AND MAINTENANCE DATA.

1.4 WARRANTY

1.4.1 Propane Stove

Full warranty includes parts and labor for on-site service on unit. Warranty period for components: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PROPANE STOVE

2.1.1 Stove

Standard Features as follows:

Ignition via match lit

Cast Iron or steel

Three (3) burners.

Large triple ring burner and three independent control valves on face of unit to produce a wide heat range and accurate temperature control.

Inner center burner ring for low heat approximately 14,000 BTUs, center and middle burner ring for approximately 26,000 BTUs, and center, middle and outer burner ring for approximately 42,000 BTUs, of evenly distributed, clean burning blue flame with all three burners on for high heat.

Leg extensions for indicated cooking height.

Hose and regulator with quick disconnect fittings.

Stainless Steel rod cooking grid

2.1.2 Materials

Except as modified herein, provide manufacturer's standard materials for propane stove. Provide quantities, physical dimensions, colors, and electrical characteristics as indicated.

2.1.3 Exhaust Hoods Over Cooking Equipment

Section 23 00 00, Paragraph 2.16, with replaceable grease filters.

2.1.3.1 Hood Construction

Section 23 00 00, Paragraph 2.16, welded joints and seams, ground and polished to match adjacent exterior surfaces. Provide stainless steel duct collars and risers.

2.1.3.2 Filter Housing, Grease Gutter, and Removable Grease Container

Section 23 00 00, Paragraph 2.16.

2.1.3.3 Accessories

Provide washable grease filters, vapor proof light fixtures, wiring in conduit between light fixtures, fan control, damper controls and fire protection system as per Section 23 00 00, Paragraph 2.16.

2.1.4 Fans - Supply and Exhaust

Section 23 00 00, Paragraph 2.16, type as indicated, centrifugal fan with maximum sound pressure level 45 dB. Provide factory fabricated adjustable roof curbs.

2.1.5 Gas Piping

Piping from the LPG tanks to the respective LPG stoves shall be wrought iron, ASTM B36.10M or steel (black or galvanized), ASTM A53. See Section 22 00 00.

2.1.6 Propane Tanks

Tank size not exceeding 100 pounds or 22 gallons (water) in volume; NFPA 58.

PART 3 EXECUTION

3.1 INSTALLATION

NFPA 70, ANSI Z21, ANSI Z83, Section 22 00 00 PLUMBING, GENERAL PURPOSE, Section 23 00 00 AIR SUPPLY, DISTRIBUTIOIN, VENTILATION, AND EXHAUST SYSTEMS and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Install propane stove in encasement (Section 04 20 00 Masonry) on concrete equipment pad (Section 03 30 00 Cast-in-place-Concrete) in accordance with manufacturers' instructions and as indicated. Field verify actual stove dimensions prior to construction of CMU and tile encasement. Verify placement of stainless steel back splash (Section 05 50 00) between bottom of hood and top of terrazo tile (Section 09 66 16) and placement of steel corner guard (Section 05 50 00) at outside corners, horizontal and vertical edges of encasement.

Terminate steel gas piping in front of propane stove with shut-off valves and quick disconnect nipple. Connect propane stove to steel piping with stainless steel flexible hose (Gastite or equal) as per NFPA 58 Section 5.8.6 using quick disconnect dielectric fittings. Provide dielectric fitting between the steel piping and the stainless steel flexible hose.

The LPG piping shall not be embedded in the concrete floor. The propane piping shall be routed from the exterior and to the respective propane stoves by passing the piping through the concrete platform.

Piping passing through the exterior wall and the concrete platform shall be provided with pipe sleeves.

LPG tanks shall be secured using chain to prevent the bottles from toppling over. LPG storage tanks shall be provided and installed in accordance with

NFPA 58. The LPG storage tanks shall be installed on a concrete pad, and provided within an enclosure to protect the tanks from the elements. The Contractor shall coordinate with the User and the Contracting officer in determining the capacity of LPG fuel required. The LPG fuel capacity shall be based on frequency of cooking, consumption of fuel every cooking cycle, frequency and availability of replacement fuel tanks and spare capacity. This project will require that the Contractor provide the agreed to amount of fuel tanks filled with LPG fuel at time of completion.

Provide chain link fence and gates around entire LPG storage facility. Fence shall match perimeter Force protection fence with lockable gates, and concertina wire etc.

3.2 FIELD QUALITY CONTROL

Conduct inspection and testing in the presence of the Contracting Officer to certify compliance with specified and manufacturer's performance parameters. Affect repairs and retest until no deficiencies exist.

3.2.1 Field Inspection

Before and after installation, inspect propane stove and ancillary work for compliance with specified requirements.

3.2.2 Operation Tests

Upon completion, but before final acceptance, perform operation tests on propane stove and ancillary work as to piping, exhaust and make-up air flow, etc. to determine that components, including controls, safety devices, and attachments, operate properly and in accordance with specified requirements.

-- End of Section --

SECTION 10 44 16

FIRE EXTINGUISHERS
06/06

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. European or Indian standards may be used in lieu of as accepted or determined by the Contracting Officer.

INTERNATIONAL CODE COUNCIL (ICC)

IFC 1414	(2004) Portable Fire Extinguishers (Where Required)(Construction, Alteration, Demolition)
IFC 906	(2004) Portable Fire Extinguishers

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 1	(2006) Uniform Fire Code, 2006 Edition
NFPA 10	(2006; Errata 2006) Standard for Portable Fire Extinguishers

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

29 CFR 1910.157	(2003) Portable Fire Extinguishers

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit fabrication drawings for the following items consisting of fabrication and assembly details to be performed in the factory. Submit installation drawings for the following items in accordance with the paragraph entitled, "Installation," of this section.

Fire Extinguishers
Accessories
Wall Brackets

SD-03 Product Data

Submit Manufacturer's catalog and warranty data for the following items:

Fire Extinguishers
Accessories
Wall Brackets

SD-04 Samples

One Fire Extinguisher of each type to be installed

One full-sized sample of each type of Cabinet to be installed

One sample of Wall Brackets and Accessories of each type to be used

Approved samples may be used for installation, with proper identification and storage.

SD-07 Certificates

Submit Certificates showing the following:

Certification that Fire Extinguishers comply with an acceptable fire code

Submit Manufacturer's Warranty with Inspection Tag on each extinguisher.

Guarantee that Fire Extinguishers are free of defects in materials, fabrication, finish, and installation and that they will remain so for a period of not less than 3 years after completion.

1.3 DELIVERY, HANDLING, AND STORAGE

Protect materials from weather, soil, and damage during delivery, storage, and construction.

Deliver materials in their original packages, containers, or bundles bearing the brand name and the name and type of the material.

PART 2 PRODUCTS

2.1 TYPES

Fire Extinguishers must conform to NFPA 10 or equivalent standard

Provide dry chemical type fire extinguishers compliant with UL 299 or equivalent standard.

Submit Manufacturer's Data for each type of Fire Extinguisher required, detailing all related wall mounting and accessories information, complete with Manufacturer's Warranty with Inspection Tag.

2.2 MATERIAL

Extinguisher shell must be corrosion-resistant steel.

2.3 SIZE

Extinguishers must be 4.5 kilogram.

2.4 ACCESSORIES

Forged brass valve

Fusible plug

Safety release

Antifreeze

Pressure gage

2.5 WALL BRACKETS

Provide wall-hook fire extinguisher wall brackets.

Wall bracket and Accessories must be as approved.

PART 3 EXECUTION

3.1 INSTALLATION

Install Fire Extinguishers where indicated on the drawings. Verify exact locations prior to installation.

Comply with the manufacturer's recommendations for all installations.

Provide extinguishers which are fully charged and ready for operation upon installation. Provide extinguishers complete with Manufacturer's Warranty with Inspection Tag attached.

3.2 ACCEPTANCE PROVISIONS

3.2.1 Repairing

Remove and replace damaged and unacceptable portions of completed work with new work at no additional cost to the Government.

Provide Replacement Parts list indicating specified items replacement part, replacement cost, and name, address and contact for replacement parts distributor.

3.2.2 Cleaning

Clean all surfaces of the work, and adjacent surfaces which are soiled as a result of the work. Remove from the site all construction equipment, tools, surplus materials and rubbish resulting from the work.

-- End of Section --

SECTION 10 90 00.00 48

MISCELLANEOUS SPECIALTIES
4/06

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.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Clothesline Structure

Drawings showing construction and installation details.

SD-03 Product Data

Product certification and installation recommendation data.

Clothesline Structure

1.3 DELIVERY AND STORAGE

All items shall be delivered to the project site in manufacturer's undamaged containers.

1.4 WARRANTY

Provide manufacturer's standard warranty for the items.

PART 2 PRODUCTS

2.1 CLOTHESLINE ASSEMBLY

Each clothesline assembly shall be approximately 5 m in length with four lines across spaced 410 mm apart and shall have sufficient strength to prevent sagging when all of the lines are loaded with wet laundry. Clotheslines shall be installed 1.6 m above surrounding finished grades.

Materials shall comply with requirements of this specification. Clothesline assemblies shall be either the standard product of a manufacturer regularly engaged in the manufacture of outdoor clotheslines, or shall be fabricated in accordance with this specification.

2.1.1 Supporting Structure

The clothesline supporting structure shall be constructed with galvanized steel pipes, fittings and eyebolts conforming to requirements of Section 05 50 00 unless otherwise approved. Piping, fittings, and eyebolts shall have sufficient strength to comply with requirements of Section 2.1 of this specification.

2.1.2 Clothesline

Clothesline shall consist of rope or vinyl covered steel wire that does not stretch when pulled taut or weighted down.

2.1.3 Concrete

Concrete for the foundations shall conform to requirements of Section 03 30 00.00 40.

PART 3 EXECUTION

3.1 INSTALLATION

Install all items in strict accordance with manufacturer's recommendations and these specifications. Install at the locations indicated on the drawings. Align and plumb all items with adjacent surfaces and set accurately in location.

Clotheslines shall be installed behind each barracks.

Clothesline posts shall be embedded below grade in concrete. The depth and width of concrete embedment shall be that needed to satisfy the clothesline assembly strength requirements outlines in Section 2.1 of this Specification. In no case shall the depth of embedment be less than the frost depth.

Clotheslines shall have a minimum furnished height of 1.6 m.

3.2 PROTECTION AND CLEANING

Protect the work from other trades and remove all protective wrappings when appropriate. Clean all surfaces in accordance with manufacturer's recommendations.

-- End of Section --

SECTION 12 30 00.00 40

CASEWORK
04/07

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. The contractor may use European or Indian standards in lieu of as directed/accepted or determined by the Contracting Officer.

ASME INTERNATIONAL (ASME)

ASME B18.6.1	(1981; R 1997) Wood Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A 1008/A 1008M	(2006a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened
ASTM A 167	(1999; R 2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 325	(2006) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 325M	(2005) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 Mpa Minimum Tensile Strength (Metric)
ASTM C 1036	(2006) Standard Specification for Flat Glass
ASTM D 4689	(1999; R 2005) Standard Specification for Adhesive, Casein-Type
ASTM D 4690	(1999; R 2005) Standard Specification for Urea Formaldehyde Resin Adhesives
ASTM F 594	(2002) Standard Specification for Staninless Steel Nuts
ASTM F 836M	(2002) Standard Specification for Style 1 Stainless Steel Metric Nuts

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA A156.9	(2003) Cabinet Hardware

INTERNATIONAL CODE COUNCIL (ICC)

ICC IPC	(2003; Errata 2003; Errata 2004; Errata 2004; Errata 2005) International Plumbing Code

and Hospital Service Fittings

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS FF-B-588	(Rev E) Bolt, Toggle: and Expansion Sleeve, Screw
FS FF-S-325	(Int Amd 3) Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)
FS MM-L-736	(1983c) Lumber; Hardwood
FS MM-L-751	(Rev H) Lumber; Softwood

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication drawings shall be submitted for steel and wood cabinets in accordance with the paragraphs entitled, "Wood Cabinet, Steel Cabinet and Counter Top and Back Splash Fabrication," of this section;

Installation Drawings shall be submitted for steel and wood cabinets in accordance with the paragraph entitled, "Installation," of this section; G.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Corrosion-Resistant Steel;
Plywood;
Hardwood;
Glass;
Adhesives;
Filler Material;
Varnish;
Fasteners;
Service Fixtures;
Accessories and Hardware;
Softwoods;

SD-04 Samples

Samples shall include:

Counter Top and Back Splash, one each, 100 millimeter in width, submitted as one unit or as separate items;

Accessories and Hardware, one each;

Manufacturer's Standard Color Charts shall be submitted in accordance with paragraph entitled, "General," of this section; G.

1.3 DELIVERY, STORAGE, AND HANDLING

Cabinets shall be delivered, stored, and handled in a manner that will prevent damage and disfigurement.

Temporary skids shall be provided under units weighing more than 80 kilograms.

PART 2 PRODUCTS

2.1 GENERAL

Manufacturer's Standard Color Charts shall be submitted for wood and metal cabinets showing the manufacturer's recommended color and finish selections.

Manufacturer's Instructions shall be submitted for wood and metal cabinet systems including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

Cabinets shall be the manufacturer's standard sizes of type and design indicated. Both wall and base cabinet assemblies shall consist of individual units joined into continuous sections as indicated. Fastenings shall be accomplished to permit removal and replacement of individual units without affecting the remainder of the installation.

2.2 MATERIALS

Steel for cabinet construction shall conform to ASTM A 1008/A 1008M.

Corrosion-Resistant Steel shall conform to ASTM A 167, Type 304 Finish 4.

Douglas-fir Plywood shall conform to ICC IPC, exterior type, fully waterproof bond.

Adhesives for application of plastic laminate shall be a thermosetting urea-resin Type II conforming to ASTM D 4690 as recommended by the manufacturer of the laminate. Adhesive for wood members shall conform to ASTM D 4689.

Filler Material shall conform to FS TT-F-336.

Hardwood shall conform to FS MM-L-736, standard hardwood lumber, S2S.

Hardwood plywood shall conform to ICC IPC.

Softwoods shall conform to FS MM-L-751, factory and shop grade.

Varnish shall conform to FS TT-V-121.

Accessories and Hardware shall conform to the following requirements, as applicable:

Extension drawer slides: BHMA A156.9, Type B85071

Semiconcealed hinges: BHMA A156.9, Type B81201, 1-1/2 inches

Full surface hinges: BHMA A156.9, Type B81131, 1-1/2 inches

Knob pulls: BHMA A156.9, 1-inch diameter, Type B12132

Bar type pulls: BHMA A156.9, 4-inch overall length, Type B12012

Semiconcealed hinges: BHMA A156.9, Type B81201, 40 millimeter

Full surface hinges: BHMA A156.9, Type B81131, 40 millimeter

Knob pulls: BHMA A156.9, 25 millimeter diameter, Type B12132

Bar type pulls: BHMA A156.9, 100 millimeter overall length, Type B12012

Locks, keying, and keys: As directed

Catches: Magnetic, 22 newton pull

Sliding door set:

Impregnated fiberboard track

Nylon glides

Fasteners shall conform to the following:

Screws: ASME B18.6.1, Group, Type and Class as applicable

Anchoring Devices: FS FF-S-325, Group, Type, and Class as applicable

Toggle bolts: FS FF-B-588, Type I, Class A, Style 2

Nuts: ASTM F 594, corrosion-resistant steel

Bolts: ASTM A 325, heavy, hexagon head bolts corrosion-resistant steel

Nuts: ASTM F 836M, corrosion-resistant steel

Bolts: ASTM A 325M, heavy, hexagon head bolts corrosion-resistant steel

2.3 WOOD CABINET FABRICATION

Wall and base cabinets shall be essentially of same construction and same outside appearance. Cabinets shall be constructed with frame fronts and solid ends, or frame construction throughout. Frame members shall be 20 by 40 millimeter kiln-dried hardwood, using mortise and tenon, dovetailed or doweled, and glued together. Top and bottom corners shall be braced with hardwood blocks that are glued with water-resistant glue and nailed in place. Base cabinets shall be provided with an integral toe space at least 65 millimeter deep and 100 millimeter high. Drawers shall be mounted on metal guides. Shelves shall be removable and adjustable, as indicated. No particle board shall be used; only solid wood products.

Minimum thicknesses of materials for frame-front, solid-end cabinet construction shall be as follows:

Backs and bottoms of base cabinets and tops of wall cabinets: 3 millimeter tempered hardboard. Bottoms shall be braced with wood members glued in place.

Cabinet ends: 15 millimeter hardwood-veneer plywood

Doors: 20 millimeter hardwood plywood, doors

Drawer fronts: 20 millimeter hardwood

Drawer bottoms: 4.76 millimeter plywood or tempered hardboard. Drawer bottoms over 380 millimeter wide shall be braced with wood members glued in place.

Drawer sides and backs: 15 millimeter hardwood

Interior partitions or dividers: 15 millimeter fir plywood, Grade A-A

Shelves: Grade A-B plywood, supported on ends and 600 millimeter on centers

Adjustable shelves: 20 millimeter plywood

Base cabinet shelves: 16 millimeter plywood

Wall cabinet shelves: 15 millimeter plywood, glued-up solid wood

Minimum thicknesses of materials for frame-type cabinet construction shall be as follows:

Cabinet ends: 6 millimeter hardwood plywood

Backs, bottoms, partitions, and dividers: 4 millimeter tempered hardboard in a frame

Materials for other components shall be as specified.

2.4 STEEL CABINET FABRICATION

2.4.1 General

Wall and base cabinets shall be of essentially the same construction, fabricated from cold-rolled furniture steel not lighter than 0.85 millimeter except that backs of cabinets and backs of doors may be 0.70 millimeter steel. Wall cabinets shall have corner mullions of full-wrap construction consisting of three 90-degree bends, with no raw edges or flanges exposed. Base cabinets shall be equipped with fixed top rails and shall have an subbase forming a recessed toe space 100 millimeter high and not less than 65 millimeter deep. Welds shall be flush and ground smooth on exposed surfaces. Heads of screws and bolts shall not show in exposed exterior surfaces. Doors and drawer fronts shall be double-wall, panel-type construction, not less than 15 millimeter thick, with a sound-absorbing material cemented between the walls. Doors and drawers shall be equipped with rubber or plastic silencers or bumpers. Drawers shall have removable fronts, shall be mounted on metal guides and shall be equipped with position stops to avoid accidental complete withdrawal. Shelving shall be fixed, adjustable as indicated, and shall be formed on four sides with two additional 90-degree bends on front edge.

2.4.2 Workmanship

End panels, top rails, bottoms and vertical posts shall be aligned at intersections in same plane, without overlap.

Exposed welds shall be ground flush and smooth.

2.4.3 Minimum Thickness of Steel

	U.S. STANDARD GAGE	THICKNESS (MILLIMETER)
Hinge reinforcement, tapping strips, gussets, drawer runners	14	1.9
Cabinet top rail, hanging brackets, frame, and base	16	1.6
Outer door pan and slide support, cross rails, cabinet fronts, scribe strips, and fillers	18	1.3
Shelves, other steel items	20	1.0

2.4.4 Cabinets

Cabinets shall have sheet steel fronts, backs, sides, tops, and bottoms.

Sides shall be formed with rabbeted stiles 28 millimeter wide, closed by welded channel containing embossed louvers spaced 40 millimeter on center, for adjustable shelves.

Cabinets shall have a steel channel-shaped top rail, 1.3 millimeter steel cross rails, and Z-shaped rear rail to engage 1.6 millimeter steel hanging bracket.

At base cabinets, 40 millimeter long leveling screws shall be provided for adjusting to floor variations and shall be accessible through plugged openings in bottom; 1.9 millimeter gussets shall be installed to support the screws.

At base cabinets, removable backs, knee space panels, or access doors shall be provided where piping occurs.

2.4.5 Doors

Doors shall be double-pan construction with 16 millimeter thick telescoped inner pan into outer pan with exposed vertical edge formed into channel shape having returned lip over inner pan and offset to receive lip.

Panels shall be coated with 3 millimeter thick asphaltic sound deadener.

Reinforcement shall be fastened for hardware attachment to inner pan and shall be concealed.

Hinged doors shall be fitted with pairs of hinges, knob pulls, locks, and bumpers.

Inside edge of cutout in front panel of glass door shall be beveled.

Glass shall be set in continuous rubber gasket between panels.

Sliding doors shall be equipped with tracks, guides, bumpers, and bar pulls.

Doors for the exposed fronts of metal cabinets shall be:

Hardwood plywood

Sound-deadened metal

Doors shall be not less than 15 millimeter thick.

2.4.6 Drawers

Drawer fronts shall be double-pan construction with 16 millimeter thick telescoped inner pan into outer pan with exposed vertical edge formed into channel shape having return lip over inner pan and offset to receive lip. Drawer bodies shall be welded to front through flanges on sides and bottom, and to back through flanges at rear.

Flanges shall be extended outward or downward, top of side, and backrolled.

Corners shall be coved to 15 millimeter radius.

Drawer accessories shall consist of slides, bar pulls, and lock and stop devices.

2.4.7 Shelves

Shelves shall be fabricated from corrosion-resistant steel sheet with front and rear edges flanged down 20 millimeter and hemmed back at 30 degrees to underside of shelf.

Shelves shall be supported with 1.6 millimeter shelf clips inserted in slots in front stile and in form channel in back.

Flanges shall be notched at sides to match and engage with embossments on side panels.

2.4.8 Dustcover Tops

Front face height shall be 25 millimeter.

Dustcover tops shall be sloped upward 30 degrees from front to back of cabinet.

Dustcover tops shall be equipped for attaching from inside of cabinet.

2.4.9 Finish

Steel cabinets shall be primed and factory-finished with two coats of synthetic enamel, baking quality, conforming to FS A-A-2962, Class B. Colors shall be as selected.

2.5 COUNTER TOP AND BACK SPLASH FABRICATION

Counter tops and back splash shall be stainless steel on plywood.

Plywood shall be a water-resistant type, Grade B-D Douglas fir plywood, with a minimum thickness of 20 millimeter. Back splash shall be the height indicated.

Steel shall be not lighter than 0.85 millimeter corrosion-resistant stainless steel for backed construction and not lighter than 1.3 millimeter corrosion-resistant stainless steel for integral construction. Steel tops shall be reinforced on edges and around sink-rim opening. Counters shall be of one-piece construction; where corrosion-resistant sink bowls are provided, joints shall be welded and polished smooth. Joints between sink, counter top, and back splash shall be made watertight. Back splash shall be of the same material as counter top and shall be formed with square edges. Height shall be as indicated.

Edging and trim:

For corrosion-resistant stainless steel counter tops and back splash, the edging and trim shall be formed as an integral part of the top.

Sink rims shall be standard products of a manufacturer regularly producing this type of equipment, and shall be fabricated from corrosion-resistant steel of the size necessary to receive the sinks.

Chopping block shall be of the size and in the location indicated. Chopping block shall be:

Portable type, of solid edge-grain clear maple, minimum 20 millimeter thick, sized to fit on a suitable rack for storage

Stationery type or built-up, edge-grain clear maple, minimum 40 millimeter thick, installed in a counter top

Chopping blocks shall not be mounted in the toprail of base cabinets.

2.6 SURFACING

2.6.1 Corrosion-Resistant Stainless Steel Surfacing

Counters and work surfaces shall be formed of 1.6 millimeter sheets with exposed edges returned.

Hat-shaped channels, 1.6 millimeter, shall be used for reinforcement, spaced 760 millimeter on center.

Surfaces shall be equipped with wood strips under edges for fastening to cabinets.

Internal corners shall be coved to 15 millimeter radius.

Underside shall be coated with 3 millimeter thick sound deadener.

Joints shall be electrically welded, ground smooth, and polished to match adjacent finish.

2.7 MISCELLANEOUS CABINETS

2.7.1 Combination Sink-and-Base Cabinet

A combination sink-and-base cabinet unit may be furnished in lieu of the base cabinet and inset sink indicated provided the combination unit affords facilities and space equal to those indicated and provided the combination unit matches the adjacent units in materials and construction. Sink, with matching drainboards, shall be corrosion-resistant stainless steel and shall be equipped with a chromium-plated swinging-spout faucet, chromium-plated water-control valves, and chromium-plated cup strainer. Joints between sink and drainboard and between drainboard and counter top shall be made watertight.

2.8 ACCESSORIES AND HARDWARE

Accessories such as utility shelves and racks for extracts, condiments, and towels; bins for sugar and flour; breadboxes; and trays for cutlery and flatware shall be furnished as indicated.

Hardware shall be corrosion resistant. Exposed hardware shall have a chromium-plated finish or a corrosion-resistant finish as approved. Semiconcealed hinges on cabinets where paint finish is required shall be painted to match the cabinets. Doors shall be equipped with bullet-type catches. Door and drawer pulls shall be as indicated.

PART 3 EXECUTION

3.1 FIELD FINISHING OF WOOD CABINETS

For painted finish, a prime coat and two coats of synthetic enamel of air-drying quality, conforming to FS A-A-2962, Class A, shall be applied. Colors shall be as selected.

For natural finish, the applicable procedure for the type of wood shall be followed:

For open-grain woods: One coat of paste wood filler shall be applied, and excess filler shall be removed. One coat of pale varnish thinned with turpentine shall then be applied, followed by one coat of pale varnish and then by one coat of satin-finish varnish, plus an additional coat of satin-finish varnish on cabinet doors and drawer fronts. Surfaces shall be lightly sanded between coats.

For close-grain woods: One coat of pale varnish thinned with turpentine shall be applied, followed by one coat of pale varnish and then by one coat of satin-finish varnish, plus an additional coat of satin-finish varnish on cabinet doors and drawer fronts. Surfaces shall be lightly sanded between coats.

At the Contractor's option, wood cabinets with a factory finish standard set by the cabinet manufacturer may be provided.

3.2 INSTALLATION

Casework shall be installed plumb with countertops level to within 1 millimeter in 3000 millimeter.

Base cabinets shall be leveled by adjusting leveling screws.

Scribe strips shall be scribed and fitted to irregularities of adjacent surfaces. Gap opening shall not exceed 0.63 millimeter.

Cases shall be secured permanently to floor and wall construction using 6 millimeter diameter masonry anchors, spaced 760 millimeter maximum on center, minimum of two for each case.

Wall cases shall be supported on continuous 1.3 millimeter galvanized steel hanging brackets.

Wall cases shall be secured in position with screws to blocking.

Adjoining cases shall be bolted together. Width of joints shall not exceed 0.79 millimeter.

Closer strips, filler strips, and finish moldings shall be provided as required.

Doors shall be aligned, hardware adjusted, and surfaces cleaned and waxed.

Installation Drawings shall be submitted for steel and wood cabinets. Drawings shall include location of cabinets, details of cabinets related and dimensional positions, and locations for roughing in plumbing, including sinks, faucets, strainers and cocks.

3.3 CLEANING

On completion of cabinet installation, marred or abraded finished surfaces shall be touched up.

Crating and packing materials shall be removed from premises.

Surfaces shall be wiped down to remove fingerprints and markings and shall be left in clean condition.

3.4 INSPECTION

Casework grounds and supports shall be examined for adequate anchorage, foreign material, moisture, and unevenness that could prevent quality casework installation.

Ensure that electrical and plumbing rough-ins for casework are complete.

Do not proceed with installation until defects are corrected.

-- End of Section --

SECTION 22 00 00

PLUMBING, GENERAL PURPOSE

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22	(1999; R 2001) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(2002) Atmospheric Type Vacuum Breakers
ASSE 1005	(1999) Water Heater Drain Valves 3/4 Inch Size
ASSE 1010	(2004) Water Hammer Arresters
ASSE 1011	(2004; Errata 2004) Hose Connection Vacuum Breakers
ASSE 1012	(2002) Backflow Preventer with Intermediate Atmospheric Vent
ASSE 1013	(2005) Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers
ASSE 1019	(2004; Errata 2005) Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type
ASSE 1020	(2004; Errata 2004) Pressure Vacuum Breaker Assembly
ASSE 1037	(1990) Performance Requirements for Pressurized Flushing Devices (Flushometer) for Plumbing Fixtures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2005) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(2004) Hypochlorites

AWWA B301	(2004) Liquid Chlorine
AWWA C203	(2002) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C651	(2005; Errata 2005) Standard for Disinfecting Water Mains

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2004; Errata 2004) Specification for Filler Metals for Brazing and Braze Welding
AWS B2.2	(1991) Brazing Procedure and Performance Qualification

ASME INTERNATIONAL (ASME)

ASME A112.1.2	(2004) Standard for Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors)
ASME A112.19.1M	(1994; R 2004) Enameled Cast Iron Plumbing Fixtures
ASME A112.19.3	(2000: R 2004) Stainless Steel Plumbing Fixtures (Designed for Residential Use)
ASME A112.36.2M	(1991; R 2002) Cleanouts
ASME A112.6.1M	(1997; R 2002) Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.6.3	(2001) Standard for Floor and Trench Drains
ASME B1.20.1	(1983; R 2001) Pipe Threads, General Purpose (Inch)
ASME B16.12	(1998) Cast Iron Threaded Drainage Fittings
ASME B16.21	(2005) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.3	(1998) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.34	(2004) Valves - Flanged, Threaded and Welding End
ASME B16.39	(1998) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.4	(1998) Standard for Gray Iron Threaded Fittings; Classes 125 and 250

ASME B16.5	(2003) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24
ASME B40.100	(2006) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2004; 2005 Addenda; 2006 Addenda) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2004; 2005 Addenda; 2006 Addenda) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

ASTM INTERNATIONAL (ASTM)

ASTM A 105/A 105M	(2005) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A 183	(2003) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A 193/A 193M	(2006a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 47/A 47M	(2004) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 53/A 53M	(2006a) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 536	(1984; R 2004) Standard Specification for Ductile Iron Castings
ASTM A 733	(2003) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A 74	(2006) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A 888	(2005) Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM C 564	(2003a) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants

ASTM D 1004	(2003) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(2005) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(2006) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(2004e1) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2665	(2004e2) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2672	(1996a; R 2003) Joints for IPS PVC Pipe Using Solvent Cement
ASTM D 2822	(2005) Asphalt Roof Cement
ASTM D 2855	(1996; R 2002) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3139	(1998; R 2005) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3212	(1996a; R 2003e1) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3311	(2006a) Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM D 4060	(2001) Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D 4551	(1996; R 2001) Poly(Vinyl Chloride) (PVC) Plastic Flexible Concealed Water-Containment Membrane

ASTM D 638	(2003) Standard Test Method for Tensile Properties of Plastics
ASTM F 477	(2002e1) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301	(2004) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI 310	(2004) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

INTERNATIONAL CODE COUNCIL (ICC)

ICC IPC	(2003; Errata 2003; Errata 2004; Errata 2004; Errata 2005) International Plumbing Code

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

MSS SP-110	(1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-44	(2006) Steel Pipeline Flanges
MSS SP-58	(2002) Standard for Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(2002a; R 2004) Standard for Butterfly Valves
MSS SP-69	(2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application
MSS SP-70	(2006) Standard for Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2005) Standard for Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(1999) Standard for Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-73	(2003) Brazing Joints for Copper and Copper Alloy Pressure Fittings

MSS SP-78	(2005a) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2003) Bronze Gate, Globe, Angle and Check Valves
MSS SP-83	(2006) Standard for Class 3000 Steel Pipe Unions Socket Welding and Threaded
MSS SP-85	(2002) Standard for Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

NACE INTERNATIONAL (NACE)

NACE RP0169	(2002) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 58	Liquified Petroleum Gas Code 2004 Edition

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201	(1992) Water Hammer Arresters Standard

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and 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 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Plumbing System;

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 including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and

operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

SD-03 Product Data

Fixtures

For the following equipment to be provided under this contract the contractor shall submit the manufacturer's standard catalog data, installation, operation and maintenance manuals:

Water closets;
Faucets and trim, all locations;
Utility sinks;
Water heaters;
Hose bibs and wall hydrants;
Shower Faucets;
Valves;
Drains and Cleanouts;
Pipe Insulation;
Propane Storage Tanks;
Welding;

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

Vibration-Absorbing Features;

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

Plumbing System

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

SD-06 Test Reports

Tests, Flushing and Disinfection;

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

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.

SD-10 Operation and Maintenance Data

Valves, Faucets, Hydrants, and Fixtures - Submit Data Package 2 in accordance with Section 01781 “OPERATION AND MAINTENANCE DATA".

Water Heaters - Submit Data Package 3 in accordance with Section 01781 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

Work should be done by qualified personnel with experience in the type of work being accomplished. Piping shall be joined per piping manufacturer’s recommendation. Piping are normally connected by threaded fittings or solvent cement.

1.5.1 Plumbing Fixtures

Water flow and consumption rates shall at a minimum comply with requirements in ICC IPC.

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

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.

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

Except as otherwise noted herein, materials for various services shall be in accordance with TABLES I and II. PVC pipe shall contain a minimum of 25 percent recycled content, with a minimum of 15 percent post-consumer recycled content. Steel pipe shall contain a minimum of 25 percent recycled content, with a minimum of 16 percent post-consumer recycled content. Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be from the same manufacturer. Material or equipment containing lead shall not be used in any potable water system. Hubless cast-iron soil pipe shall not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors. Cast-iron pipe shall contain a minimum of 100 percent recycled content.

Domestic cold water shall be distributed by means of standard weight (schedule 40) galvanized steel pipe. Domestic hot water shall be distributed by means of standard weight (schedule 40) galvanized steel pipe. Waste and vent piping can be made of either galvanized steel pipe (schedule 40), or Polyvinyl Vinyl Chloride (PVC) conforming to ASTM D 2665.

2.1.1 Pipe Joint Materials

Grooved pipe and hubless cast-iron soil pipe shall not be used underground. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Institute. Joints and gasket materials shall conform to the following:

a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A 74, AWWA C606. For hubless type: CISPI 310.

b. Coupling for Steel Pipe: AWWA C606.

c. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1.6 mm thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.

d. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe.

e. Flexible Elastomeric Seals: ASTM D 3139, ASTM D 3212 or ASTM F 477.

f. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D 2564 and ASTM D 2855.

g. Flanged fittings including flanges, bolts, nuts, bolt patterns, etc., shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105/A 105M. Blind flange material shall conform to ASTM A 516/A 516M cold service and ASTM A 515/A 515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193/A 193M.

2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

a. Water Hammer Arrester: PDI WH 201. Water hammer arrester shall be diaphram or piston type.

c. Hose Clamps: SAE J1508.

d. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

e. Metallic Cleanouts: ASME A112.36.2M.

f. Hypochlorites: AWWA B300.

g. Liquid Chlorine: AWWA B301.

h. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.100.

i. Thermometers: ASTM E 1. Mercury shall not be used in thermometers.

2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 22 07 19 PLUMBING PIPING INSULATION.

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

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

2.3 VALVES

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

Description	Standard
Butterfly Valves	MSS SP-67

Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Water Heater Drain Valves	ASSE 1005
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22
Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers	ASME CSD-1 Safety Code No., Part CW, Article 5

2.3.1 Wall Faucets (HB-1)

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

2.3.2 Wall Hydrants (Frostproof)(WH-1)

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 20 mm exposed hose thread on spout and 20 mm male pipe thread on inlet.

2.3.3 Relief Valves

Water heaters shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature

element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22. Relief valves for systems where the maximum rate of heat input is less than 59 kW (200,000 Btuh) shall have 20 mm minimum inlets, and 20 mm outlets. Relief valves for systems where the maximum rate of heat input is greater than 59 kW (200,000 Btuh) shall have 25 mm minimum inlets, and 25 mm outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

2.4 FIXTURES

Fixtures shall be water conservation type, in accordance with ICC IPC. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years. Plastic in contact with hot water shall be suitable for 82 degrees C (180 degrees F) water temperature.

The following plumbing fixtures shall be provided:

Eastern Water Closet: Eastern water closet with low consumption (6.1 Liter/Flush)flush valve assembly. Provide acid resisting fired porcelain enameled cast iron water closet complete with rotating No-Hub 'P' trap and No-Hub coupling to meet piping requirements. Eastern Style water closet shall be furnished with integral non-skid foot pads and bowl wash down non-splashing flushing rim. The water closet shall be completely self supporting requiring no external mounting hardware and shall be flush with floor. The Eastern Style water closet shall incorporate waterproofing membrane flashing flange. Provide a cold water spigot 300mm above finished floor on the right (from a perspective of standing inside of the cubicle and looking out) sidewall of the cubicle. Toilets shall be oriented north and south. Toilets shall not face east or west.

Lavatories: All sinks shall be trough type constructed of block and concrete with ceramic tile exterior and lining capable of withstanding abuse. Provide maintenance access to waste piping and P-traps from under the sink. Faucets shall be chrome plated brass or bronze alloy with hot and cold water valves for manual mixing. Faucet handles shall be chrome plated brass or bronze alloy and non-lever type. No goose neck faucet fixtures shall be used.

Janitor's Sink: Floor mount janitor, constructed out of concrete. Provide hot and cold water valves with manual mixing. Faucet handles shall be copper alloy. Include a stainless steel shelf and three mop holders.

Shower: Showerhead and faucet handles shall be chrome plated brass or bronze alloy. Provide for manual mixing with hot and cold water valves. In addition to a shower head, provide each shower stall with a threaded faucet approximately 1.2 m AFF with hot and cold-water controls, mixing valve and a diverter type valve so water can be directed to either the shower or to the lower faucet. Diverter valve shall be factory made for this specific package, by the mixing valve manufacturer. Shower shall be provided with low (9.5 LPM) flow shower head. The shower head shall be surface mounted, heavy duty type and securely fastened to the wall.

Kitchen Sink: Two (2) compartment sink shall be corrosion resisting formed stainless steel. Faucet bodies and spout shall be chrome plated brass or bronze alloy. Handles, drain assembly, and stopper shall be corrosion resisting steel or brass/bronze alloy. Install complete with trim, furnished by Plumbing Contractor. Completely connected by this contractor.

Floor or Shower Drain: Cast iron construction with galvanized body, integral seepage pan, and adjustable perforated or slotted chromium plated bronze, nickel-bronze, or nickel brass strainer consisting of a grate and threaded collar. Toilet room floor drains are similar except are provided with built-in, solid, hinged grate.

Floor Sink: Provide floor sink, circular or square, with 300mm overall width or diameter and 250mm nominal overall depth. They shall have acid resistant enamel interior with cast iron body, aluminum sediment bucket and perforated grate of cast iron. Outlet size as indicated on plans.

Trench Drain: Floor trench shall be concrete construction with a cast iron grate. The cast iron grate shall be sectionalized and hinged so that it can easily be opened to clean out the trench. Iron grates shall be fabricated in sections in length not greater than 1500 mm. The floor trench shall be provided with perforated aluminum pan inserts which can be removed to clean out large food particles. The floor trench drain shall be adjustable perforated or slotted chromium plated bronze, nickel-bronze, or nickel brass strainer consisting of a grate and threaded collar. This style of floor trench shall be installed in the kitchen area of the DFACs in response to kitchen cleaning practices of the local national staff.

Grease Interceptor (Exterior only): Shall be constructed out of concrete, manual cleaning type with removable checker-plate cover complete with flow control valve. Tested and rated in accordance with PDI G-101. Concrete shall have a minimum compressive strength of 21 MPa (3045 psi) in 28 days (kitchen use only).

Room hose bibs and floor drains: Room hose bibs and floor drains shall be provided as required. Afghan dining facility area clean-up hose bib to be supplied with connecting hose on reel including approximately 12 meters of hose. Provide clean-up spray nozzle on end of hose assembly.

P-Traps: Provide P-Traps per International Plumbing Code IPC for all fixture drains, floor and trench drains, and shower drains. P-traps shall have minimum of 50 mm water seal.

2.5 BACKFLOW PREVENTERS

Backflow preventers shall be the double check valve type which is approved and listed by the Foundation for Cross-Connection Control & Hydraulic

Research. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Pressure vacuum breaker assembly shall conform to ASSE 1020. Air gaps in plumbing systems shall conform to ASME A112.1.2.

2.6 TRAPS

Unless otherwise specified, traps shall be plastic per ASTM F 409. Traps shall be with a cleanout. Provide traps with removable access panels for easy clean-out at sinks and lavatories. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 50 mm. The interior diameter shall be not more than 3.2 mm over or under the nominal size, and interior surfaces shall be reasonably smooth throughout.

2.7 WATER HEATERS

Water heater types and capacities shall be as indicated. Each water heater shall have replaceable anodes. Each primary water heater shall have controls with an adjustable range that includes 32 to 71 degrees C. The thermal efficiencies and standby heat losses shall conform to TABLE III for each type of water heater specified. A factory pre-charged expansion tank shall be installed on the cold water supply to each water heater. Expansion tanks shall be specifically designed for use on potable water systems and shall be rated for 93 degrees C water temperature and 1034 kPa working pressure. The expansion tank size and acceptance volume shall be as indicated.

In cases where the pressure of the water coming into the tank will violate manufacturer recommendations, a pressure reducer shall be installed in the line before the water heater.

Each water heater shall be equipped with a vacuum relief valve and temperature and pressure (T&P) relief valve that discharge into a nearby floor drain; discharge piping shall terminate 50 mm (2 inches) above the floor drain. The discharge pipe shall not be installed horizontally along the floor to eliminate any tripping hazards. Multiple water heaters shall be connected by common inlet and outlet manifolds to ensure equal flow and drawdown rates.

2.7.1 Automatic Storage Type

Heaters shall be complete with control system, temperature gauge, and pressure gauge, and shall have ASME rated combination pressure and temperature relief valve.

2.7.1.1 Electric Type (HWH-1)

Electric type water heaters shall consist of single or dual heating elements. Each element shall be of KW noted. The elements shall be wired so that only one element can operate at a time.

2.8 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.

2.9 MISCELLANEOUS PIPING ITEMS

2.9.1 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.

2.9.2 Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors. Provide 25 mm minimum clearance between exterior of piping or pipe insulation, and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide a mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, seal both ends of sleeves or core-drilled holes with fire rated fill, void, or cavity material.

2.9.2.1 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.

2.9.3 Sleeves Not in Masonry and Concrete

Provide 26 gage galvanized steel sheet or PVC plastic pipe sleeves.

2.9.4 Pipe Hangers (Supports)

Provide MSS SP-58 and MSS SP-69, 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.

2.9.5 Nameplates

Provide 3.2 mm 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 6.4 mm high normal block lettering into the white core. Minimum size of nameplates shall be 25 by 63 mm. 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.

2.10 SPARE PARTS

2.10.1 General Requirements

The contractor shall furnish to the Contracting Officer, fifteen per cent (15%) spare parts of total items installed, as directly coordinated with the Contracting Officer. Spare parts shall include such items as: faucets, flush valves, shower heads, shower mixing valves, hoses, hose valves, spray nozzles, wall hydrant and hose bibb components, backflow preventer parts of each type, fixture stops and traps, heater relief valves, internal valve components for each type of valve, hangers, pipe hammer arrestors, hose clamps, PVC solvent cement, pipe couplings, gaskets, flanges, nuts, bolts, faucet cartridges, pump bearings, pump micro switches, and floor drain and cleanout tops.

2.10.2 Itemizing and Tagging Spare Parts

All spare parts shall be itemized, tagged for future use, and stored by the contractor where directed by the Contracting Officer. Spare parts shall be handled, loaded, unloaded, and stored by the contractor. Final decision of spare part items shall be directly coordinated with the Contracting Officer.

2.11 PROPANE TANKS, PIPING, AND VALVES

Propane tanks (cylindrical bottles), piping, and valve installations shall be furnished and installed under this Contract, including underfloor pipe sleeves and sleeve vent piping, in accordance with NFPA 58. Provide standard tank regulating equipment for the bottles. Propane tanks shall be secured in such a manner that they do not move or topple over. The Project will require that the Contractor provide the agreed to amount of fuel tanks filled with propane fuel at time of completion.

The Contractor shall furnish and install propane gas piping from service entrance tank equipment to the various propane gas-consuming equipment shown. Make final connections to the tanks. Surface mounted piping shall not be susceptible to damage or cause any safety hazards. Piping passing through exterior walls shall be provided with pipe sleeves.

Propane tanks (bottles) shall be of number shown, 100 lb. (45 kilograms). Each propane bottle shall be factory tested and inspected.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Domestic cold and hot water shall be provided in the facilities to serve the water usage and plumbing fixtures provided for the facility. Water service to each facility shall enter the building in a mechanical, toilet, storage, or similar type space. The building service line shall be provided with a shut off valve installed inside the mechanical room or similar spaces. Water piping shall not be installed in or under the concrete foundation except for the service line. All water piping shall be exposed and routed parallel to the building lines and tight to the walls and ceiling. Insulation shall be provided where required to control sweating of pipes or to provide protection from freezing. Electric heat trace cable for freeze protection shall not be provided as a substitute for space heating systems.

The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 1.5 m outside the building, unless otherwise indicated. A ball valve and drain shall be installed on the water service line inside the building approximately 150 mm above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 300 mm below the average local frost depth or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.

Hot water shall be provided for the facility to supply 49 degrees C (120 degrees F) hot water to fixtures and outlets requiring hot water. Hot water of a higher temperature shall be provided only where required for special use or process. Hot water piping shall be routed parallel to the building lines and concealed within finished rooms. All hot water piping shall be

insulated. A hot water re-circulating pump shall be provided if hot water piping run exceeds 30m.

Floor drains shall be provided in each room that contains a water source. Floor drains shall be provided in the mechanical equipment and toilet rooms as required. Floor drains shall be provided next to the electric water heaters. In mechanical rooms, floor drains shall be provided to avoid running drain piping long distances above or over the floor. A trench drain shall be provided for the DFAC Kitchen. All waste and vent piping shall be provided in accordance with the latest edition of IPC. Drain outlet shall use p-trap system to trap sewer gases. P-trap drain should be a one-piece system without removable parts.

Every trap and trapped fixture shall be vented in accordance with the IPC. Do not run horizontal dry vent piping beneath the flood rim level of the highest fixture served. Vent piping shall come off the top of the drain line and run vertically until above the flood rim level before turning to run horizontally.

IPC Section 708.3 states that cleanouts be provided no more than 100 feet apart measured from the upstream entrance of the cleanout. AED standard is to provide cleanouts at 25 feet intervals due to the nature of Afghans plugging up the drains and the limitation of the cleanout routers available in Afghanistan.

3.1.1 Water Pipe, Fittings, and Connections

3.1.1.1 Utilities

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

3.1.1.2 Cutting and Repairing

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

3.1.1.3 Protection of Fixtures, Materials, and Equipment

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

3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 12 mm between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 100 mm and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

3.1.1.5 Pipe Drains

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

3.1.1.6 Expansion and Contraction of Piping

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

3.1.1.7 Thrust Restraint

Plugs, caps, tees, valves and bends deflecting 11.25 degrees or more, either vertically or horizontally, in waterlines 100 mm in diameter or larger shall be provided with thrust blocks, to prevent movement. Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 14 MPa after 28 days. Blocking shall be placed between solid ground and the fitting to be anchored. The base and thrust bearing sides of the thrust block shall be poured against undisturbed earth. The side of the thrust block not subject

to thrust shall be poured against forms. The area of bearing will be as shown. Blocking shall be placed so that the joints of the fitting are accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

3.1.1.8 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on hot- and cold-water supplies, flush valve systems, quick-closing valves, and similar locations 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 or horizontal capped pipe columns will not be permitted.

3.1.2 Joints

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

3.1.2.1 Threaded

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

3.1.2.2 Unions and Flanges

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 65 mm and smaller; flanges shall be used on pipe sizes 80 mm and larger.

3.1.2.3 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

3.1.2.4 Plastic Pipe

PVC pipe shall have joints made with solvent cement elastomeric, threading, (threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed), or mated flanged.

3.1.3 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally

lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

3.1.4 Corrosion Protection for Buried Pipe and Fittings

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. Coatings shall be selected, applied, and inspected in accordance with NACE RP0169 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.

3.1.5 Pipe Sleeves and Flashing

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

3.1.5.1 Sleeve Requirements

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Provide waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. Sleeves shall not be installed in structural members, except where indicated or approved. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 100 mm above the finished floor. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 6 mm clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C 920 and with a primer, backstop material and surface preparation as specified in Section 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. Sleeves through below-grade walls in contact with earth shall be recessed 12 mm from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and concrete or masonry wall as specified above. Sealant selected for the earth side of the wall shall be compatible with damp proofing/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.

3.1.5.2 Flashing Requirements

Pipes passing through roof shall be installed through a 4.9 kg per square meter copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 200 mm from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 250 mm. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 200 mm from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 250 mm in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

3.1.5.3 Waterproofing

Waterproofing at floor-mounted water closets shall be accomplished proper installation of the manufacturer provided waterproof membrane flashing flange.

3.1.5.4 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

a. A standard roof coupling for threaded pipe up to 150 mm in diameter.

b. A tack-welded or banded-metal rain shield around the pipe.

3.1.5.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs Flashing Requirements and Waterproofing, a groove 6 to 13 mm wide by 6 to 10 mm deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07 92 00 JOINT SEALANTS.

3.1.5.6 Pipe Penetrations

Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed to prevent infiltration of air, insects, and vermin.

3.1.6 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07 84 00 FIRESTOPPING.

3.1.7 Supports

3.1.7.1 General

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

3.1.7.2 Pipe Supports and Structural Bracing, Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads. Design for vibration isolation using NEBB TABLES, NEBB Procedural Standards ASHRAE-05, Chapter 42, as applicable. 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.

Pipe Vibration Isolation

Isolators shall be devices with contained chloroprene-elastomer elements for connecting to building-structure attachments. Devices shall be loaded by supported system during operating conditions to produce a minimum elastomer static deflection of 10 millimeter.

3.1.7.3 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe.

c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Type 39 saddles shall be used on insulated pipe 100 mm and larger when the temperature of the medium is 15 degrees C or higher. Type 39 saddles shall be welded to the pipe.

h. Type 40 shields shall:

(1) Be used on insulated pipe less than 100 mm.

(2) Be used on insulated pipe 100 mm and larger when the temperature of the medium is 15 degrees C or less.

(3) Have a high density insert for all pipe sizes. High density inserts shall have a density of 128 kg per cubic meter (8 pcf) or greater.

i. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 m apart at valves. Operating temperatures in determining hanger spacing for PVC pipe shall be 49 degrees C for PVC. Horizontal pipe runs shall include allowances for expansion and contraction.

j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 4.5 m nor more than 2 m from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.

k. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:

(1) On pipe 100 mm and larger when the temperature of the medium is 15 degrees C or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.

(2) On pipe less than 100 mm a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

(3) On pipe 100 mm and larger carrying medium less that 15 degrees C a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

l. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.

m. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall

be separated from the slide material by at least 100 mm or by an amount adequate for the insulation, whichever is greater.

n. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3.1.7.4 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.

3.1.8 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 100 mm will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 100 mm. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 450 mm of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron.

3.3 FIXTURES AND FIXTURE TRIMMINGS

Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected

to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Plumbing fixtures and accessories shall be installed within the space shown.

3.3.1 Fixture Connections

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

3.3.3 Height of Fixture Rims Above Floor

Lavatories and sinks shall be mounted with rim 775 mm above finished floor. Wall-hung utility sinks shall be mounted with rim 700 mm above the floor.

3.3.4 Shower Bath Outfits

The area around the water supply piping to the mixing valves and behind the escutcheon plate shall be made watertight by caulking or gasketing.

3.3.5 Fixture Supports

Fixtures shall be set into the concrete floor or constructed out of masonry and concrete. Kitchen sinks shall be set into counter tops.

3.3.6 Sight Drains

Sight drains shall be installed so that the indirect waste will terminate 50 mm above the flood rim of the funnel to provide an acceptable air gap.

3.3.7 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D 3311.

3.4 VIBRATION-ABSORBING FEATURES

Mechanical equipment, shall be isolated from the building structure by approved vibration-absorbing features, unless otherwise shown.

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 35 mm minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.5.2 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.6 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.7 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.

3.7.1 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.

3.7.1.1 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 B 117, 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 3 mm 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 50 degrees C, the factory painting system shall be designed for the temperature service.

3.7.1.2 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 50 degrees C 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 50 Degrees C: Immediately after cleaning, the metal surfaces subject to temperatures less than 50 degrees C shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm, one coat of primer applied to a minimum dry film thickness of 0.0255 mm; and two coats of enamel applied to a minimum dry film thickness of 0.0255 mm per coat.

b. Temperatures Between 50 and 205 Degrees C: Metal surfaces subject to temperatures between 50 and 205 degrees C shall receive two coats of 205 degrees C heat-resisting enamel applied to a total minimum thickness of 0.05 mm.

c. Temperatures Greater Than 205 Degrees C: Metal surfaces subject to temperatures greater than 205 degrees C shall receive two coats of 315 degrees C heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm.

3.8 TESTS, FLUSHING AND DISINFECTION

3.8.1 Plumbing System

The following tests shall be performed on the plumbing system in accordance with ICC IPC except that the drainage and vent system final test shall include the smoke test. The Contractor has the option to perform a peppermint test in lieu of the smoke test. If a peppermint test is chosen, the Contractor must submit a testing procedure to the Contracting Officer for approval.

a. Drainage and Vent Systems Tests. The final test shall include a smoke test.

b. Building Sewers Tests.

c. Water Supply Systems Tests.

e. Propane Gas Supply, Sleeve, and Vent Systems Tests.

3.8.1.1 Shower Pans

After installation of the pan and finished floor, the drain shall be temporarily plugged below the weep holes. The floor area shall be flooded with water to a minimum depth of 25 mm for a period of 24 hours. Any drop in the water level during test, except for evaporation, will be reason for rejection, repair, and retest.

3.8.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be

repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

3.8.3 System Flushing

3.8.3 During Flushing

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

3.8.3.1 After Flushing

System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation according to manufacturer's instructions.

3.8.4 Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory 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.

b. Water pressures at the most remote and the highest fixtures.

c. Operation of each fixture and fixture trim.

d. Operation of each valve, hydrant, and faucet.

e. Temperature of each domestic hot-water supply.

f. Operation of each floor drain, shower, and Eastern closet by flooding with water.

g. Operation of each vacuum breaker and backflow preventer.

3.8.5 Disinfection

After operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. System shall be flushed as specified, before introducing chlorinating material. The chlorinating material shall be hypochlorites. Except as herein specified, water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the main with a hypochlorinator injected into the main through a solution-feed chlorinator and booster pump, shall be used. If after the 24 hour and 6 hour holding periods, the residual solution contains less than 25 ppm and 50 ppm chlorine respectively, flush the piping and tank with potable water, and repeat the above procedures until the required residual chlorine levels are satisfied. The system including the tanks shall then be flushed with clean water until the residual chlorine level is reduced to less than one part per million. During the flushing period each valve and faucet shall be opened and closed several times. Samples of water in disinfected containers shall be obtained from several locations selected by the Contracting Officer. The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA 10084. The testing method used shall be either the multiple-tube fermentation technique or the membrane-filter technique. Disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.9 WASTE MANAGEMENT

Place materials defined as hazardous or toxic waste in designated containers. Return solvent and oil soaked rags for contaminant recovery and laundering or for proper disposal. Close and seal tightly partly used sealant and adhesive containers and store in protected, well-ventilated, fire-safe area at moderate temperature. Place used sealant and adhesive tubes and containers in areas designated for hazardous waste. Separate copper and ferrous pipe waste in accordance with the Waste Management Plan and place in designated areas for reuse.

3.10 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.

3.11 PERFORMANCE OF WATER HEATING EQUIPMENT

Standard rating condition terms are as follows:

EF = Energy factor, overall efficiency.

ET = Thermal efficiency with 21 degrees C delta T.

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

HL = Heat loss of tank surface area.

V = Storage volume in liters

3.11.1 Storage Water Heaters

3.11.1.1 Electric

a. Storage capacity of 454 liters or less, and input rating of 12 kW or less: minimum energy factor (EF) shall be 0.95-0.00132V per 10 CFR 430.

b. Storage capacity of more than 454 liters or input rating more than 12 kW: maximum SL shall be 1.9 w/0.093 sq. m. per ASHRAE 90.1 - SI, Addenda B.

3.12 TABLES

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

		SERVICE			
Item #	Pipe and Fitting Materials	A	B	C	D
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A 74 with compression gaskets. Pipe and fittings shall be marked with the CISPI trademark.	X	X	X	X
2	Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A 888. Pipe and fittings shall be marked with the CISPI trademark.		X	X	X
3	Cast iron drainage fittings, threaded, ASME B16.12	X		X	X
4	Cast iron screwed fittings (threaded) ASME B16.4				X
5	Polyvinyl Chloride plastic drain, waste and vent pipe and fittings, ASTM D 2665, ASTM F 891, (Sch 40) ASTM F 1760	X	X	X	X

SERVICE:

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

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

		SERVICE					
Item No.	Pipe and Fitting Materials	A	B	D	E	F	G
1	Malleable-iron threaded fittings, a. Galvanized, ASME B16.3 for use with Item 4a b. Same as "a" but not galvanized for use with Item 4b	X	X	X			
2	Steel pipe:	X	X	X			
	a. Seamless, galvanized, ASTM A 53/A 53M, Type S, Grade B						X
	b. Seamless, black, ASTM A 53/A 53M, Type S, Grade B		X	X			X
3	Polyvinyl chloride (PVC) plastic pipe, Schedules 40, 80, and 120, ASTM D 1785	X		X			
4	Polyvinyl chloride (PVC) pressure-rated pipe (SDR Series), ASTM D 2241	X		X			
5	Polyvinyl chloride (PVC) plastic pipe fittings, Schedule 40, ASTM D 2466	X		X			
6	Socket-type polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2467 for use with Items 6 and 7	X		X			
7	Threaded polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2464	X		X			
8	Joints for IPS PVC pipe using solvent cement, ASTM D 2672	X		X			
9	Steel pipeline flanges, MSS SP-44	X		X			
10	Fittings: brass or bronze; ASME B16.15, and ASME B16.18 ASTM B 828	X	X				
11	Fittings: forged, threaded or socket weld ASME B16.11				X	X	
12	Carbon steel pipe unions,	X	X				X

	socket-welding and threaded, MSS SP-83					
13	Fittings: butt weld			X	X	
14	Malleable-iron threaded pipe unions ASME B16.39	X	X			X
15	Nipples, pipe threaded ASTM A 733	X	X			X
16	Wrought iron pipe, ASTM B36.10M					X

A - Cold Water Service Aboveground
B - Hot and Cold Water Distribution 82 degree C Maximum Aboveground
D - Cold Water Service Belowground
E - Propane Gas in Buildings, Including Sleeves and Vent Piping
Indicated types are minimum wall thicknesses.

TABLE III
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT

A. STORAGE WATER HEATERS

FUEL	STORAGE CAPACITY LITERS	INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE
Elect.	100 max.	12 kW max.	10 CFR 430	EF = 0.95-0.00132V minimum
Elect.	50 min. OR	12 kW min.	ASHRAE 90.1 - SI (Addenda B)	SL = 1.9 W/0.09 sq.m. maximum

TERMS:

EF = Energy factor, overall efficiency.

ET = Thermal efficiency with 21 degrees C delta T.

EC = Combustion efficiency, 100 percent - flue loss when smoke = 0 (trace is permitted).

SL = Standby loss in W/0.09 sq. m. based on 27 degrees C delta T, or in percent per hour based on nominal 32 degrees C delta T.

HL = Heat loss of tank surface area

V = Storage volume in gallons

-- End of Section --

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM B 209	(2007) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 209M	(2007) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C 1136	(2006) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C 195	(2000) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C 534	(2007a) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 547	(2007) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C 552	(2003) Standard Specification for Cellular Glass Thermal Insulation
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM C 921	(2003a) Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM E 84	(2007) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E 96/E 96M	(2005) Standard Test Methods for Water Vapor Transmission of Materials

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 220	(2006) Standard on Types of Building Construction
NFPA 255	(2005; Errata 2006) Standard Method of Test of Surface Burning Characteristics of Building Materials

1.2 PERFORMANCE REQUIREMENTS

Thermal-insulation system materials shall be noncombustible, as defined by NFPA 220. Adhesives, coatings, sealants, facings, jackets, and thermal-insulation materials, except cellular elastomers, shall have a flame-spread classification (FSC) of 25, and a smoke-developed classification (SDC) of 50. These maximum values shall be determined in accordance with ASTM E 84, NFPA 255. Coatings and sealants shall be nonflammable in their wet state.

Adhesives, coatings, and sealants shall have published or certified temperature ratings suitable for the entire range of working temperatures normal for the surfaces to which they are to be applied.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and 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 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings for pipe insulation shall be submitted in accordance with paragraph entitled, "Installation," of this section.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Adhesives;
Coatings;
Insulating Cement;
Insulation Materials;
Jacketing;
Tape;

PART 2 PRODUCTS

2.1 MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials shall be asbestos free and conform to the following.

2.1.1 Adhesives

2.1.1.1 Cloth Adhesives

Adhesives for adhering, sizing, and finishing lagging cloth, canvas, and open-weave glass cloth shall be a pigmented polyvinyl acetate emulsion.

2.1.1.2 Vapor-Barrier Material Adhesives

Adhesives for attaching laps of vapor-barrier materials and presized glass cloth and for attaching insulation to itself, to metal, and to various other substrates, and shall be solvent-base. Solvent shall be nonflammable.

2.1.2 Coatings

2.1.2.1 Vapor-Barrier Finishing

Coatings for indoor vapor-barrier finishing of insulation surfaces shall be a pigmented resin and solvent compound.

2.1.2.2 Nonvapor-Barrier Finishing

Coatings for outdoor and indoor nonvapor-barrier finishing of insulation surfaces shall be pigmented polymer-emulsion type recommended by the insulation material manufacturer for the surface to be coated and shall be applied to specified dry-film thickness.

2.1.2.3 Cellular-Elastomer Insulation Coating

Finish coating for cellular-elastomer insulation shall be a polyvinylchloride lacquer approved by the manufacturer of the cellular elastomer.

2.1.3 Insulating Cement

2.1.3.1 General Purpose Insulating Cement

General purpose insulating cement shall be mineral fiber and shall conform to ASTM C 195. Composite shall be rated for 982 degrees C service and shall have a thermal-conductivity maximum of .123 watt per meter per degree Kelvin temperature differential at 93 degrees C mean temperature for 25 millimeter thickness.

2.1.3.2 Finishing Insulating Cement

Finishing insulating cement shall be mineral-fiber, hydraulic-setting type conforming to ASTM C 449/C 449M.

2.1.4 Calking

Calking used with specified insulation materials shall be an elastomeric joint sealant in accordance with ASTM C 920, Type S, Grade NS, Class 25, Use A.

2.1.5 Corner Angles

Corner angle piping insulation shall be nominal 0.41 millimeter aluminum 25 by 25 millimeter with factory applied kraft backing. Aluminum shall be in accordance with ASTM B 209M, Alloy 3003.

2.1.6 Insulation Materials

Insulation conductance shall be maximum values, as tested at any point, not an average. Insulation conductance found by test to exceed the specified maximum shall either be replaced or augmented by an additional thickness to bring it to the required maximum conductance and a complete finishing system.

2.1.6.1 Mineral Fiber

Mineral fiber shall conform to ASTM C 592, shall be suitable for surface temperatures up to 188 degrees C, and shall be of not less than 64.1 kilograms per cubic meter density. Thermal conductivity shall be not greater than 0.037 watt per meter per degree Kelvin at 66 degrees C mean.

2.1.7 Jacketing

2.1.7.1 Glass Cloth Jackets

Glass cloth shall be plain-weave glass cloth conforming to ASTM D 579, Style 141 and shall weigh not less than 0.25 kilogram/square meter before sizing. Cloth shall be factory applied wherever possible.

Glass reinforcing cloth shall be a leno weave, 26-end and 12-pick thread conservation, with a warp and fill tensile strength of 7.9 and 5.3 kilonewton per meter of width, respectively, and with a weight of not less than 0.51 kilogram per square meter. At the Contractor's option, Style 191 leno-weave glass cloth conforming to ASTM D 579 may be provided.

2.1.8 Tape

Glass lagging shall be a knitted elastic cloth specifically suitable for continuous spiral wrapping of insulated pipe bends and fittings and shall produce a smooth, tight, wrinkle-free surface. Tape shall conform to requirements of SAE AMS 3779, SAE AMS 3779, ASTM D 579, and ASTM C 921, and shall weigh not less than 0.339 kilogram per square meter.

2.2 PIPING SYSTEMS

Insulation thickness and pipe sizes are in millimeter. Pipe size is inclusive dimensionally, and includes pipe nominal pipe size (NPS) and tubing outside diameter.

2.2.1 Hot-Water Piping

Insulation shall be mineral fiber with glass cloth jacket, Type T-2. Thickness shall be not less than that given in the following list. Aboveground pipes, valve bodies, fittings, unions, flanges, and miscellaneous surfaces shall be insulated.

PIPE SIZE (MILLIMETER)	INSULATION THICKNESS (MILLIMETER)
Up to 100	25

2.2.2 Cold-Water and Condensate-Drain Piping

Aboveground pipes, valve bodies, fittings, unions, flanges, and miscellaneous surfaces shall be insulated. Insulation shall be 10 millimeter mineral fiber with glass cloth jacket, Type T-2.

2.2.3 Refrigerant Suction Piping

Insulation shall be per manufacturer supplied pre-insulated piping material.

PART 3 EXECUTION

3.1 INSTALLATION OF INSULATION SYSTEMS

Contours on exposed work shall be smooth and continuous. Cemented laps, flaps, bands, and tapes shall be smoothly and securely pasted down. Adhesives shall be applied on a full-coverage basis.

Insulation shall be applied only to system or component surfaces that have been tested and approved.

Joints shall be tight with insulation lengths tightly butted against each other. Where lengths are cut, cuts shall be smooth and square and without breakage of end surfaces. Where insulation terminates, ends shall be neatly tapered and effectively sealed, or finished as specified. Longitudinal seams of exposed insulation shall be directed away from normal view.

Materials shall be applied in conformance with the recommendations of the manufacturer.

Surfaces shall be clean and free of oil and grease before insulation adhesives or mastics are applied. Solvent cleaning required to bring metal surfaces to such condition shall be provided.

Installation Drawings for pipe insulation shall be in accordance with the adhesive manufacturer's written instructions for installation.

3.2 SYSTEM TYPES

3.2.1 Type T-2, Mineral Fiber with Glass Cloth Jacket

Piping shall be covered with a mineral-fiber, pipe insulation with factory-attached, pre-sized, white, glass cloth. Jackets, jacket laps, flaps, and bands shall be securely cemented in place with vapor-barrier adhesive. Jacket overlap shall be not less than 40 millimeter. Jacketing bands for butt joints shall be 75 millimeter wide.

Exposed-to-view fittings shall be covered with preformed mineral-fiber fitting insulation of the same thickness as the pipe insulation and temporarily secured in place with light cord ties. Impregnated glass

lagging tape shall be installed with indoor vapor-barrier on 50 percent overlap basis and the tape shall be blended smoothly into the adjacent jacketing. Additional coating shall be applied as needed, and rubber gloved to a smooth contour. Ends of insulation shall be taped to the pipe at valves DN50 and smaller. On-the-job fabricated insulation for concealed fittings and special configurations shall be built up from mineral fiber and a mixture of insulating cement and lagging adhesive, diluted with 3 parts water. Surfaces shall be finished with glass cloth or tape lagging.

In lieu of materials and methods specified above, fittings may be wrapped with a twine-secured, mineral-wool blanket to the required thickness and covered with premolded polyvinylchloride jackets. All jacket ends shall be held in place with AISI 300 series corrosion-resistant steel straps, 0.381 millimeter thick by 15 millimeter wide. Fitting insulation shall be thermally equivalent to pipe-barrel insulation to preclude surface temperatures detrimental to polyvinylchloride.

3.2.2 Type T-3, Cellular Elastomer

Piping-system surfaces shall be covered with flexible cellular-elastomer sheet or preformed insulation. Vapor seal shall be maintained. Insulation shall be cemented into continuous material with a solvent cutback chloroprene adhesive recommended by the manufacturer for the specific purpose. Adhesive shall be applied to both of the surfaces on a 100-percent coverage basis to a minimum thickness of 0.254 millimeter wet or approximately 4 square meter per liter of undiluted adhesive.

At pipe hangers or supports where the insulation rests on the pipe hanger strap, the insulation shall be cut with a brass cork borer and a No. 3 superior grade cork inserted. Seams shall be sealed with approved adhesive. Sweat fitting shall be insulated with miter-cut pieces of cellular elastomer insulation of the same nominal pipe size and thickness as the insulation on the adjacent piping or tubing. Miter-cut pieces shall be joined with approved adhesive. Covers shall be slit and snapped over the fitting, and joints shall be sealed with approved adhesive.

3.3 ACCEPTANCE

Final acceptance will depend upon providing construction (Record Drawings) details to the Contracting Officer. Construction details shall include, by building area, the insulation material type, amount, and installation method. Data shall have a cover letter/sheet clearly marked with the system name, date, and the words "Record Drawings insulation/material."

-- End of Section --

SECTION 23 00 00

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM A 924/A 924M	(2006) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 209M	(2006) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM E 84	(2007) Standard Test Method for Surface Burning Characteristics of Building Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(2006) Standard for Industrial Controls and Systems Enclosures
NEMA MG 1	(2006) Standard for Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005; TIA 2005) National Electrical Code
NFPA 96	(2004) Ventilation Control and Fire Protection of Commercial Cooking Operations

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA HVAC Duct Const Stds	(1995; Addendum 1997, 2nd Ed) HVAC Duct Construction Standards - Metal and Flexible

1.2 COORDINATION OF TRADES

Furnish ductwork, piping offsets, fittings, and accessories as required to provide a complete installation and to eliminate interference with other construction.

1.3 DELIVERY AND STORAGE

Store equipment at the jobsite so that it is protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, cap or plug all pipes until installed.

1.4 FIELD MEASUREMENTS

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

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings;

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 will properly function as a unit on the drawings and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

SD-03 Equipment Submittals

For the following equipment to be provided under this contract the contractor shall submit the manufacturer's standard catalog data, installation, operation and maintenance manuals:

Duct Connectors;
Duct Access Doors;
Manual Balancing Dampers;
Registers and Grille;
Louvers;
Centrifugal Fans;
Centrifugal Type Power Wall Ventilators;

Centrifugal Type Power Roof Ventilators;
Filtered Supply Fans;
Electric Resistant Heater;
Test Procedures;
Kitchen Hoods;
Make up Air;
Ceiling Fans;
Wall Fans;

SD-06 Test Reports

Performance Tests;

Test reports for the ductwork leak test, and performance tests in booklet form, upon completion of testing. Document phases of tests performed including initial test summary, repairs/adjustments made, and final test results in the reports.

Damper Acceptance Test;

Proposed schedule, at least 2 weeks prior to the start of test.

SD-10 Operation and Maintenance Data

Dampers, Diffusers, Louvers, and Grilles - Submit Data Package 2 in accordance with Section 01781 "OPERATION AND MAINTENANCE DATA".

Proposed on-site training schedule, submitted concurrently with the operation and maintenance manuals.

Powered Equipment - Submit Data Package 3 in accordance with Section 01781 "OPERATION AND MAINTENANCE DATA".

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. The 2-year manufacturer's experience shall include applications of components and equipment under similar circumstances and of similar size. The 2 years must be satisfactorily completed by a product that is sold on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization.

2.2 ASBESTOS PROHIBITION

Asbestos and asbestos-containing products shall not be used.

2.3 NAMEPLATES

All equipment shall have a nameplate, installed by the manufacturer, that identifies the manufacturer's name, address, type or style, and model or serial number.

2.4 EQUIPMENT GUARDS AND ACCESS

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded according to OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified.

2.5 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. 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, shall be provided. For packaged equipment, the manufacturer shall provide controllers including 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.

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. 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. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Motor bearings shall be fitted 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 may be provided to accomplish the same function. Use solid-state variable-speed controllers for motors rated 7.45 kW or less and adjustable frequency drives for larger motors.

2.6 INDOOR AIR QUALITY

All equipment and components furnished as part of this Section shall comply with the requirements of ASHRAE 62.1 unless more stringent requirements are specified herein.

2.7 DUCT SYSTEMS

2.7.1 Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with SMACNA HVAC Duct Const Stds unless otherwise specified. Elbows shall be radius type with a centerline radius of 1.5 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 may be used. Ductwork shall meet the requirements of Seal Class A. Sealants shall conform ASTM E8 and shall be suitable for the range of air distribution and ambient temperatures that it will be exposed to. Do not use pressure sensitive tape as a sealant. Apply the sealant to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. Apply one brush coat of the sealant over the outside of the joint to at least 50 mm band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar will not be acceptable.

2.7.1.1 General Service Duct Connectors

Provide a flexible duct connector approximately 150 mm 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.

2.7.1.2 Aluminum Ducts

Provide aluminum ducts at all areas carrying moisture laden air as indicated on the drawings. Ducts shall be ASTM B 209M, alloy 3003-H14 for aluminum sheet and alloy 6061-T6 or equivalent strength for aluminum connectors and bar stock.

2.7.2 Ductwork Accessories

2.7.2.1 Duct Access Doors

Provide hinged access doors conforming to SMACNA HVAC Duct Const Stds in ductwork for access to coils, thermostats, and other apparatus requiring service and inspection in the duct system. Doors shall be minimum 375 x 450 mm, unless otherwise shown. Where duct size will not accommodate this size door, the doors shall be made as large as practicable. Equip doors 600 x 600 mm or larger with fasteners operable from inside and outside the duct. Use insulated type doors in insulated ducts.

2.7.2.2 Manual Balancing Dampers

Furnish manual balancing dampers with accessible operating mechanisms. Manual volume control dampers shall be operated by locking-type quadrant operators. Dampers shall be 2 gauges heavier than the duct in which installed. Unless otherwise indicated, multileaf dampers shall be opposed blade type with maximum blade width of 300 mm. Provide access doors or panels for all concealed damper operators and locking setscrews. Unless otherwise indicated, the locking-type quadrant operators for dampers, when installed on ducts to be thermally insulated, shall be provided with stand-off mounting brackets, bases, or adapters to provide clearance between the duct surface and the operator not less than the thickness of the insulation. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer.

2.7.3 Registers, and Grilles

Units shall be factory-fabricated of steel or aluminum and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 0.25 m/s in occupied zone, or dead spots anywhere in the conditioned area. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers. Units shall be fixed horizontal or vertical louver type. Furnish registers with sponge-rubber gasket between flanges and wall or ceiling.

2.8 AIR SYSTEMS EQUIPMENT

2.8.1 Fans

Fans shall be tested and rated according to manufacturer standards. Fan motors located in hazardous areas, as indicated in schedule, shall have motor installed out of air stream, fans shall be explosion proof. 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. For discharge air provide fans with manufactures standard low leakage gravity discharge louvers with security bars. 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.

2.8.1.1 Centrifugal Fans

Centrifugal fans shall be fully enclosed, single-width single-inlet, or double-width double-inlet, AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Impeller wheels shall be rigidly constructed, accurately balanced both statically and dynamically. Fan blades may be forward curved or backward-inclined airfoil design in wheel sizes up to 750 mm. Fan blades for wheels over 750 mm in diameter shall be backward-inclined airfoil design. Fan wheels over 900 mm in diameter shall have overhung pulleys and a bearing on each side of the wheel. Fan wheels 900 mm or less in diameter may have one or more extra long bearings between the fan wheel and the drive. Bearings shall be sleeve type, self-aligning and self-oiling with oil reservoirs, or precision self-aligning roller or

ball-type with accessible grease fittings or permanently lubricated type. Grease fittings shall be connected to tubing and serviceable from a single accessible point. Fan shafts shall be steel, accurately finished, and shall be provided with key seats and keys for impeller hubs and fan pulleys. Each fan outlet shall be of ample proportions and shall be designed for the attachment of angles and bolts for attaching flexible connections. Manually operated inlet vanes shall be provided on suction inlets. Manually operated outlet dampers shall be provided. Motors, unless otherwise indicated, shall not exceed 1800 rpm and shall have open drip proof enclosures. Motor starters shall be manual type with weather-resistant enclosure.

2.8.1.2 Centrifugal Type Power Wall Ventilators

Fans shall be direct driven centrifugal type with backward inclined, non-overloading wheel. Motor housing shall be removable and weatherproof. Unit housing shall be 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 wall grille, manufacturer's standard gravity damper, an airtight and liquid-tight metallic wall sleeve. Motor enclosure shall be totally enclosed fan cooled & explosion-proof (where indicated) type. Use only lubricated bearings.

2.8.1.3 Centrifugal Type Power Roof Ventilators

Fans shall be direct driven centrifugal type with backward inclined, non-overloading wheel. Motor compartment housing shall be hinged or removable and weatherproof, constructed of heavy gauge aluminum. Provide fans with birdscreen, disconnect switch, gravity dampers, roof curb, and extended base. Motors enclosure shall be drip-proof type. Kitchen exhaust fans shall be centrifugal type according to UL 705 with direct drive, round hood, and windband upblast discharge configuration, integral residue trough and collection device, motor and power transmission components located in outside positively air ventilated compartment. Use only lubricated bearings.

2.8.1.4 In-line Centrifugal Fans

Welded steel casings, centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards and adjustable motor mounts. Inlet and outlet connections for fan casings to duct work and equipment casings, may be of the slip fit or flanged type. Provide guards for discharges. Air shall enter and leave the fan axially. Inlet shall be streamlined and conversion vanes shall eliminate turbulence and provide smooth discharge air flow. Enclose fan bearings and drive shafts, and isolate from the air stream. Fan bearings shall be mechanically sealed against dust and dirt and shall be self-aligning, pillow block ball or roller type. Motor and drive shall be provided by fan manufacturer.

2.8.1.5 Filtered Supply Fan

For kitchen supply fan. Roof mounted, filtered supply fans shall be direct drive axial type. Propeller construction shall be cast aluminum, airfoil. Propellers shall be statically and dynamically balanced. Fan Hood and base construction shall be aluminum. Hood panels shall be arched with interlocking seams for weather protection. Fan bases shall be tall to allow for low leakage backdraft dampers. Welded galvanized mesh birdscreens shall

be mounted horizontally across the intake area of the hood. Support members shall be heavy gauge galvanized steel angles. Motors shall be heavy duty ball bearing type carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. A standard square key and set screws or tapered locking bushing shall attaché the propeller securely to the motor shaft. Motor support frame assemblies shall be constructed of heavy gauge steel angles. Fan panels shall be heavy gauge steel with formed flanges and double venture. Safety guards of heavy welded wire construction shall be attached to the underside of the fan panel.

2.8.1.6 Wall/Ceiling Fan

Wall fans shall be mounted approximately 2meters high on the wall and shall be the oscillating type. Wall fans shall be securely mounted on the wall and shall be hard wired. Do not provide plug in type wall fans.

Ceiling fans shall have reversible motors. Fans shall be centered or distributed evenly throughout the room. Fan mount shall be flush, standard, or angle mount depending on ceiling height. Fan shall be mounted such that the fan blade is approximately 2.5 meters (98 inches) above the finished floor. The fan shall be provided without light kit. The finish shall be factory painted white. The controls shall be wall-mounted from either a single pole switch or from two (2) 3-way switches to provide on/off operation. The electrical supply shall be as indicated. Install per manufacturers’ instructions.

2.8.1.7 Prefabricated Roof Curb

For kitchen hood exhaust and supply fan. Curb shall be galvanized steel, with continuous welded corner seams, 50 mm wall thickness, treated wood nailer,.38 mm thick, 48 kg per cubic meter density rigid mineral fiberboard insulation with metal liner, built-in cant strip. Curbs shall be built for pitched roof as required to keep top of curb level. Curb Height shall be 450 mm above finished roof or as required to comply with NFPA 96.

2.10 ELECTRIC UNIT HEATERS

UL 1025; Electric unit heaters shall be of the KW rating, voltage and phase specified in the schedule. They shall be fan-forced type, UL approved. Provide control-circuit terminals and single source of power supply. Limit leaving air temperature to 60 degrees C with entering air of 15 degrees C. Include limit controls for overheat protection of heaters. Heating wire element shall be nickel chromium. Provide tamper resistant integral thermostat. Completely factory-prewired to terminal strips, ready to receive branch circuit and control connections for 60 degrees C copper or aluminum wiring. Provide factory-installed safety disconnect switch in the housing with "off" position marking on the face plate. Size of units shall be limited to 5kW only, units over 5kW are not allowed. Provide multiple units to meet needs above 5kW.

Unit heaters shall be of the industrial grade, very durable and securely fastened to the ceiling, wall or structure. Provide a self-contained electric heating unit, suspended from ceiling or structure, fan with at least two-speeds and heating elements. Provide control-circuit terminals and single source of power supply with disconnect. Heating wire element shall be nickel chromium. Include limit controls for overheat protection of heaters.

Provide hard-wired tamper resistant integral thermostat located as indicated on the drawings

2.10.1 Enclosure

Standard unit shall be Minimum 20 gage steel. Explosion proof, corrosion resistant heater shall be NEMA 7, 9 cast aluminum enclosure.

2.10.2 Heating Element (Standard Unit)

Nickel chromium heating wire element, free from expansion noise and hum. Embed element in magnesium-oxide insulating refractory. Seal element in corrosion-resisting metallic sheath with fins. Enclose element ends in terminal box. Provide not more than six fins per 25 mm. Limit fin surface temperature 285 degrees C at any point during normal operation.

2.10.3 Thermostat

Shall be integral and tamper proof.

2.12 POWER-OPERATED DAMPERS

2.12.1 Frame and Blade Assembly

Frames and blades shall be constructed of galvanized steel.

Resilient seals shall be mechanically attached, field replaceable seals. Attachment by adhesive shall not be acceptable. Jamb seals shall be neoprene.

Frames shall have corner reinforcement and stay rods, where necessary. Frames shall be fabricated by welding or riveting. Damaged galvanized surfaces shall be repaired by coating with an equal weight of zinc.

For static pressures in excess of 750 pascal, master-blade-driven dampers with blades longer than 610 millimeter shall have a maximum blade width of 200 millimeter. Maximum blade width for other services shall be 250 millimeter. Maximum blade length shall be 1220 millimeter. Dampers more than 1220 millimeter wide shall be made in two or more sections with intermediate mullions; each section shall be mechanically interlocked with adjoining section or sections.

Minimum shaft size shall be 15 millimeter, round.

Where linkage is such that operator torque is applied to a master blade and transmitted there from, that blade shall be reinforced and the shaft shall be full length. This type construction shall be limited to 500 pascal, static pressure.

Blades shall be attached to round shafts by hardened cup-point setscrews, or by being pinned. A minimum three-thread engagement shall be provided. Where setscrews are used, two setscrews, 90 degrees apart, shall be provided to secure master blade. Shaft end retainers may be secured by pins or spring washers in grooved shaft or by similar construction.

Frames shall be calked with elastomer compounds to prevent bypass leakage.

Blades without resilient seals shall have interlocking edges.

2.14 SEISMIC RESTRAINT

2.14.1 Mountings

Combination spring and rubber-in-shear steel framed for hanger-rod mounting. Minimum total static deflection shall be 25 millimeter.
Air spring with body constructed of reinforced elastomer specifically suitable for application environment. Air spring shall be selected to provide a natural frequency equal to 127 millimeter of deflection of conventional specified steel springs. Facilities shall be provided for dead-level adjustment and height-control of supported equipment.

2.14.2 Duct Vibration Isolation

Isolators shall be devices with contained chloroprene-elastomer elements for connecting to building-structure attachments. Devices shall be loaded by supported system during operating conditions to produce a minimum elastomer static deflection of 10 millimeter.

2.15 SPARE PARTS

2.15.1 General Requirements

The Contractor shall furnish to the Contracting Officer, fifteen per cent (15%) spare parts of total items installed, as directly coordinated with the Contracting Officer. Spare parts shall include but not be limited to such items as: fan motors, filters, thermostats, diffusers, registers, grilles, actuators, damper motors.

2.15.2 Itemizing and Tagging Spare Parts

All spare parts shall be itemized, tagged for future use, and stored by the Contractor where directed by the Contracting Officer. Spare parts shall be handled, loaded, unloaded, and stored by the Contractor. Final design of spare part items shall be directly coordinated with the Contracting Officer.

2.16 EXHAUST HOODS OVER COOKING EQUIPMENT

Conform to NFPA 96. Conform to SMACNA HVAC Duct Const Stds. Provide seismic restraints in accordance with SMACNA KEFG. The hood must not vary from design listing of air requirements or static pressure by more than five percent. Fabricate from 1.2 mm thick 18 gage stainless steel. Run electrical wiring in conduit or raceways. When total hood length is more than 3600 mm 12 feet long, provide hoods individually complete in all respects, of approximately equal length less than 3600 mm 12 feet long, and mounted end to end.

2.16.1 Hoods with face supply

Hood shall be full compensating wall canopy with the capability to replace up to 95% of the exhausted air with fresh outside air. Air shall be supplied through perforated panels in a manner that does not interfere with the cooking operations beneath the hood. Perforated panels shall be located on

the face to ensure precise volume control and shall limit the throw to within several feet of the hood.

The hood shall include a filter housing constructed of the same material as the hood. The filters shall be aluminum baffle type (stainless optional). Classified, and in sufficient number and sizes to ensure optimum performance. The filter housing shall terminate in a pitched, full length grease trough which shall drain into a removable grease container.

2.16.1.1 Types of Hoods

Provide the following hood types as indicated:

a. Wall-Mounted: Provide over ranges located along wall. Mount at height indicated.

2.16.1.2 Features

Provide the following:

a. Fan control.
b. Damper controls.
c. Fire protection system, for hoods over heavy duty ranges.
d. Washable grease filters.
e. Vapor-proof lights.

2.16.1.3 Fan Control

Provide delay-time starter on starter leg of exhaust fan so supply fan starts first and run 5 seconds before exhaust fan starts, to insure the required balance in exhausted and make-up air flow. Provide the following operations:

a. Operation by manual push buttons labeled "start" and "stop".

2.16.1.4 Fire Protection Systems

Provide a pre-engineered dry chemical system in accord with NFPA 96. Include micro-switch for electric power and fuel shut off to equipment under hood and a fuel shut-off and reset button. Exposed piping under hood and surface nozzles to be stainless steel or chrome plated. Paint exposed piping running to hood with rust-inhibiting aluminum paint. Provide electrical wiring, contactors, shunt breakers, electrical control for gas valves, and other electrical components required to install fire systems in accord with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

a. Actuating Stations. Provide manual actuating station and remote manual actuating station as indicated. Clearly label actuating station as "Hood Fire Protection" and specific device protected.

b. Alarm Connection: Provide capability to signal operational readiness and to generate electronic signal when hood fire system is activated.

2.16.1.6 Vapor proof Lights

Provide incandescent or fluorescent lights in accord with UL 1598 or UL 1598. Locate switches for operating hood lights on face of hood in lower right corner.

2.17 LOUVERS

Weather resistant type, with bird screens and made to withstand a wind load of not less than 1.44 kilopascals. Wall louvers shall bear the AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 500 and AMCA 511. The rating shall show a water penetration of 0.06 kilograms or less per square meter of free area at a free velocity of 244 meters. Finish shall be a factory-applied coating. Clean and phosphate treat exposed surfaces and apply rust-inhibitive primer and baked enamel finish coat, 0.025 mm minimum total dry film thickness, color as directed by architect. Install using stops or moldings, flanges, strap anchors, or jamb fasteners as appropriate for the wall construction and in accordance with manufacturer's recommendations. Mount screens in removable, rewirable frames of same material and finish as the louvers. Provide zinc-coated or stainless steel screws and fasteners for louvers. Provide other accessories as required for complete and proper installation. Provide 12.5 mm square mesh, 1.5 mm thick zinc-coated steel or copper bird screening.

2.17.1 Bird Screens and Frames

Bird screens shall conform to ASTM E 2016, No. 2 mesh, aluminum or stainless steel. Aluminum screens shall be rated "medium-light". Stainless steel screens shall be rated "light". Frames shall be removable type, and fabricated from either stainless steel or extruded aluminum.

2.17.2 Sand Trap Louver

Extruded aluminum frame and blades 1.5 mm and 1.2 mm thick, composed of two sets of inverted U - channels mounted vertically on two opposite rows. Channels shall be fixed with a removable volume control damper to ensure control of air stream. Louver shall be provided with 2 rows of 20 mm dia. self draining holes for emptying filtered sand and dust. Volume damper shall be low leakage, galvanized steel with extruded aluminum blades. Bird screen shall be 12 mm x 12 mm x 1.5 mm diameter aluminum wire mesh. Aluminum filters with washable expanded aluminum media, 50 mm thickness, designed to separate and dust from the air stream.

2.18 ELECTRIC HEAT MAKE-UP AIR UNIT

Make up air units shall be self-contained packaged with a permanent washable) air filter, electric heating element, modulating element temperature control, and blower, designed specifically for outside air inlet. Heaters shall be the manufacturer standard. Units shall be factory prewired, ready for field terminal connections. Cabinet enclosure shall be galvanized insulated sheet metal sealed tight. Provide unit with finned rod modulating electric elements, high temperature limit switch, airflow proving switch and an outlet temperature sensing control. Unit shall include adjustable speed blower with PSC motor. Outside air inlet shall include a sand-trap type intake louver with washable pre filter. Include remote mounted thermostat with Auto, Fan and Heat modes. Unit shall be mounted tight to structure above with vibration isolators.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be as shown and according to the manufacturer's diagrams, recommendations and manufacturer's installation instructions. Installation shall be accomplished by a specialist experienced in the design and construction of this type of work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.

3.1.2 Equipment and Installation

Provide frames and supports for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Accomplish installation by a specialist sub-contractor experienced in the design and construction of this type of work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.

3.1.3 Access Panels

Install access panels for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05 50 00 METAL: MISCELLANEOUS AND FABRICATIONS.

3.1.4 Metal Ductwork

Installation shall be according to SMACNA HVAC Duct Const Stds unless otherwise indicated. Duct supports for sheet metal ductwork shall be according to SMACNA HVAC Duct Const Stds, unless otherwise specified. Friction beam clamps indicated in SMACNA HVAC Duct Const Stds shall not be used. Risers on high velocity ducts shall be anchored in the center of the vertical run to allow ends of riser to move due to thermal expansion. Supports on the risers shall allow free vertical movement of the duct. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided.

3.1.5 Kitchen Exhaust Ductwork

3.1.5.1 Ducts Conveying Smoke and Grease Laden Vapors

Ducts conveying smoke and grease laden vapors shall conform to requirements of NFPA 96. Seams, joints, penetrations, and duct-to-hood collar connections shall have a liquid tight continuous external weld. Duct material shall be minimum 1.3 mm, Type 304L or 316L, stainless steel Duct construction shall include external perimeter angle sized in accordance with SMACNA HVAC Duct Const Stds, except welded joint reinforcement shall be on maximum of 600 mm 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. Angles, pipe couplings, frames, bolts, etc., shall be same material as that specified for the duct unless indicated otherwise.

3.1.5.2 Exposed Ductwork

Exposed ductwork shall be fabricated from minimum 1.3 mm, Type 304L or 316L, stainless steel with continuously welded joints and seams. Ducts shall be pitched to drain at hoods and low points indicated. Surface finish shall match hoods.

3.1.5.3 Concealed Ducts Conveying Moisture Laden Air

Concealed ducts conveying moisture laden air shall be fabricated from minimum 1.3 mm, Type 300 series, stainless steel Joints shall be continuously welded, brazed, or soldered to be liquid tight. Duct shall be pitched to drain at points indicated. Transitions to other metals shall be liquid tight, companion angle bolted and gasketed.

3.1.6 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, temporary dust control protection shall be provided. The distribution system (supply and return) shall be protected with temporary seal-offs at all inlets and outlets at the end of each day's work. Temporary protection shall remain in place until system is ready for startup.

3.1.7 Power Roof Ventilator Mounting

Foamed 13 mm thick, closed-cell, flexible elastomer insulation shall cover width of roof curb mounting flange. Where wood nailers are used, holes shall be pre-drilled for fasteners.

3.1.8 Exhaust Hoods Over Cooking Equipment Installation

Install in accordance with manufacturer's printed instructions.

3.1.9 Installation of Hoods

Install in accord with NFPA 96. Install hoods to remain free from vibration under all conditions of operation.

Upon completion perform operational tests on each piece of equipment to determine that equipment and components, including controls, safety devices, and attachments, operate as specified and are properly installed and adjusted. Notify the Contracting Officer 14 calendar days prior to testing. Submit 6 copies of the Exhaust Hood Air-Balance Report to the Contracting Officer.

3.2 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. Provide sleeves for round

duct 380 mm and smaller. Provide framed prepared openings for round duct larger than 380 mm and square, rectangular or oval ducts. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide 25 mm 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 C 553, Type 1, Class B-2.

a. Sleeves: Fabricate sleeves, except as otherwise specified or indicated, from 1 mm thick mill galvanized sheet metal. Where sleeves are installed in bearing walls or partitions, provide black steel pipe conforming with ASTM A 53/A 53M, Schedule 20.

b. Framed Prepared Openings: Fabricate framed prepared openings from 1 mm galvanized steel, unless otherwise indicated.

d. Closure Collars: Provide closure collars of a minimum 100 mm 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 380 mm in diameter or less from 1 mm galvanized steel. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 380 mm from 1.40 mm galvanized steel. Fabricate collars for square and rectangular ducts with a maximum side of 380 mm or less from 1 mm galvanized steel. Install collars with fasteners a maximum of 150 mm on center. Attach to collars a minimum of 4 fasteners where the opening is 300 mm in diameter or less, and a minimum of 8 fasteners where the opening is 500 mm in diameter or less.

3.6 PERFORMANCE TESTS

After testing, adjusting, and balancing is complete, test each system as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Make corrections and adjustments as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests shall be conducted by an experienced engineer. Tests shall cover a period of not less than 10 days for each system and shall demonstrate that the entire system is functioning according to the specifications.

3.7 CLEANING AND ADJUSTING

Inside of ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Wipe equipment clean, with no traces of oil, dust, dirt, or paint spots. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as recommended by the manufacturer. 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.

3.8 OPERATION AND MAINTENANCE TRAINING

The Contractor shall conduct a training course for the members of the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 4 hours of normal working time and shall start after all work specified herein is functionally completed and the Performance Tests have been approved. The field instruction shall cover all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Notify the Contracting Officer at least 14 days prior to the date of proposed conduct of the training course.

-- End of Section --

SECTION 26 00 00.00 20

BASIC ELECTRICAL MATERIALS AND METHODS
07/06

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.

ASTM INTERNATIONAL (ASTM)

ASTM D 709	(2001) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2005) National Electrical Safety Code
IEEE Std 100	(2000) The Authoritave Dictionary of IEEE Standards Terms

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005; TIA 2005) National Electrical Code

1.1.1 EQUIVALENT REFERENCES

Equipment and material meeting standards that are deemed equivalent (by the Authority Having Jurisdiction) to the above referenced standards may be submitted for approval.

1.2 RELATED REQUIREMENTS

This section applies to certain sections of Division 13, SPECIAL CONSTRUCTION, and Divisions 22, 23, 27 and 28, PLUMBING and HEATING VENTILATING AND AIR CONDITIONING COMMUNITCATIONS AND ELECTRICAL SAFETY. This section applies to all sections of Division 26 and 33, ELECTRICAL and UTILITIES, of this project specification unless specified otherwise in the individual sections.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

c. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.4 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be 220/380 volts, three phase, four wire, 50 Hz.

1.5 ADDITIONAL SUBMITTALS INFORMATION

Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

1.5.1 Shop Drawings (SD-02)

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

1.5.2 Product Data (SD-03)

Submittal shall include performance and characteristic curves.

1.6 QUALITY ASSURANCE

1.6.1 Regulatory Requirements

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. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer;

however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

1.6.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.8 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.

c. Safety precautions.

d. The procedure in the event of equipment failure.

e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.9 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.

1.10 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 3 mm thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be 25 by 65 mm. Lettering shall be a minimum of 6.35 mm high normal block style.

1.11 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.12 INSTRUCTION TO GOVERNMENT PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. 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 equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instructions to acquaint the operating personnel with the changes or modifications.

PART 2 PRODUCTS

2.1 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.1 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 9 meters apart.

-- End of Section --

SECTION 26 05 48.00 10

SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT
04/06

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	(2005e13) Manual of Steel Construction

ASTM INTERNATIONAL (ASTM)

ASTM E 580	(2002e1) Application of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Requiring Moderate Seismic Restraint

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-03A	(2005) Seismic Design for Buildings

UNDERWRITERS LABORATORIES (UL)

UL 1598	(2004; Rev thru May 2006) Luminaires

UNITED STATE GEOLOGICAL SURVEY (USGS)

SS Map	Seismic maps prepared for Afghanistan SS Horizontal Spectral Response for 0.20 second period
S1 Map	Seismic maps prepared for Afghanistan S1 Horizontal Spectral Response for 1.0 second period

1.1.1 EQUIVALENT REFERENCES

Equipment and material meeting standards that are deemed equivalent (by the Authority Having Jurisdiction) to the above referenced standards may be submitted for approval.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for

Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Lighting Fixtures in Buildings
Equipment Requirements

Detail drawings along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction.

SD-03 Product Data

Lighting Fixtures in Buildings;
Equipment Requirements;

Copies of the design calculations with the detail drawings. Calculations shall be stamped by a registered engineer and shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

Contractor Designed Bracing;

Copies of the Design Calculations with the Drawings. Calculations shall be approved, certified, stamped and signed by a Registered Professional Engineer. Calculations shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

1.3 SYSTEM DESCRIPTION

1.3.1 General Requirements

The requirements for seismic protection measures described in this section shall be applied to the electrical equipment and systems listed below. Structural requirements shall be in accordance with Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

1.3.2 Electrical Equipment

Electrical equipment shall include the following items to the extent required on the drawings or in other sections of these specifications:

Control Panels	Air Handling Units
Pumps with Motors	Light Fixtures
Motor Control Centers	Transformers
Switchboards (Floor Mounted)	

1.3.3 Electrical Systems

The following electrical systems shall be installed as required on the drawings and other sections of these specifications and shall be seismically protected in accordance with this specification:

Interior Electrical System
Interior Lighting System
Exterior Lighting System

1.3.4 Contractor Designed Bracing

The Contractor shall design the bracing in accordance with UFC 3-310-03A and additional data furnished by the Contracting Officer. Resistance to lateral forces induced by earthquakes shall be accomplished without consideration of friction resulting from gravity loads. UFC 3-310-03A uses parameters for the building, not for the equipment in the building; therefore, corresponding adjustments to the formulas shall be required. Loadings determined using UFC 3-310-03A are based on strength design; therefore, AISC 325 shall be used for the design. The bracing for the following electrical equipment and systems shall be developed by the Contractor.

Interior Electrical System
Interior Lighting System
Exterior Lighting System

1.3.5 Conduits Requiring No Special Seismic Restraints

Seismic restraints may be omitted from electrical conduit less than 64 mm trade size. All other interior conduit, shall be seismically protected as specified.

1.4 EQUIPMENT REQUIREMENTS

1.4.1 Rigidly Mounted Equipment

The following specific items of equipment are to be furnished under this contract shall be constructed and assembled to withstand the seismic forces specified in UFC 3-310-03A, Chapter 10. Each item of rigid electrical equipment shall be entirely located and rigidly attached on one side only of a building expansion joint. Piping, electrical conduit, etc., which cross the expansion joint shall be provided with flexible joints that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions.

Transformers
Switch Boards

PART 2 PRODUCTS

2.1 LIGHTING FIXTURE SUPPORTS

Lighting fixtures and supports shall conform to UL 1598.

2.2 SWAY BRACING MATERIALS

Sway bracing materials (e.g. rods, plates, rope, angles, etc.) shall be as specified in Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

PART 3 EXECUTION

3.1 SWAY BRACES FOR CONDUIT

Conduit shall be braced as for an equivalent weight pipe in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.2 LIGHTING FIXTURES IN BUILDINGS

Lighting fixtures and supports shall conform to the following:

3.2.1 Pendant Fixtures

Pendant fixtures shall conform to the requirements of UFC 3-310-03A, Chapter 10.

3.2.2 Ceiling Attached Fixtures

3.2.2.1 Recessed Fluorescent Fixtures

Recessed fluorescent individual or continuous-row mounted fixtures shall be supported by a seismic-resistant suspended ceiling support system built in accordance with ASTM E580. Seismic protection for the fixtures shall conform to the requirements of UFC 3-310-03A, Chapter 10. Recessed lighting fixtures not over 25 kg in weight may be supported by and attached directly to the ceiling system runners using screws or bolts, number and size as required by the seismic design. Fixture accessories, including louvers, diffusers, and lenses shall have lock or screw attachments.

3.2.2.2 Surface-Mounted Fluorescent Fixtures

Surface-mounted fluorescent individual or continuous-row fixtures shall be attached to a seismic-resistant ceiling support system built in accordance with ASTM E580. Seismic protection for the fixtures shall conform to the requirements of UFC 3-310-03A, Chapter 10.

3.2.3 Assembly Mounted on Outlet Box

A supporting assembly, that is intended to be mounted on an outlet box, shall be designed to accommodate mounting features on 100 mm boxes, plaster rings, and fixture studs.

3.2.4 Wall-Mounted Emergency Light Unit

Attachments for wall-mounted emergency light units shall be designed and secured for the worst expected seismic disturbance at the site.

3.2.5 Lateral Force

Structural requirements for light fixture bracing shall be in accordance with Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANIOUS EQUIPMENT.

-- End of Section --

SECTION 26 20 00

INTERIOR DISTRIBUTION SYSTEM
07/07

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.

ASTM INTERNATIONAL (ASTM)

ASTM B 1	(2001) Standard Specification for Hard-Drawn Copper Wire

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2005) National Electrical Safety Code
IEEE Std 100	(2000) The Authoritave Dictionary of IEEE Standards Terms
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1) Normal Measurements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA C80.1	(2005) Standard for Electrical Rigid Steel Conduit (ERSC)
NEMA C80.3	(2005) Standard for Electrical Metallic Tubing (EMT)
NEMA FU 1	(2002) Low Voltage Cartridge Fuses
NEMA ICS 2	(2000; Errata 2002; R 2005; Errata 2006) Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
NEMA KS 1	(2001) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
NEMA MG 1	(2006) Standard for Motors and Generators

NEMA MG 11	(1977; R 1997; R 2001) Energy Management Guide for Selection and Use of Single Phase Motors
NEMA TC 2	(2003) Standard for Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
NEMA TC 3	(2004) Standard for Polyvinyl Chloride PVC Fittings for Use With Rigid PVC Conduit and Tubing
NEMA WD 1	(1999; R 2005) Standard for General Requirements for Wiring Devices
NEMA WD 6	(2002) Standard for Wiring Devices - Dimensional Requirements
NEMA Z535.4	(2002) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005; TIA 2005) National Electrical Code
NFPA 70E	(2004; AMD 2004) Electrical Safety in the Workplace
NFPA 780	(2004) Standard for the Installation of Lightning Protection Systems

UNDERWRITERS LABORATORIES (UL)

UL 1	(2005) Standard for Flexible Metal Conduit
UL 1242	(2006; Rev thru Jun 2006) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 1660	(2004; Rev thru Jan 2005) Liquid-Tight Flexible Nonmetallic Conduit
UL 1699	(1999; Rev thru May 2003) Arc-Fault Circuit-Interrupters
UL 198E	(1988; Rev Jul 1988) Class R Fuses
UL 20	(2004) Standard for General-Use Snap Switches
UL 2043	(1996; Rev thru Jun 2001) Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
UL 360	(2003) Liquid-Tight Flexible Steel Conduit
UL 44	(2005; Rev thru Nov 2005) Thermoset-Insulated Wires and Cables

UL 467	(2004) Standard for Grounding and Bonding Equipment
UL 486A-486B	(2003; Rev thru Aug 2006) Standard for Wire Connectors
UL 486C	(2004; Rev thru Aug 2006) Standard for Splicing Wire Connectors
UL 489	(2004; Rev thru Jun 2006) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 498	(2001; Rev thru Mar 2006) Attachment Plugs and Receptacles
UL 50	(2003; R 2005) Standard for Enclosures for Electrical Equipment
UL 510	(2005; Rev thru Aug 2005) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 512	(1993; Rev thru Mar 1999) Fuseholders
UL 514A	(2005) Standard for Metallic Outlet Boxes
UL 514B	(2004; Rev thru Apr 2006) Standard for Conduit, Tubing and Cable Fittings
UL 6	(2004e13) Standard for Electrical Rigid Metal Conduit-Steel
UL 651	(2005e7) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings
UL 67	(1993; Rev thru Apr 2006) Standard for Panelboards
UL 6A	(2000; Rev thru Jan 2004) Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel
UL 797	(2004) Standard for Electrical Metallic Tubing -- Steel
UL 817	(2001; Rev thru May 2005) Cord Sets and Power-Supply Cords
UL 83	(2003; Rev thru Apr 2006) Standard for Thermoplastic-Insulated Wires and Cables
UL 854	(2004; Rev thru Nov 2005) Service-Entrance Cables
UL 869A	(2006) Reference Standard for Service Equipment

UL 870	(1995; Rev thru Jul 2003) Wireways, Auxiliary Gutters, and Associated Fittings
UL 886	(1994; Rev thru Nov 2005) Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
UL 943	(2006) Ground-Fault Circuit-Interrupters
UL 984	(1996; Rev thru Sept 2005) Hermetic Refrigerant Motor-Compressors

1.1.1 EQUIVALENT REFERENCES

Equipment and material meeting standards that are deemed equivalent (by the Authority Having Jurisdiction) to the above referenced standards may be submitted for approval.

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Panelboards; G

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

Wireways;

Marking strips drawings;

SD-03 Product Data

Receptacles; G

Circuit breakers; G

Switches;

Enclosed circuit breakers; G

Motor controllers; G

Combination motor controllers; G

Manual motor starters; G

Telecommunications Grounding Busbar; G

Surge protective devices; G

Submittals shall include performance and characteristic curves.

SD-06 Test Reports

600-volt wiring test; G

Grounding system test; G

Ground-fault receptacle test;

SD-07 Certificates

Fuses;

1.4 QUALITY ASSURANCE

1.4.1 Fuses

Submit coordination data as specified in paragraph, FUSES of this section.

1.4.2 Regulatory Requirements

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. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.5 MAINTENANCE

1.5.1 Electrical Systems

Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. This shall include:

a. Single line diagram of the "as-built" building electrical system.

b. Schematic diagram of electrical control system (other than HVAC, covered elsewhere).

c. Manufacturers' operating and maintenance manuals on active electrical equipment.

1.6 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials, equipment, and devices shall, as a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70.

2.2 CONDUIT AND FITTINGS

Shall conform to the following:

2.2.1 Rigid Metallic Conduit

2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit

NEMA C80.1, UL 6.

2.2.2 Intermediate Metal Conduit (IMC)

UL 1242, zinc-coated steel only.

2.2.3 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797, NEMA C80.3.

2.2.4 Flexible Metal Conduit

UL 1.

2.2.4.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360.

2.2.5 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit

UL 514B. Ferrous fittings shall be cadmium- or zinc-coated in accordance with UL 514B.

2.2.5.1 Fittings for Rigid Metal Conduit and IMC

Threaded-type. Split couplings unacceptable.

2.2.5.2 Fittings for EMT

Steel compression type.

2.2.6 Fittings for Rigid Nonmetallic Conduit

NEMA TC 3 for PVC, and UL 514B.

2.2.7 Liquid-Tight Flexible Nonmetallic Conduit

UL 1660.

2.2.8 Fittings for CFNC

UL 514B

2.3 SURFACE RACEWAY

2.3.1 Surface Nonmetallic Raceway

UL 5A, nonmetallic totally enclosed, snap-cover type.

2.4 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal.

2.4.1 Outlet Boxes for Telecommunications System

Provide standard type 100 mm square by 54 mm deep. Depth of boxes shall be large enough to allow manufacturers' recommended conductor bend radii.

2.5 CABINETS, JUNCTION BOXES, AND PULL BOXES

Volume greater than 1640 mL, UL 50, hot-dip, zinc-coated, if sheet steel.

2.6 WIRES AND CABLES

Wires and cables shall meet applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Wires and cables manufactured more than 12 months prior to date of delivery to site shall not be used.

2.6.1 Conductors

Conductors No. 8mm^2 and larger diameter shall be stranded. Conductors No. 6mm^2 and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

2.6.1.1 Minimum Conductor Sizes

Minimum size for branch circuits shall be No. 4mm^2; for Class 1 remote-control and signal circuits, No. 2.5mm^2; for Class 2 low-energy, remote-control and signal circuits, No. 1.5mm^2; and for Class 3 low-energy, remote-control, alarm and signal circuits, No. .5mm^2.

2.6.2 Color Coding

Provide for service, feeder, branch, control, and signaling circuit conductors. Color shall be green/yellow bicolor for grounding conductors and blue for neutrals. Color of ungrounded conductors in different voltage systems shall be as follows:

a. 380/220 volt, three-phase

(1) Phase A - brown

(2) Phase B - black

(3) Phase C - grey

b. 220 volt, single phase: brown, black, or grey depending on phase.

2.6.3 Insulation

Unless specified or indicated otherwise or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN/THHN conforming to UL 83, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.6.4 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 10MM^2 and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 16MM^2 and larger diameter.

2.6.5 Service Entrance Cables

Service Entrance (SE) and Underground Service Entrance (USE) Cables, UL 854.

2.7 SPLICES AND TERMINATION COMPONENTS

UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 6mm^2 and smaller diameter wires shall be insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

2.8 DEVICE PLATES

Provide UL listed, one-piece device plates for outlets to suit the devices installed. For metal outlet boxes, plates on unfinished walls shall be of zinc-coated sheet steel or cast metal having round or beveled edges. Plates on finished walls shall be nylon or lexan, minimum 0.792 mm wall thickness. Plates shall be same color as receptacle or toggle switch with which they are mounted. Screws shall be machine-type with countersunk heads in color to match finish of plate. Sectional type device plates will not be permitted. Plates installed in wet locations shall be gasketed and UL listed for "wet locations."

2.9 SWITCHES

2.9.1 Toggle Switches

NEMA WD 1, UL 20, single pole, double pole, three-way, and four-way, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Handles shall be brown thermoplastic. Wiring terminals shall be screw-type, side-wired. Contacts shall be silver-cadmium and contact arm shall be one-piece copper alloy. Switches shall be rated quiet-type ac only, 220 volts, with current rating and number of poles indicated.

2.9.2 Breakers Used as Switches

For 220-Volt fluorescent fixtures, mark breakers "SWD" in accordance with UL 489.

2.9.3 Disconnect Switches

NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Fused switches shall utilize Class R fuseholders and fuses, unless indicated otherwise. Switches serving as motor-disconnect means shall be horsepower rated. Provide switches in NEMA 1 (IP10), or 3R (IP14) enclosure as indicated per NEMA ICS 6.

2.10 FUSES

NEMA FU 1. Provide complete set of fuses for each fusible switch. Time-current characteristics curves of fuses serving motors or connected in series with circuit breakers or other circuit protective devices shall be coordinated for proper operation. Submit coordination data for approval. Fuses shall have voltage rating not less than circuit voltage.

2.10.1 Fuseholders

Provide in accordance with UL 512.

2.10.2 Cartridge Fuses, Current Limiting Type (Class R)

UL 198E, Class RK-1 RK-5 time-delay type. Associated fuseholders shall be Class R only.

2.10.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type (Classes J, L, and CC)

UL 198C, Class J for zero to 600 amperes, Class L for 601 to 6,000 amperes, and Class CC for zero to 30 amperes.

2.10.4 Cartridge Fuses, Current Limiting Type (Class T)

UL 198H, Class T for zero to 1,200 amperes, 300 volts; and zero to 800 amperes, 600 volts.

2.11 SOCKET

Socket shall be CEE 7/7 “Schuko” style, 230V, 50Hz, 20A and shall conform to German DIN standard 49440.

2.11.1 Weatherproof Receptacles

Provide in cast metal box with gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening. Provide caps with a spring-hinged flap. Receptacle shall be UL listed for use in "wet locations with plug in use."

2.11.2 Ground-Fault Socket

Provide a RCD socket 13A, 250 volts conforming to IEC 60755. Socket shall have mechanical latching that does not trip on power failure (Passive) RCD unit 2 gang OP 10 mA. Flush box shall be a minimum of 25 mm deep. Cover plate shall be stainless steel 86x146 mm.

2.11.3 Special Purpose Receptacles

Special Purpose Receptacles will be specified on plans. Furnish one matching plug with each receptacle.

2.12 PANELBOARDS

UL 67 and UL 50 having a short-circuit current rating as indicated of 10,000 amperes symmetrical minimum. Panelboards for use as service disconnecting means shall additionally conform to UL 869A. Panelboards shall be circuit breaker-equipped unless indicated otherwise. Design shall be such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the drawings. Use of "Subfeed Breakers" is not acceptable unless specifically indicated otherwise. Main breaker shall be "separately" mounted "above" branch breakers. Where "space only" is indicated, make provisions for future installation of breakers. Directories shall indicate load served by each circuit in panelboard. Directories shall

also indicate source of service to panelboard (e.g., Panel PA served from Panel MDP). Type directories and mount in holder behind transparent protective covering. Panelboard shall have nameplates in accordance with paragraph FIELD FABRICATED NAMEPLATES.

UL 67 and UL 50. Panelboards for use as service disconnecting means shall additionally conform to UL 869A. Panelboards shall be circuit breaker-equipped. Design shall be such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL. Where "space only" is indicated, make provisions for future installation of breaker sized as indicated. Directories shall indicate load served by each circuit of panelboard. Directories shall also indicate source of service (upstream panel, switchboard, etc.) to panelboard. Type directories and mount in holder behind transparent protective covering. Panelboard shall have nameplates in accordance with paragraph FIELD FABRICATED NAMEPLATES.

2.12.1 Enclosure

Enclosures shall meet the requirements of UL 50. All cabinets shall be fabricated from sheet steel of not less than 3.5 millimeters if flush-mounted or mounted outdoors, and not less than 2.7 millimeters if surface-mounted indoors, with full seam-welded box ends. Cabinets mounted outdoors or flush-mounted shall be hot-dipped galvanized after fabrication. Cabinets shall be painted in accordance with paragraph PAINTING. Outdoor cabinets shall be of NEMA 3R raintight (IP 14) with conduit hubs welded to the cabinet. Front edges of cabinets shall be form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front. All cabinets shall be so fabricated that no part of any surface on the finished cabinet shall deviate from a true plane by more than 3 millimeters. Holes shall be provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 15 millimeter clear space between the back of the cabinet and the wall surface. Flush doors shall be mounted on hinges that expose only the hinge roll to view when the door is closed. Each door shall be fitted with a combined catch and lock, except that doors over 600 millimeters long shall be provided with a three-point latch having a knob with a T-handle, and a cylinder lock. Two keys shall be provided with each lock, and all locks shall be keyed alike. Finished-head cap screws shall be provided for mounting the panelboard fronts on the cabinets.

2.12.2 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Main buses and back pans shall be designed so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

2.12.3 Circuit Breakers

UL 489, thermal magnetic-type having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker shall be mounted. Breaker terminals shall be UL listed as suitable for type of conductor provided. Where indicated on the drawings,

provide circuit breakers with shunt trip devices. Provide earth leakage circuit breakers, three pole for 2 and 3 wire circuits and four pole for 3 phase circuits.

2.12.3.1 Multipole Breakers

Provide common trip-type with single operating handle. Breaker design shall be such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.12.3.2 Circuit Breaker With GFI

UL 943 and NFPA 70. Provide with "push-to-test" button, visible indication of tripped condition, and ability to detect and trip on current imbalance of 6 milliamperes or greater per requirements of UL 943 for Class A GFI devices, for personnel protection

2.12.3.3 Circuit Breakers for HVAC Equipment

Circuit breakers for HVAC equipment having motors (group or individual) shall be marked for use with HACR type and UL listed as HACR type.

2.13 ENCLOSED CIRCUIT BREAKERS

UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated. Provide solid neutral.

2.14 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

Motor short-circuit protectors, also called motor circuit protectors (MCPs); shall conform to UL 508 and UL 489 and shall be provided as shown. MSCPs shall consist of an adjustable instantaneous trip circuit breaker used only in conjunction with a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection. MSCPs shall be rated in accordance with the requirements of NFPA 70.

2.15 MOTORS

NEMA MG 1; hermetic-type sealed motor compressors shall also comply with UL 984. Provide the size in terms of kW, or kVA, or full-load current, or a combination of these characteristics, and other characteristics, of each motor as indicated or specified. Determine specific motor characteristics to ensure provision of correctly sized starters and overload heaters. Motors for operation on 380-volt, 3-phase circuits shall have terminal voltage rating of 380 volts. Motors shall be designed to operate at full capacity with voltage variation of plus or minus 10 percent of motor voltage rating. Unless otherwise indicated, motors rated 745 Watts (1 HP) and above shall be continuous duty type.

Where fuse protection is specifically recommended by the equipment manufacturer, provide fused switches in lieu of non-fused switches indicated.

2.15.1 High Efficiency Single-Phase Motors

Single-phase fractional-horsepower alternating-current motors shall be high efficiency types corresponding to the applications listed in NEMA MG 11. In exception, for motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

2.15.2 Motor Sizes

Provide size for duty to be performed, not exceeding the full-load nameplate current rating when driven equipment is operated at specified capacity under most severe conditions likely to be encountered. When motor size provided differs from size indicated or specified, make adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually provided. Provide controllers for motors rated 1-hp and above 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.

2.15.3 Wiring and Conduit

Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field-installed equipment as specified herein. Power wiring and conduit shall conform to the requirements specified herein. Control wiring shall be provided under, and conform to the requirements of the section specifying the associated equipment.

2.16 MOTOR CONTROLLERS

UL 508, NEMA ICS 1, and NEMA ICS 2. Controllers shall have thermal overload protection in each phase and shall have one spare normally open and one spare normally closed auxiliary contact. Provide controllers for motors rated 1-hp and above 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. Magnetic-type motor controllers shall have undervoltage protection when used with momentary-contact pushbutton stations or switches and shall have undervoltage release when used with maintained-contact pushbutton stations or switches. When used with pressure, float, or similar automatic-type or maintained-contact switch, controller shall have hand/off/automatic selector switch. Connections to selector switch shall be such that only normal automatic regulatory control devices are bypassed when switch is in "hand" position. Safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices, shall be connected in motor control circuit in "hand" and "automatic" positions. Control circuit connections to hand/off/automatic selector switch or to more than one automatic regulatory control device shall be made in accordance with indicated or manufacturer's approved wiring diagram.For each motor not in sight of controller or where controller disconnecting means is not in sight of motor location and driven machinery location, controller disconnecting means shall be capable of being locked in open position. As an alternative, provide a manually operated, lockable, nonfused switch which disconnects motor from supply source within sight of motor. Overload protective devices shall provide adequate protection to motor windings; be thermal inverse-time-limit type; and include manual

reset-type pushbutton on outside of motor controller case. Cover of combination motor controller and manual switch or circuit breaker shall be interlocked with operating handle of switch or circuit breaker so that cover cannot be opened unless handle of switch or circuit breaker is in "off" position. Minimum short circuit withstand rating of combination motor controller shall be 10,000 rms symmetrical amperes. Provide controllers in hazardous locations with classifications as indicated.

2.16.1 Control Wiring

All control wire shall be stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44, or Type MTW meeting UL 1063, and shall pass the VW-1 flame tests included in those standards. Hinge wire shall have Class K stranding. Current transformer secondary leads shall be not smaller than No. 6mm^2. The minimum size of control wire shall be No. 2.5mm^2. Power wiring for 480-volt circuits and below shall be of the same type as control wiring and the minimum size shall be No. 4MM^2. Special attention shall be given to wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

2.16.2 Control Circuit Terminal Blocks

NEMA ICS 4. Control circuit terminal blocks for control wiring shall be molded or fabricated type with barriers, rated not less than 600 volts. The terminals shall be removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts. The terminals shall be not less than No. 6mm^2 in size and shall have sufficient length and space for connecting at least two indented terminals for 6mm^2 conductors to each terminal. The terminal arrangement shall be subject to the approval of the Contracting Officer and not less than four (4) spare terminals or 10 percent, whichever is greater, shall be provided on each block or group of blocks. Modular, pull apart, terminal blocks will be acceptable provided they are of the channel or rail-mounted type. The Contractor shall submit data showing that the proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

2.16.2.1 Types of Terminal Blocks

a. Short-Circuiting Type: Short-circuiting type terminal blocks shall be furnished for all current transformer secondary leads and shall have provision for shorting together all leads from each current transformer without first opening any circuit. Terminal blocks shall meet the requirements of paragraph CONTROL CIRCUIT TERMINAL BLOCKS above.

b. Load Type: Load terminal blocks rated not less than 600 volts and of adequate capacity shall be provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits, except those for feeder tap units. The terminals shall be of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, screws shall have hexagonal heads. Conducting parts between connected terminals shall have adequate contact surface and cross-section to

operate without overheating. Each connected terminal shall have the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

2.16.3 Control Circuits

Control circuits shall have maximum voltage of 220 volts derived from control transformer in same enclosure. Transformers shall conform to UL 506, as applicable. Transformers, other than transformers in bridge circuits, shall have primaries wound for voltage available and secondaries wound for correct control circuit voltage. Size transformers so that 80 percent of rated capacity equals connected load. Provide disconnect switch on primary side. Provide fuses in each ungrounded primary feeder. One secondary lead shall be fused; other shall be grounded.

2.16.4 Enclosures for Motor Controllers

NEMA ICS 6.

2.16.5 Multiple-Speed Motor Controllers and Reversible Motor Controllers

Across-the-line-type, electrically and mechanically interlocked. Multiple-speed controllers shall have compelling relays and shall be multiple-button, station-type with pilot lights for each speed.

2.16.6 Pushbutton Stations

Provide with "start/stop" momentary contacts having one normally open and one normally closed set of contacts, and red lights to indicate when motor is running. Stations shall be heavy duty, oil-tight design.

2.16.7 Pilot and Indicating Lights

Provide LED cluster lamps.

2.16.8 Reduced-Voltage Controllers

Reduced-voltage starters shall be single-step, closed transition solid state-type, or as indicated, and shall have adjustable time interval between application of reduced and full voltages to motors. Wye-delta reduced voltage starter or part winding increment starter having adjustable time delay between application of voltage to first and second winding of motor may be used in lieu of the reduced-voltage starters for starting of centrifugally operated equipment.

2.17 MANUAL MOTOR STARTERS (MOTOR RATED SWITCHES)

Single, double, andthree pole designed for surface mounting with overload protection and pilot lights.

2.17.1 Pilot Lights

Provide yoke-mounted, seven element LED cluster light module. Color shall be green, red, amber in accordance with NEMA ICS 2.

2.18 LOCKOUT REQUIREMENTS

Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147. Mechanical isolation of machines and other equipment shall be in accordance with requirements of Division 23, Heating Ventilation and Air Conditioning"; Division 22, "Plumbing"; and Division 33."

2.18.1 Other Equipment-Ceiling Fans

Wobble-free canopy,52" blade span (except for models with feather blades (54"), min. 188 mm x 15 mm diameter motor, 14° (degree) blade pitch for maximum air flow, 3 speeds (high, medium, low), reversible air flow whisper-quiet operation (no hum), top quality finishes and plating, wall-mounted switch.

2.19 GROUNDING AND BONDING EQUIPMENT

2.19.1 Ground Rods

UL 467. Ground rods shall be copper-clad steel, with minimum diameter of 19 mm and minimum length of 3050 mm.

2.19.2 Ground Bus

A copper ground bus shall be provided in the electrical equipment rooms as indicated.

2.20 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.

2.21 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 3 mm thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be 25 by 65 mm. Lettering shall be a minimum of 6.35 mm high normal block style.

2.22 FIRESTOPPING MATERIALS

Provide firestopping around electrical penetrations in accordance with Section 07 84 00, FIRESTOPPING .

2.23 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and the additional requirements as specified herein. Interior and exterior steel surfaces of equipment enclosures shall be thoroughly cleaned and then receive a rust-inhibitive phosphatizing or equivalent treatment

prior to painting. Exterior surfaces shall be free from holes, seams, dents, weld marks, loose scale or other imperfections. Interior surfaces shall receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice. Exterior surfaces shall be primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish. Equipment located indoors shall be ANSI Light Gray, and equipment located outdoors shall be ANSI Dark Gray. Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces, shall conform to requirements of NFPA 70 and IEEE C2 and to requirements specified herein.

3.1.1 Underground Service

Underground service conductors and associated conduit shall be continuous from service entrance equipment to outdoor power system connection.

3.1.2 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures shall be labeled and identified as such.

3.1.2.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, each enclosure, new and existing, shall be labeled as one of several enclosures containing service entrance disconnect devices. Label, at minimum, shall indicate number of service disconnect devices housed by enclosure and shall indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use lettering of at least 6.35 mm in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure, shall be provided only as permitted by NFPA 70.

3.1.3 Wiring Methods

Provide insulated conductors installed in rigid steel conduit, IMC, rigid nonmetallic conduit, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor shall be separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Minimum conduit size shall be 21 mm in diameter for low voltage lighting and power circuits. Metal conduit shall extend through shafts for minimum distance of 150 mm. Conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors shall be firestopped in accordance with Section 07 84 00, FIRESTOPPING.

3.1.3.1 Pull Wire

Install pull wires in empty conduits. Pull wire shall be plastic having minimum 890-N (200-pound) force tensile strength. Leave minimum 915 mm of slack at each end of pull wire.

3.1.4 Conduit Installation

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Keep conduit minimum 150 mm away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.

3.1.4.1 Restrictions Applicable to EMT

a. Do not install underground.

b. Do not encase in concrete, mortar, grout, or other cementitious materials.

c. Do not use in areas subject to severe physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.

d. Do not use in hazardous areas.

e. Do not use outdoors.

3.1.4.2 Restrictions Applicable to Nonmetallic Conduit

a. PVC Schedule 40 and PVC Schedule 80

(1) Do not use in areas where subject to severe physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms.

(2) Do not use in hazardous (classified) areas.

(3) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

(4) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.

3.1.4.3 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS.

3.1.4.4 Service Entrance Conduit, Underground

PVC, Type-EPC 80, galvanized rigid steel or steel IMC. Underground portion shall be encased in minimum of 75 mm of concrete and shall be installed minimum 460 mm below slab or grade.

3.1.4.5 Conduit Installed Under Floor Slabs

Conduit run under floor slab shall be located a minimum of 305 mm below the vapor barrier. Seal around conduits at penetrations thru vapor barrier.

3.1.4.6 Conduit Through Floor Slabs

Where conduits rise through floor slabs, curved portion of bends shall not be visible above finished slab.

3.1.4.7 Conduit Installed in Concrete Floor Slabs

Rigid steel; steel IMC; or PVC, Type EPC-80, e unless indicated otherwise. Locate so as not to adversely affect structural strength of slabs. Install conduit within middle one-third of concrete slab. Do not stack conduits. Space conduits horizontally not closer than three diameters, except at cabinet locations. Curved portions of bends shall not be visible above finish slab. Increase slab thickness as necessary to provide minimum 25 mm cover over conduit. Where embedded conduits cross building and/or expansion joints, provide suitable watertight expansion/deflection fittings and bonding jumpers. Expansion/deflection fittings shall allow horizontal and vertical movement of raceway. Conduit larger than 27 mm trade size shall be parallel with or at right angles to main reinforcement; when at right angles to reinforcement, conduit shall be close to one of supports of slab.

3.1.4.8 Stub-Ups

Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used 150 mm above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.1.4.9 Conduit Support

Support conduit by pipe straps, wall brackets, hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Load applied to fasteners shall not exceed one-fourth proof test load. Fasteners attached to concrete ceiling shall be vibration resistant and shock-resistant. Holes cut to depth of more than 40 mm in reinforced concrete beams or to depth of more than 20 mm in concrete joints shall not cut main reinforcing bars. Fill unused holes. In partitions of light steel construction, use sheet metal screws. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Installation shall be coordinated with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations. Where conduit crosses building expansion joints, provide suitable expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than 63 mm inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.4.10 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.1.4.11 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Locknuts shall have sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

3.1.4.12 Flexible Connections

Provide flexible steel conduit between 915 and 1830 mm in length for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size shall be 16 mm diameter. Provide liquid tight flexible conduit in wet and damp locations for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections.

3.1.5 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when surface mounted on interior walls exposed up to 2135 mm above floors and walkways, and when specifically indicated. Boxes in other locations shall be sheet steel, except that aluminum boxes may be used with aluminum conduit. Each box shall have volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures shall be minimum 100 mm square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; fixtures shall be readily removable for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel or nail-type. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with

approved-type fastener maximum 610 mm from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.5.1 Boxes

Boxes for use with raceway systems shall be minimum 40 mm deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets shall be minimum 100 mm square, except that 100 by 50 mm boxes may be used where only one raceway enters outlet. Telecommunications outlets shall be a minimum of 120 mm square by 54 mm deep. Mount outlet boxes flush in finished walls.

3.1.5.2 Pull Boxes

Construct of at least minimum size required by NFPA 70 of code-gauge galvanized sheet steel, except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

3.1.6 Mounting Heights

Mount panelboards, enclosed circuit breakers, motor controller and disconnecting switches so height of operating handle at its highest position is maximum 1980 mm above floor. Mount receptacles and telecommunications outlets 460 mm above finished floor, unless otherwise indicated. Wall-mounted telecommunications outlets shall be mounted at height 1525 mm above finished floor. Measure mounting heights of wiring devices and outlets to center of device or outlet.

3.1.7 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 16mm^2 and smaller diameter, color coding shall be by factory-applied, color-impregnated insulation. For conductors No. 25mm^2 and larger diameter, color coding shall be by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Identify control circuit terminations in accordance with manufacturer's recommendations

3.1.7.1 Marking Strips

White or other light-colored plastic marking strips, fastened by screws to each terminal block, shall be provided for wire designations. The wire numbers shall be made with permanent ink. The marking strips shall be reversible to permit marking both sides, or two marking strips shall be furnished with each block. Marking strips shall accommodate the two sets of wire numbers. Each device to which a connection is made shall be assigned a device designation in accordance with NEMA ICS 1 and each device terminal to which a connection is made shall be marked with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, additional wire and cable designations for identification of remote (external) circuits shall be provided for the Government's wire designations. Prints of the marking strips drawings submitted for approval will be so marked and

returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

3.1.8 Splices

Make splices in accessible locations. Make splices in conductors No. $6mm^2$ and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. $10MM^2$ and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

3.1.9 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 0.58 mm. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

3.1.10 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings in accordance with Section 07 84 00, FIRESTOPPING.

3.1.11 Grounding and Bonding

Provide In accordance with NFPA 70. Ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, and neutral conductor of wiring systems. Make ground connection at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode in compliance with NFPA 70. Make ground connection to driven ground rods on exterior of building. Interconnect all grounding media in or on the structure to provide a common ground potential. This shall include lightning protection, electrical service, telecommunications system grounds, as well as underground metallic piping systems. Use main size lightning conductors for interconnecting these grounding systems to the lightning protection system.

3.1.11.1 Ground Rods

Provide cone pointed ground rods. The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, additional rods not less than 1830 mm on centers. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer who will decide on the number of ground rods to add.

3.1.11.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, by exothermic weld or compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

3.1.11.3 Ground Bus

A copper ground bus shall be provided in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of electrical equipment shall be effectively grounded by bonding to the ground bus. The ground bus shall be bonded to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 100 mm above the floor. Connections and splices shall be of the brazed, welded, bolted, or pressure-connector type, except that pressure connectors or bolted connections shall be used for connections to removable equipment.

3.1.12 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications but shall be provided under the section specifying the associated equipment.

3.1.13 Government-Furnished Equipment

Contractor shall rough-in for Government-furnished equipment to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings.

3.1.14 Workmanship

Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to buildings, piping, and equipment using skilled craftsmen of trades involved.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00, PAINTS AND COATINGS.

3.5 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer 5 working days notice prior to each test.

3.5.1 Devices Subject to Manual Operation

Each device subject to manual operation shall be operated at least five times, demonstrating satisfactory operation each time.

3.5.2 600-Volt Wiring Test

Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. $16MM^2$and larger diameter using instrument which applies voltage of approximately 500 volts to provide direct reading of resistance. Minimum resistance shall be 250,000 ohms.

3.5.3 Grounding System Test

Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

-- End of Section --

SECTION 26 28 01.00 10

COORDINATED POWER SYSTEM PROTECTION
04/06

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 D 2472	(2000; R 2006) Standard Specification for Sulphur Hexafluoride

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2005) National Electrical Safety Code
IEEE C37.13	(1990; R 2005) Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C37.16	(2000) Recommendations for Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors, - Preferred Ratings, Related Requirements, and Application
IEEE C37.2	(1996) Electrical Power System Device Function Numbers and Contact Designations
IEEE C37.20.1	(2002) Standard for Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear
IEEE Std 242	(2001) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - Buff Book
IEEE Std 399	(1997) Recommended Practice for Power Systems Analysis - Brown Book

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA C37.50	(1989; R 2000) Low-Voltage AC Power Circuit Breakers Used in Enclosures - Test Procedures
NEMA FU 1	(2002) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000; R 2005) Standard for Industrial Control and Systems General Requirements

NEMA ICS 2	(2000; Errata 2002; R 2005; Errata 2006) Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
NEMA ICS 6	(2006) Standard for Industrial Controls and Systems Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005; TIA 2005) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 198B	(1995) Class H Fuses
UL 198C	(1986; Rev thru Feb 1998) High-Interrupting-Capacity Fuses, Current-Limiting Types
UL 198D	(1995) Class K Fuses
UL 198E	(1988; Rev Jul 1988) Class R Fuses
UL 198H	(1988; Rev thru Nov 1993) Class T Fuses
UL 486E	(1994; Rev thru May 2000) Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
UL 489	(2004; Rev thru Jun 2006) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 508	(2005) Standard for Industrial Control Equipment

1.1.1 EQUIVALENT REFERENCES

Equipment and material meeting standards that are deemed equivalent (by the Authority Having Jurisdiction) to the above referenced standards may be submitted for approval.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fault Current Analysis
Protective Device Coordination Study

The study along with protective device equipment submittals. No time extensions or similar contact modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed will be based on recommendations of this study. The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Equipment

Data consisting of manufacturer's time-current characteristic curves for individual protective devices, recommended settings of adjustable protective devices, and recommended ratings of non-adjustable protective devices.

System Coordinator

Verification of experience and license number, of a registered Professional Engineer with at least 3 years of current experience in the design of coordinated power system protection. Experience data shall include at least five references for work of a magnitude comparable to this contract, including points of contact, addresses and telephone numbers. This engineer must perform items required by this section to be performed by a registered Professional Engineer.

Protective Relays

Data shall including calibration and testing procedures and instructions pertaining to the frequency of calibration, inspection, adjustment, cleaning, and lubrication.

Installation

Procedures including diagrams, instructions, and precautions required to properly install, adjust, calibrate, and test the devices and equipment.

SD-06 Test Reports

Field Testing

The proposed test plan, prior to field tests. Plan shall consist of complete field test procedure including tests to be performed, test equipment required, and tolerance limits, including complete testing and verification of the ground fault protection equipment, where used. Performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

SD-07 Certificates

Devices and Equipment

Certificates certifying that all devices or equipment meet the requirements of the contract documents.

1.3 SYSTEM DESCRIPTION

The power system covered by this specification consists of: The installation of the complete electrical distribution system including the furnishing and installation of the prime power generators.

1.4 QUALIFICATIONS

1.4.1 System Coordinator

System coordination, recommended ratings and settings of protective devices, and design analysis shall be accomplished by a registered professional electrical power engineer with a minimum of 3 years of current experience in the coordination of electrical power systems.

1.4.2 System Installer

Calibration, testing, adjustment, and placing into service of the protective devices shall be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of two years of current product experience in protective devices.

1.5 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced.

1.6 PROJECT/SITE CONDITIONS

Devices and equipment furnished under this section shall be suitable for the following site conditions. Seismic details shall conform to Section 26 05 48.00 10 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

1.6.1 Altitude

Altitude: As determined by site location.

1.6.2 Ambient Temperature

Ambient Temperature: +50 degrees C -30 degrees C.

1.6.3 Frequency

Frequency: 50 HZ.

1.6.4 Seismic Parameters

Seismic Parameters: As determined by site conditions.

1.7 EXTRA MATERIALS

The following spare fuses or spare fuse elements shall be delivered to the Contracting officer when the electrical system is accepted:

PART 2 PRODUCTS

2.1 STANDARD PRODUCT

Protective devices and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory utility type use for at least two years prior to bid opening.

2.2 NAMEPLATES

Nameplates shall be provided to identify all protective devices and equipment. Nameplate information shall be in accordance with NEMA AB 1 or NEMA SG 6 as applicable.

2.3 CORROSION PROTECTION

Metallic materials shall be protected against corrosion. Ferrous metal hardware shall be zinc or chrome-plated.

2.4 MOTOR CONTROLS AND MOTOR CONTROL CENTERS

2.4.1 Motor Starters

Combination starters shall be provided with circuit breakers or fusible switches.

2.4.2 Thermal-Overload Protection

Each motor of 93 W (1/8 hp) or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

2.4.3 Low-Voltage Motor Overload Relays

2.4.3.1 General

Thermal and magnetic current overload relays shall conform to NEMA ICS 2 and UL 508. Overload protection shall be provided either integral with the motor or controller, and shall be rated in accordance with the requirements of NFPA 70. Standard units shall be used for motor starting times up to 7 second. Slow units shall be used for motor starting times from 8 to 12 seconds. Quick trip units shall be used on hermetically sealed, submersible pumps, and similar motors.

2.4.3.2 Construction

Manual reset type thermal relays shall be bimetallic construction. Automatic reset type relays shall be bimetallic construction.

2.4.3.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Trip current ratings shall be established by selection of the replaceable overload device and shall not be adjustable. Where the controller is remotely-located or difficult to reach, an automatic reset, non-compensated overload relay shall be provided. Manual reset overload relays shall be provided otherwise, and at all locations where automatic starting is provided. Where the motor is located in a constant ambient temperature, and the thermal device is located in an ambient temperature that regularly varies by more than minus 10 degrees C, an ambient temperature-compensated overload relay shall be provided.

2.4.4 Automatic Control Devices

2.4.4.1 Direct Control

Automatic control devices (such as thermostats, float or pressure switches) which control the starting and stopping of motors directly shall be designed for that purpose and have an adequate kilowatt rating.

2.4.4.2 Pilot-Relay Control

Where the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit.

2.4.4.3 Manual/Automatic Selection

a. Where combination manual and automatic control is specified and the automatic-control device actuates the pilot control circuit of a magnetic starter, the magnetic starter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC.

b. Connections to the selector switch shall only allow the normal automatic regulatory control devices to be bypassed when the switch is in the Manual position; all safety control devices, such as low- or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the contracting Officer unless such diagram is included on the drawings. All controls shall be 220 volts or less unless otherwise indicated.

2.5 LOW-VOLTAGE FUSES

2.5.1 General

Low-voltage fuses shall conform to NEMA FU 1. Time delay and nontime delay options shall be as specified. Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment

manufacturer utilizes fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics requires for effective power system coordination.

2.5.2 Cartridge Fuses; Noncurrent-Limiting Type

Cartridge fuses of the noncurrent-limiting type shall be Class H, nonrenewable, dual element, time lag type and shall have interrupting capacity of 10,000 amperes. Class H Fuses shall conform to UL 198B. At 500 percent current, cartridge fuses shall not blow in less than 10 seconds. Cartridge fuses shall be used for circuits rated in excess of 30 amperes, 220 volts, except where current-limiting fuses are indicated.

2.5.3 Cartridge Fuses; Current-Limiting Type

Cartridge fuses, current-limiting type, Class G, J, K, L, RK1, RK5, RK9, T, CC shall have tested interrupting capacity not less than 200,000 amperes. Fuse holders shall be the type that will reject Class H fuses.

a. Class G, J, L, CC fuses shall conform to UL 198C.

b. Class K fuses shall conform to UL 198D.

c. Class R fuses shall conform to UL 198E.

d. Class T fuses shall conform to UL 198H.

2.5.3.1 Continuous Current Ratings (600 amperes and smaller)

Service entrance and feeder circuit fuses (600 amperes and smaller) shall be Class RK1, RK5, J, current-limiting, time-delay with 200,000 amperes interrupting capacity.

2.5.3.2 Continuous Current Ratings (greater than 600 amperes)

Service entrance and feeder circuit fuses (greater than 600 amperes) shall be Class L, current-limiting, time-delay with 200,000 amperes interrupting capacity.

2.5.3.3 Motor and Transformer Circuit Fuses

Motor, motor controller, transformer, and inductive circuit fuses shall be Class RK1 or RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

2.6 MOLDED-CASE CIRCUIT BREAKERS

2.6.1 General

Molded-case circuit breakers shall conform to NEMA AB 1 and UL 489. Circuit breakers may be installed in panelboards, switchboards, enclosures, or combination motor controllers. Circuit breakers and circuit breaker enclosures located in hazardous (classified) areas shall conform to UL 877.

2.6.2 Construction

Molded-case circuit breakers shall be assembled as an integral unit in a supporting and enclosing housing of glass reinforced insulating material providing high dielectric strength. Circuit breakers shall be suitable for mounting and operating in any position. Lugs shall be listed for copper conductors only in accordance with UL 486E. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

2.6.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards and switchboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with NEMA AB 1. Ratings shall be coordinated with system X/R ratio.

2.6.4 Cascade System Ratings

Circuit breakers used in series combinations shall be in accordance with UL 489. Equipment, such as switchboards and panelboards, which house series-connected circuit breakers shall be clearly marked accordingly. Series combinations shall be listed in the UL Recognized Component Directory under "Circuit Breakers-Series Connected."

2.6.5 Thermal-Magnetic Trip Elements

Thermal magnetic circuit breakers shall be provided as shown. Automatic operation shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. The instantaneous magnetic trip shall be adjustable and accessible from the front of all circuit breakers on frame sizes above 150 amperes.

2.6.6 SWD Circuit Breakers

Circuit breakers rated 15 amperes or 20 amperes and intended to switch 220 volts or less fluorescent lighting loads shall be marked "SWD."

2.6.7 HACR Circuit Breakers

Circuit breakers 60 amperes or below, 380 volts, 1-pole or 2-pole, intended to protect multi-motor and combination-load installations involved in heating, air conditioning, and refrigerating equipment shall be marked "Listed HACR Type."

2.6.8 Motor Circuit Protectors (MCP)

Motor circuit protectors shall conform to NEMA AB 1 and UL 489 and shall be provided as shown. MCPs shall consist of an adjustable instantaneous trip circuit breaker in conjunction with a combination motor controller which provides coordinated motor circuit overload and short-circuit protection. Motor Circuit Protectors shall be rated in accordance with NFPA 70.

2.7 LOW-VOLTAGE POWER CIRCUIT BREAKERS

2.7.1 Construction

Low-voltage power circuit breakers shall conform to IEEE C37.13, IEEE C37.16, and NEMA SG 6 and shall be three-pole, single-throw, stored energy, manually operated. Circuit breakers shall have an open/close contact position indicator, charged/discharged stored energy indicator, primary disconnect devices, and a mechanical interlock to prevent making or breaking contact of the primary disconnects when the circuit breaker is closed. Control voltage shall be 220 V ac. The circuit breaker enclosure shall be suitable for its intended location.

2.7.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Circuit breakers shall be rated for 100 percent continuous duty and shall have trip current ratings and frame sizes as shown. Nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings shall be in accordance with IEEE C37.16. Tripping features shall be as follows:

a. Long-time current pick-up, adjustable from 50 percent to 100 percent of sensor current rating.

b. Adjustable long-time delay.

c. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.

d. Adjustable short-time delay.

e. Short-time I square times t switch.

f. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.

g. Adjustable ground-fault delay.

h. Ground-fault I square times t switch.

i. Ground-fault trip indicators shall be provided.

2.8 COORDINATED POWER SYSTEM PROTECTION

Analyses shall be prepared to demonstrate that the equipment selected and system constructed meet the contract requirements for ratings, coordination, and protection. They shall include a load flow analysis, a fault current analysis, and a protective device coordination study. The studies shall be performed by a registered professional engineer with demonstrated experience in power system coordination in the last 3 years. The Contractor shall provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

2.8.1 Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: the source bus and extend down to system buses where fault availability is 10,000 amperes (symmetrical) for building/facility 600 volt level distribution buses.

2.8.2 Determination of Facts

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented. The Contractor shall utilize the fault current availability indicated as a basis for fault current studies.

2.8.3 Single Line Diagram

A single line diagram shall be prepared to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Each bus, device or transformation point shall have a unique identifier. If a fault-impedance diagram is provided, impedance data shall be shown. Location of switches, breakers, and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating.

2.8.4 Fault Current Analysis

2.8.4.1 Method

The fault current analysis shall be performed in accordance with methods described in IEEE Std 242, and IEEE Std 399.

2.8.4.2 Data

Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedance shall be those proposed. Data shall be documented in the report.

2.8.4.3 Fault Current Availability

Balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values shall be provided at each voltage transformation point and at each power distribution bus. The maximum and minimum values of fault available at each location shall be shown in tabular form on the diagram or in the report.

2.8.5 Coordination Study

The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. The study shall include a description of the coordination of the protective devices in this project. A written narrative shall be provided describing: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap); coordination between upstream and downstream devices; and relay settings. Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost damages (addition or reduction) shall be provided. Composite coordination plots shall be provided on log-log graph paper.

2.8.6 Study report

a. The report shall include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.

b. The study shall include descriptive and technical data for existing devices and new protective devices proposed. The data shall include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.

c. The report shall document system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device numbers and settings.

d. The report shall contain fully coordinated composite time-current characteristics curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form.

e. The report shall provide the calculation performed for the analyses, including computer analysis programs utilized. The name of the software package, developer, and version number shall be provided.

PART 3 EXECUTION

3.1 VERIFICATION OF DIMENSIONS

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

3.2 INSTALLATION

Protective devices shall be installed in accordance with the manufacturer's published instructions and in accordance with the requirements of NFPA 70 and IEEE C2.

3.3 FIELD TESTING

3.3.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 14 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results.

3.3.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.3.3 Molded-Case Circuit Breakers

Circuit breakers shall be visually inspected, operated manually, and connections checked for tightness. Current ratings shall be verified and adjustable settings incorporated in accordance with the coordination study.

-- End of Section --

SECTION 26 32 15.00 10

DIESEL-GENERATOR SET STATIONARY 100-2500 KW, WITH AUXILIARIES
04/06

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 C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments

ASME INTERNATIONAL (ASME)

ASME B16.11	(2005) Forged Fittings, Socket-Welding and Threaded
ASME B16.3	(1998) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2003) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24

ASTM INTERNATIONAL (ASTM)

ASTM A 53/A 53M	(2006a) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM D 975	(2007) Standard Specification for Diesel Fuel Oils

ELECTRICAL GENERATING SYSTEMS ASSOCIATION (EGSA)

EGSA 101P	(1995) Engine Driven Generator Sets

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2005) National Electrical Safety Code
IEEE C57.13	(1993; R 2003) Standard Requirements for Instrument Transformers
IEEE Std 1	(2000) General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation

IEEE Std 100	(2000) The Authoritave Dictionary of IEEE Standards Terms
IEEE Std 115	(1995; R 2002) Test Procedures for Synchronous Machines: Part I: Acceptance and Performance Testing; Part II: Test Procedures and Parameter Determination for Dynamic Analysis
IEEE Std 120	(1989) Master Test Guide for Electrical Measurements in Power Circuits
IEEE Std 43	(2000) Testing Insulation Resistance of Rotating Machinery
IEEE Std 484	(2002) Recommended Practice for Installation Design and Implementation of Vented Lead-Acid Batteries for Stationary Applications
IEEE Std 485	(1997) Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications
IEEE Std 519	(1992) Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1) Normal Measurements

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

MSS SP-58	(2002) Standard for Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application
MSS SP-80	(2003) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(2006) Standard for Industrial Controls and Systems Enclosures
NEMA MG 1	(2006) Standard for Motors and Generators
NEMA PB 1	(2006) Standard for Panelboards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 110	(2005) Standard for Emergency and Standby Power Systems

NFPA 30	(2003; Errata 2004; Errata 2006) Flammable and Combustible Liquids Code
NFPA 37	(2006) Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	(2005; TIA 2005) National Electrical Code

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J537	(2000) Storage Batteries

UNDERWRITERS LABORATORIES (UL)

UL 1236	(2006) Standard for Safety Battery Chargers for Charging Engine-Starter Batteries

1.1.1 EQUIVALENT REFERENCES

Equipment and material meeting standards that are deemed equivalent (by the Authority Having Jurisdiction) to the above referenced standards may be submitted for approval.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detailed Drawings; G

SD-03 Product Data

Performance Criteria; G

Calculations of the engine and generator output power capability, including efficiency and parasitic load data.

Sound Limitations

Sound power level data for the packaged unit operating at 100% load in a free field environment. The data should demonstrate compliance with the sound limitation requirements of this specification.

Cooling System

A letter which certifies that the engine-generator set and cooling system function properly in the ambient temperature specified, stating the following values:

a. The maximum allowable inlet temperature of the coolant fluid.

b. The minimum allowable inlet temperature of the coolant fluid.

c. The maximum allowable temperature rise in the coolant fluid through the engine.

Time-Delay on Alarms

The magnitude of monitored values which define alarm or action set points, and the tolerance (plus and/or minus) at which the devices activate the alarm or action for items contained within the alarm panels.

Generator; G

Manufacturer's standard data for each generator (prototype data at the specified rating or above is acceptable), listing the following information:

a. Direct-Axis subtransient reactance (per unit).

b. The generator kW rating and short circuit current capacity (both symmetric and asymmetric).

Manufacturer's Catalog

Manufacturer's standard catalog data describing and depicting each engine-generator set and all ancillary equipment in sufficient detail to demonstrate complete specification compliance.

Spare Parts

List of spare parts, as specified.

Onsite Training

A letter giving the date proposed for conducting the onsite training course, the agenda of instruction, a description of the video taping service to be provided, and the kind and quality of the tape to be left with the Contracting Officer at the end of the instructional period.

Battery Charger

Battery charger sizing calculations.

Instructions;

Instructions including: the manufacturers pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Instructions shall be weatherproof, laminated in plastic, and posted where directed.

Experience

Statement showing that each component manufacturer has a minimum of 3 years experience in the manufacture, assembly and sale of components used with stationary diesel engine-generator sets for commercial and industrial use. The engine-generator set manufacturer/assembler has a minimum of 3 years experience in the manufacture, assembly and sale of stationary diesel engine-generator sets for commercial and industrial use.

Field Engineer

A letter listing the qualifications, schools, formal training, and experience of the field engineer.

General Installation

A copy of the manufacturer's installation procedures and a detailed description of the manufacturer's recommended break-in procedure.

SD-06 Test Reports

Factory Inspection and Tests

Six complete reproducible copies of the factory inspection result on the checklist format specified in paragraph FACTORY INSPECTION AND TESTS.

Factory Tests

a. A letter giving notice of the proposed dates of factory inspections and tests at least 14 days prior to beginning tests.

b. A detailed description of the manufacturer's procedures for factory tests at least 14 days prior to beginning tests.

c. Six copies of the Factory Test data described below in 215.9 x 279.4 mm binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs. Data plots shall be full size 215.9 x 279.4 mm, showing grid lines, with full resolution.

(1) A detailed description of the procedures for factory tests.

(2) A list of equipment used, with calibration certifications.

(3) A copy of measurements taken, with required plots and graphs.

(4) The date of testing.

(5) A list of the parameters verified.

(6) The condition specified for the parameter.

(7) The test results, signed and dated.

(8) A description of adjustments made.

Onsite Inspection and Tests; G

a. A letter giving notice of the proposed dates of onsite inspections and tests at least 14 days prior to beginning tests.

Prototype Test

Manufacturer's standard certification that prototype tests were performed for the generator model proposed.

Reliability and Durability

A reliability and durability certification letter from the manufacturer and assembler to prove that existing facilities are and have been successfully utilizing the same components proposed to meet this specification, in similar service. Certification may be based on components, i.e. engines used with different models of generators and generators used with different engines, and does not exclude annual technological improvements made by a manufacturer in the basic standard-model component on which experience was obtained, provided parts interchangeability has not been substantially affected and the current standard model meets the performance requirements specified. Provide a list with the name of the installations, completion dates, and name and telephone number of a point of contact.

Emissions

A certification from the engine manufacturer stating that the engine exhaust emissions meet the federal, state, and local regulations and restrictions specified. At a minimum this certification shall include emission factors for criteria pollutants including nitrogen oxides, carbon monoxide, particulate matter, sulfur dioxide, non-methane hydrocarbon, and for hazardous air pollutants (HPAs).

Sound Limitations

A certification from the manufacturer stating that the sound emissions meet the specification.

Site Visit

A letter stating the date the site was visited and listing discrepancies found.

Current Balance

A certification stating that the flywheel has been statically and dynamically balanced and is capable of being rotated at 125% of rated speed without vibration or damage.

Materials and Equipment

A certification stating that where materials or equipment are specified to comply with requirements of UL, written proof of such compliance has been obtained. The label or listing of the

specified agency, or a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency are acceptable as proof.

Inspections

A letter certifying that all facilities are complete and functional; that each system is fully functional; and that each item of equipment is complete, free from damage, adjusted, and ready for beneficial use.

Cooling System

Certification that the engine-generator set and cooling system function properly in the ambient temperatures specified.

1.3 SYSTEM DESCRIPTION

Each engine-generator set shall be provided and installed complete and totally functional, with all necessary ancillary equipment to include: air filtration; starting system; generator controls, protection, and isolation; instrumentation; lubrication; fuel system; cooling system; and engine exhaust system. Each engine-generator set shall satisfy the requirements specified in the Engine-Generator Parameter Schedule.

1.3.1 Engine-Generator Parameter Schedule

ENGINE-GENERATOR PARAMETER SCHEDULE

Power Rating	Prime
Overload Capacity (Prime applications only)	110% of Service Load for 1 hour in 12 consecutive hours
Service Load	kVA (maximum) as shown on plans kVA (continuous) as shown on plans
Power Factor	0.8 lagging
Engine-Generator Applications	stand-alone
Maximum Speed	1500 rpm
Heat Exchanger Type	fin-tube (radiator)
Frequency Bandwidth (steady state)	0.4%
Governor Type	Droop
Frequency Regulation (droop) (No Load to Full Load)	3% (maximum)
Frequency Bandwidth	±0.4%

(steady state)	
Voltage Regulation (No Load to Full Load) (Stand alone applications)	± 2% (maximum)
Voltage Bandwidth (steady state)	± 1%
Frequency	50 Hz
Voltage	380/220 volts
Phases	3 Phase, Wye
Max Time to Start and be Ready to Assume Load	10 seconds
Max Summer Outdoor Temp (Prior to Genset Operation)	± 50 degrees
Min Winter Outdoor Temp (Prior to Genset Operation)	- 40 degrees
Installation Elevation	Coordinate with Site Conditions

1.3.2 Rated Output Capacity

Each engine-generator-set shall provide power equal to the sum of Service Load plus the machine's efficiency loss. Rated output capacity shall also consider engine and/or generator oversizing required to meet requirements in paragraph Engine-Generator Parameter Schedule.

1.3.3 Power Ratings

Power ratings shall be in accordance with EGSA 101P.

1.3.4 Transient Response

The engine-generator set governor and voltage regulator shall cause the engine-generator set to respond to the maximum step load changes such that output voltage and frequency recover to and stabilize within the operational bandwidth within the transient recovery time. The engine-generator set shall respond to maximum step load changes such that the maximum voltage and frequency deviations from bandwidth are not exceeded.

1.3.4 Reliability and Durability

Each prime engine-generator set shall have both an engine and a generator capable of delivering the specified power on a prime basis with an anticipated mean time between overhauls of not less than 10,000 hours operating with a 70% load factor. Two like engines and two like generators shall be cited that have performed satisfactorily in a stationary power plant, independent from the physical location of the manufacturer's and assembler's facilities. The engine and generators should have been in operation for a minimum of 8000 actual hours at a minimum load of 70% of the

rated output capacity. During two consecutive years of service, the units should not have experienced any failure resulting in a downtime in excess of 72 hours. Like engines shall be of the same model, speed, bore, stroke, number and configuration of cylinders and rated output capacity. Like generators shall be of the same model, speed, pitch, cooling, exciter, voltage regulator and rated output capacity.

1.4 GENERAL REQUIREMENTS

1.4.1 Engine-Generator Set

Each set shall consist of one engine, one generator, and one exciter mounted, assembled, and aligned on one base; and other necessary ancillary equipment which may be mounted separately. Sets having a capacity of 750 kW or smaller shall be assembled and attached to the base prior to shipping. Each set component shall be environmentally suitable for the location shown and shall be the manufacturer's standard product offered in catalogs for commercial or industrial use. Any nonstandard products or components and the reason for their use shall be specifically identified in paragraph SUBMITTALS.

1.4.2 Nameplates

Each major component of this specification shall have the manufacturer's name, type or style, model or serial number and rating on a plate secured to the equipment. As a minimum, nameplates shall be provided for:

Engines
Relays
Generators
Regulators
Governors
Pumps and pump motors
Generator Breaker

Where the following equipment is not provided as a standard component by the diesel engine generator set manufacturer, the nameplate information may be provided in the maintenance manual in lieu of nameplates.

Battery charger
Heaters
Exhaust mufflers
Battery

1.4.3 Personnel Safety Devices

Exposed moving parts, parts that produce high operating temperatures, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. The safety devices shall be installed so that proper operation of the equipment is not impaired.

1.4.4 Conformance to Codes and Standards

Where equipment is specified to conform to requirements of any code or standard such as UL, NEMA, etc., the design, fabrication and installation shall also conform to the code.

1.4.5 Engine-Generator Set Enclosure

The engine-generator set enclosure shall be corrosion resistant and fully weather resistant. The enclosure shall contain all set components and provide ventilation to permit operation at Service Load under secured conditions. Doors shall be provided for access to controls and equipment requiring periodic maintenance or adjustment. Removable panels shall be provided for access to components requiring periodic replacement. The enclosure shall be capable of being removed without disassembly of the engine-generator set or removal of components other than the exhaust system. The enclosure shall reduce the noise of the generator set to within the limits specified in the paragraph SOUND LIMITATIONS.

1.4.6 Seismic Requirements

Generator sets to be furnished under this contract shall be constructed and assembled to withstand the seismic forces specified in UFC 3-310-04.

1.4.7 Detailed Drawings

The Contractor shall submit detailed drawings showing the following:

a. Base-mounted equipment, complete with base and attachments, including anchor bolt template and recommended clearances for maintenance and operation.

b. Complete starting system.

c. Complete fuel system.

d. Complete cooling system.

e. Complete exhaust system.

f. Layout of breakers and switches including applicable single line and wiring diagrams with written description of sequence of operation and the instrumentation provided.

1.4.8 Spare Parts

The Contractor shall submit a complete list of spare parts for each piece of equipment and a complete list of all material and supplies needed for continued operation. Lists shall include supply source and current prices. Each list shall be separated into two parts, those elements recommended by the manufacturer to be replaced after 3 years of service, and the remaining elements.

1.5 STORAGE AND INSTALLATION

The Contractor shall properly protect material and equipment, in accordance with the manufacturers recommended storage procedures,before, during, and after installation. Stored items shall be protected from the weather and contamination. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Filter Elements

Fuel-oil, lubricating-oil, and combustion-air filter elements shall be manufacturer's standard.

2.1.2 Instrument Transformers

NEMA C12.11.

2.1.3 Pipe (Sleeves, Fuel/Lube-Oil, and Exhaust)

ASTM A 53/A 53M, or ASTM A 106/A 106M steel pipe. Pipe smaller than 50 mm shall be Schedule 80. Pipe 50 mm and larger shall be Schedule 40.

a. Flanges and Flanged Fittings: ASTM A 181/A 181M, Class 60, or ASME B16.5, Grade 1, Class 150.

b. Pipe Welding Fittings: ASTM A 234/A 234M, Grade WPB or WPC, Class 150 or ASME B16.11, 1360.7 kg.

c. Threaded Fittings: ASME B16.3, Class 150.

d. Valves: MSS SP-80, Class 150.

e. Gaskets: Manufacturer's standard.

2.1.4 Pipe Hangers

MSS SP-58 and MSS SP-69.

2.1.5 Electrical Enclosures

NEMA ICS 6.

2.1.5.1 Panelboards

NEMA PB 1.

2.2 ENGINE

Each engine shall operate on No. 2-D diesel fuel conforming to ASTM D 975, shall be designed for stationary applications and shall be complete with ancillaries. The engine shall be a standard production model described in the manufacturer's catalog. The engine shall be naturally aspirated, supercharged, or turbocharged. The engine shall be 4-stroke-cycle and compression-ignition type. The engine shall be vertical in-line, V- or opposed-piston type, with a solid cast block or individually cast cylinders. The engine shall have a minimum of two cylinders. Opposed-piston type engines shall have not less than four cylinders. Each block shall have a coolant drain port. Each engine shall be equipped with an overspeed sensor.

2.3 FUEL SYSTEM

The entire fuel system for each engine-generator set shall conform to the requirements of NFPA 30 and NFPA 37 and contain the following elements.

2.3.1 Pumps

2.3.1.1 Main Pump

Each engine shall be provided with an engine driven pump. The pump shall supply fuel at a minimum rate sufficient to provide the amount of fuel required to meet the performance indicated within the parameter schedule. The fuel flow rate shall be based on meeting the load requirements and all necessary recirculation.

2.3.2 Fuel Filter

A minimum of one full-flow fuel filter shall be provided for each engine. The filter shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. The filter shall have inlet and outlet connections plainly marked.

2.3.3 Relief/Bypass Valve

A relief/bypass valve shall be provided to regulate pressure in the fuel supply line, return excess fuel to a return line and prevent the build-up of excessive pressure in the fuel system.

2.3.4 Day Tank

Each engine shall be provided with an integral day tank. Each day tank shall be provided with connections for fuel supply line, fuel return line, fuel overflow line, local fuel fill port, gauge, vent line, drain line, and float switch assembly for control. A fuel return line cooler shall be provided as recommended by the manufacturer and assembler. The temperature of the fuel returning to the day tank shall be below the flash point of the fuel. A temperature sensing device shall be installed in the fuel supply line.Each engine-generator set provided with weatherproof enclosures shall have its day tank mounted within the enclosure. The fuel fill line shall be accessible without opening the enclosure.

2.3.4.1 Capacity, Prime

Each day tank shall have capacity to supply fuel to the engine for an uninterrupted 8-hour period at 100 percent rated load without being refilled, plus any fuel which may be returned to the main fuel storage tank. The calculation of the capacity of each day tank shall incorporate the requirement to stop the supply of fuel into the day tank at a "High" level mark of 90 percent of the ultimate volume of the tank.

2.3.4.3 Drain Line

Each day tank drain line shall be accessible and equipped with a shutoff valve.

2.3.4.4 Local Fuel Fill

Each local fuel fill port on the day tank shall be provided with a screw-on

cap.

2.3.4.5 Fuel Level Controls

Each day tank shall have a float-switch assembly to perform the following functions:
a. Start the supply of fuel into the day tank when the fuel level is at the "Low" level mark, 75 percent of the rated tank capacity.
b. Stop the supply of fuel into the day tank when the fuel level is at 90 percent of the rated tank capacity.
c. Activate the "Overfill Fuel Level" alarm at 95 percent of the rated tank capacity.
d. Activate the "Low Fuel Level" alarm at 70 percent of the rated tank capacity.
e. Activate the automatic fuel supply shut-off valve located on the fill line of the day tank and shut down the fuel pump which supplies fuel to the day tank at 95 percent of the rated tank capacity. The flow of fuel shall be stopped before any fuel can be forced into the fuel overflow line.

2.3.4.6 Arrangement

Integral day tanks may allow gravity flow into the engine. Gravity flow tanks shall be provided with an internal or external valve located as near as possible to the shell of the tank. The valve shall close when the engine is not operating. Integral day tanks shall be provided with any necessary pumps to supply fuel to the engine as recommended by the generator set manufacturer. The overflow connection and the fuel supply line for integral day tanks which do not rely upon gravity flow shall be arranged so that the highest possible fuel level is below the fuel injectors. When the main fuel storage tanks are located below the day tank, a check valve shall be provided in the fuel supply line entering the day tank. When the main fuel storage tanks are located above the day tank, a solenoid valve shall be installed in the fuel supply line entering the day tank. The solenoid valve shall be in addition to the automatic fuel shut off valve. The fuel supply line from the day tank to the manufacturer's standard engine connection shall be welded pipe.

2.4 LUBRICATION

Each engine shall have a separate lube-oil system conforming to NFPA 30 and NFPA 37. Each system shall be pressurized by engine-driven pumps. System pressure shall be regulated as recommended by the engine manufacturer. The crankcase shall be vented in accordance with the manufacturer's recommendation except that it shall not be vented to the engine exhaust system. Crankcase breathers, if provided on engines installed in buildings or enclosures, shall be piped to vent to the outside. The system shall be readily accessible for service such as draining, refilling, etc. Each system shall permit addition of oil and have oil-level indication with the set operating. The system shall utilize an oil cooler as recommended by the engine manufacturer.

2.4.1 Lube-Oil Filter

One full-flow filter shall be provided for each pump. The filter shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. The filter shall have inlet and outlet connections plainly marked.

2.4.2 Lube-Oil Sensors

Each engine shall be equipped with lube-oil pressure sensors. Pressure sensors shall be located downstream of the filters and provide signals for required indication and alarms.

2.5 COOLING SYSTEM

Each engine shall have its own cooling system. Each system shall operate automatically while its engine is running. The cooling system coolant shall use a combination of water and ethylene-glycol sufficient for freeze protection at the minimum winter outdoor temperature specified. The maximum temperature rise of the coolant across each engine shall not exceed that recommended and submitted in paragraph SUBMITTALS.

2.5.1 Coolant Pumps

Coolant pumps shall be the centrifugal type. Each engine shall have an engine-driven primary pump.

2.5.2 Fin-Tube-Type Heat Exchanger (Radiator)

Heat exchanger may be factory coated with corrosive resistant film, provided that correction measures are taken to restore the heat rejection capability of the radiator to the initial design requirement via over sizing, or other compensating methods. Internal surfaces shall be compatible with liquid fluid coolant used. Materials and coolant are subject to approval by the Contracting Officer. Heat exchangers shall be pressure type incorporating a pressure valve, vacuum valve and a cap. Caps shall be designed for pressure relief prior to removal. Each heat exchanger and the entire cooling system shall be capable of withstanding a minimum pressure of 48 kPa and shall be protected with a strong grille or screen guard. Each heat exchanger shall have at least two tapped holes; one tapped hole shall be equipped with a drain cock, the rest shall be plugged.

2.5.3 Thermostatic Control Valve

A modulating type, thermostatic control valve shall be provided in the coolant system to maintain the coolant temperature range submitted in paragraph SUBMITTALS.

2.5.4 Temperature Sensors

Each engine shall be equipped with coolant temperature sensors. Temperature sensors shall provide signals for pre-high and high indication and alarms.

2.6 AIR INTAKE EQUIPMENT

Filters shall be provided in locations that are convenient for servicing. Provide enclosure with supply side 50 MM thick, high velocity, washable, zinc steel mechanical screen type air filter. Filter initial efficiency of 80 percent per UL Class I. Modify enclosure to accept air filters.

2.6.1 Sound Limitations

Sound Limitations shall be per the following table under the heading:

Frequency Band (Hz)	Maximum Acceptable Sound Level (Decibels)	
	Industrial	Residential
20-75	87	81
75-150	77	71
150-300	70	64
300-600	64	58
600-1,200	61	55
1,200-2,400	60	54
2,400-4,800	60	54
4,800-10 kHz	62	56

2.7 EXHAUST SYSTEM

The system shall be separate and complete for each engine. Piping shall be supported to minimize vibration. Where a V-type engine is provided, a V-type connector, with necessary flexible sections and hardware, shall connect the engine exhaust outlets.

2.7.1 Flexible Sections and Expansion Joints

A flexible section shall be provided at each engine and an expansion joint at each muffler. Flexible sections and expansion joints shall have flanged connections. Flexible sections shall be made of convoluted seamless tube without joints or packing. Expansion joints shall be the bellows type. Expansion and flexible elements shall be stainless steel suitable for diesel-engine exhaust gas at the maximum exhaust temperature that is specified by the engine manufacturer. Expansion and flexible elements shall be capable of absorbing vibration from the engine and compensation for thermal expansion and contraction.

2.7.2 Exhaust Muffler

A chamber type exhaust muffler shall be provided. The muffler shall be constructed of welded steel and designed for outside mounting. Eyebolts, lugs, flanges, or other items shall be provided as necessary for support in the location and position indicated. Pressure drop through the muffler shall not exceed the recommendations of the engine manufacturer. Outside mufflers shall be zinc coated or painted with high temperature 540 C degrees resisting paint. The muffler and exhaust piping together shall reduce the noise level to less than the maximum acceptable level listed for sound limitations in paragraph SOUND LIMITATIONS. The muffler shall have a drain valve, nipple, and cap at the low-point of the muffler.

2.7.3 Exhaust Piping

Horizontal sections of exhaust piping shall be sloped downward away from the engine to a drip leg for collection of condensate with drain valve and cap. Changes in direction shall be long radius. Exhaust piping, mufflers and silencers shall be insulated in accordance with specification Section 23 07 00, "THERMAL INSULATION FOR MECHANICAL SYSTEMS" and covered to protect personnel. Vertical exhaust piping shall be provided with a hinged, gravity-operated, self-closing, rain cover.

2.8 EMISSIONS

The finished installation shall comply with Federal, state, and local regulations and restrictions regarding the limits of emissions, as listed.

2.9 STARTING SYSTEM

The starting system for engine generator sets used in non-emergency applications shall be as follows.

2.9.1 Controls

An engine control switch shall be provided with functions including: run/start(manual), off/reset, and, automatic mode. Start-stop logic shall be provided for adjustable cycle cranking and cool down operation. The logic shall be arranged for manual starting. Electrical starting systems shall be provided with an adjustable cranking limit device to limit cranking periods from 1 second up to the maximum duration.

2.9.2 Capacity

The starting system shall be of sufficient capacity, at the maximum outdoor summer temperature specified to crank the engine without damage or overheating. The system shall be capable of providing a minimum of three cranking periods with 15 second intervals between cranks. Each cranking period shall have a maximum duration of 15 seconds.

2.9.3 Electrical Starting

Manufacturers recommended dc system, utilizing a negative circuit ground.

2.9.3.1 Battery

A starting battery system shall be provided and shall include the battery, intercell connectors, spacers, automatic battery charger with over-current protection, metering and relaying. The battery shall be in accordance with SAE J537. Critical system components shall be sized to withstand the seismic acceleration forces specified. The battery shall be lead-acid, with sufficient capacity, at the minimum outdoor and maximum outdoor temperature specified, to provide the specified cranking periods. Valve-regulated lead-acid batteries are not acceptable. Furnish spare set of starting batteries for each generator.

2.9.3.2 Battery Charger

A current-limiting battery charger, conforming to UL 1236, shall be provided and shall automatically recharge the batteries. The charger shall be capable of an equalize-charging rate which is manually adjustable in a continuous range and a floating charge rate for maintaining the batteries at fully charged condition. An ammeter shall be provided to indicate charging rate. A voltmeter shall be provided to indicate charging voltage. A timer shall be provided for the equalize-charging-rate setting. A battery is considered to be fully depleted when the output voltage falls to a value which will not operate the engine generator set and its components.

2.9.4 Starting Aids

The manufacturer shall provide one or more of other following methods to assist engine starting.

2.9.4.1 Glow Plugs

Glow plugs shall be designed to provide sufficient heat for combustion of fuel within the cylinders to guarantee starting at an ambient temperature of -32 degrees C.

2.9.4.2 Jacket-Coolant Heaters

A thermostatically controlled electric heater shall be mounted in the engine coolant jacketing to automatically maintain the coolant within plus or minus 1.7 degrees C of the control temperature. The heater shall operate independently of engine operation so that starting times are minimized. Power for the heaters shall be 220 volts ac.

Prime Rated Sets: The control temperature shall be the higher of the manufacturer's recommended temperature or the minimum coolant inlet temperature of the engine recommended in paragraph SUBMITTALS.

The control temperature shall be the higher of the manufacturer's recommended temperature or the minimum coolant inlet temperature of the engine recommended in paragraph SUBMITTALS.

2.10 GOVERNOR

Each engine shall be provided with a governor which maintains the frequency within a bandwidth of the rated frequency, over a steady-state load range of zero to 100% of rated output capacity. The governor shall be configured for safe manual adjustment of the speed/frequency during operation of the engine-generator set, without special tools, from 90 to 110% of the rated speed/frequency, over a steady state load range of 0 to 100% or rated capacity. Isochronous governors shall maintain the midpoint of the frequency bandwidth at the same value for steady-state loads over the range of zero to 100% of rated output capacity. Droop governors shall maintain the midpoint of the frequency bandwidth linearly for steady-state loads over the range of zero to 100 percent of rated output capacity, with 3 percent droop.

2.11 GENERATOR

Each generator shall be of the synchronous type, one or two bearing, conforming to the performance criteria in NEMA MG 1, equipped with winding terminal housings in accordance with NEMA MG 1, equipped with an amortisseur winding, and directly connected to the engine. Insulation shall be Class F. Generator design shall protect against mechanical, electrical and thermal damage due to vibration, 25% overspeeds, or voltages and temperatures at a rated output capacity of 110% for prime applications and 100% for standby applications. Generator ancillary equipment shall meet the short circuit requirements of NEMA MG 1. Frames shall be the drip-proof type.

2.11.1 Current Balance

At 100% rated output capacity, and load impedance equal for each of the 3 phases, the permissible current difference between any 2 phases shall not exceed 2% of the largest current on either of the 2 phases.

2.11.2 Voltage Balance

At any balanced load between 75 and 100% of rated output capacity, the difference in line-to-neutral voltage among the 3 phases shall not exceed 1% of the average line-to-neutral voltage. For a single-phase load condition, consisting of 25% load at unity power factor placed between any phase and neutral with no load on the other 2 phases, the maximum simultaneous difference in line-to-neutral voltage between the phases shall not exceed 3% of rated line to neutral voltage. The single-phase load requirement shall be valid utilizing normal exciter and regulator control. The interpretation of the 25% load for single phase load conditions means 25% of rated current at rated phase voltage and unity power factor.

2.11.3 Waveform

The deviation factor of the line-to-line voltage at zero load and at balanced rated output capacity shall not exceed 10%. The RMS of all harmonics shall be less than 5.0% and that of any one harmonic less than 3.0% of the fundamental at rated output capacity. Each engine-generator shall be designed and configured to meet the total harmonic distortion limits of IEEE Std 519.

2.12 EXCITER

The generator exciter shall be of the brushless type. Semiconductor rectifiers shall have a minimum safety factor of 300% for peak inverse voltage and forward current ratings for all operating conditions, including 110% generator output at 4O degrees C ambient. The exciter and regulator in combination shall maintain generator-output voltage within the limits specified.

2.13 GENERATOR ISOLATION AND PROTECTION

Devices necessary for electrical protection and isolation of each engine-generator set and its ancillary equipment shall be provided. The generator circuit breaker (IEEE Device 52) ratings shall be consistent with the generator rated voltage and frequency, with continuous, short circuit withstand, and interrupting current ratings to match the generator capacity. The generator circuit breaker shall be manually operated. A set of surge capacitors, to be mounted at the generator terminals shall be provided.

2.14 SAFETY SYSTEM

2.14.1 Audible Signal

The audible alarm signal shall sound at a frequency of 70 Hz at a volume of 75 dB at 3.1 m. The sound shall be continuously activated upon alarm and silenced upon acknowledgment. Signal devices shall be located as shown.

2.14.2 Visual Signal

The visual alarm signal shall be a panel light. The light shall be normally off, activated to be blinking upon alarm. The light shall change to continuously lit upon acknowledgement. If automatic shutdown occurs, the display shall maintain activated status to indicate the cause of failure and shall not be reset until cause of alarm has been cleared and/or restored to normal condition. Shutdown alarms shall be red; all other alarms shall be amber.

2.14.3 Local Alarm Panel

A local alarm panel shall be provided with the following shutdown and alarm functions.

Device/Condition	What/Where/Size	NFPA 99	/Function
Shutdowns w/Alarms			
High engine temperature	Automatic/jacket/ water/cylinder	SD/CP VA	SD/CP VA
Low lube-oil pressure	Automatic/pressure/ level	SD/CP VA	SD/CP VA
Overspeed Shutdown& Alarm	(110 percent (± 2 % of rated speed)	SD/CP VA	
Overcrank, Failure to start	Automatic/Failure to start when used	SD/CP VA	SD/CP VA SD/CP VA
Red emergency stop switch	Manual Switch		SD/CP VA
Alarms			
Low fuel level	Main tank, 3 hrs remaining	VA/AA	CP VA
Low Coolant Temperature	jacket water	CP VA	CP VA
Pre-High Temperature	jacket water/ cylinder	CP VA	CP VA
Pre-Low Lube-oil Pressure		CP VA	
High battery Voltage			
Low battery Voltage			
Battery charger AC Failure	AC supply not available		

2.14.4 Time-Delay on Alarms

For startup of the engine-generator set, time-delay devices shall be installed bypassing the low lubricating oil pressure alarm during cranking, and the coolant-fluid outlet temperature alarm. The lube-oil time-delay device shall return its alarm to normal status after the engine starts. The

coolant time-delay device shall return its alarm to normal status 5 minutes after the engine starts.

2.15 ENGINE GENERATOR SET CONTROLS AND INSTRUMENTATION

Devices, wiring, remote panels, local panels, etc. shall be provided and installed as a complete system to automatically activate the appropriate signals and initiate the appropriate actions.

2.15.1 Controls

A local control panel shall be provided with controls mounted on or adjacent to the engine generator set.

Device/Condition/ Function	Corps Requirement
Controls	
Switch: run/start - off/reset - auto	CP
Emergency stop switch & alarm	CP
Lamp test/indicator test	CP
Common alarm contacts/ fault relay	
Panel lighting	CP
Audible alarm & silencing/reset switch	CP
Voltage adjust for voltage regulator	CP
Remote emergency stop Switch	

2.22 PANELS

Each panel shall be of the type and kind necessary to provide specified functions. Panels shall be mounted on the engine-generator set base by vibration/shock absorbing type mountings. Instruments shall be mounted flush or semiflush. Convenient access to the back of panels shall be provided to facilitate maintenance. Instruments shall be calibrated using recognized industry calibration standards. Each panel shall be provided with a panel identification plate which clearly identifies the panel function. Each instrument and device on the panel shall be provided with a plate which clearly identifies the device and its function as indicated. Switch plates shall clearly identify the switch-position function.

2.22.1 Enclosures

Enclosures shall be designed for the application and environment, conforming to NEMA ICS 6. Locking mechanisms shall be keyed alike.

2.22.2 Analog

Analog electrical indicating instruments shall be in accordance with ANSI C39.1 with semiflush mounting. Switchboard, switchgear, and control-room panel-mounted instruments shall have 250 degree scales with an accuracy of

not less than 99 percent. Unit-mounted instruments shall be the manufacturer's standard with an accuracy of not less than 98 percent. The instrument's operating temperature range shall be minus 20 to plus 65 degrees C. Distorted generator output voltage waveform of a crest factor less than 5 shall not affect metering accuracy for phase voltages, hertz and amps.

2.22.3 Electronic
Electronic indicating instruments shall be true RMS indicating instruments, 100 percent solid state, state-of-the-art, microprocessor controlled to provide specified functions. Control, logic, and function devices shall be compatible as a system, sealed, dust and water tight, and shall utilize modular components with metal housings and digital instrumentation. An interface module shall be provided to decode serial link data from the electronic panel and translate alarm, fault and status conditions to set of relay contacts. Instrument accuracy shall be not less than 98 percent for unit mounted devices and 99 percent for control room, panel mounted devices, throughout a temperature range of minus 20 to plus 65 degrees C. Data display shall utilize LED or back lit LCD. Additionally, the display shall provide indication of cycle programming and diagnostic codes for troubleshooting. Numeral height shall be 13mm.

2.22.4 Parameter Display
Indication or readouts of the tachometer, lubricating-oil pressure, ac voltmeter, ac ammeter, frequency meter, and safety system parameters shall be provided. A momentary switch shall be specified for other panels.

2.24 MANUAL ENGINE-GENERATOR-SET SYSTEM OPERATION

Complete facilities shall be provided for manual starting and testing of each set without load, loading and unloading of each set, and synchronization of each set with an energized bus.

2.26 BASE
The base shall be constructed of steel. The base shall be designed to rigidly support the engine-generator set, ensure permanent alignment of rotating parts, be arranged to provide easy access to allow changing of lube-oil, and ensure that alignment is maintained during shipping and normal operation. The base shall permit skidding in any direction during installation and shall withstand and mitigate the effects of synchronous vibration of the engine and generator. The base shall be provided with suitable holes for anchor bolts and jacking screws for leveling.

2.28 PAINTING AND FINISHING
The engine-generator set shall be cleaned, primed and painted in accordance with the manufacturer's standard color and practice.
2.29 FACTORY INSPECTION AND TESTS

Perform the factory tests on each engine-generator set. The component manufacturer's production line test is acceptable as noted. Each engine-generator set shall be run not less than 1 hour at rated output capacity prior to inspections. Inspections shall be completed and all necessary repairs made, prior to testing. Engine generator controls and protective devices that are provided by the generator set manufacturer as part of the standard package shall be used for factory tests. When controls and switchgear are not provided as part of the generator set manufacturer's standard package, the actual controls and protective devices provided for the

project are not required to be used during the factory test. The Contracting Officer may provide one or more representatives to witness inspections and tests.

2.29.1 Factory Inspection

Inspections shall be performed prior to beginning and after completion of testing of the assembled engine-generator set. Inspectors shall look for leaks, looseness, defects in components, proper assembly, etc. and any item found to be in need of correction shall be noted as a necessary repair. The following checklist shall be used for the inspection:

INSPECTION ITEM GOOD BAD NOTES

1. Drive belts
2. Governor and adjustments
3. Engine timing mark
4. Starting motor
5. Starting aids
6. Coolant type and concentration
7. Radiator drains
8. Block coolant drains
9. Coolant fill level
10. All coolant line connections
11. All coolant hoses
12. Combustion air filter
13. Combustion air silencer
14. Lube oil type
15. Lube oil sump drain
16. Lube-oil filter
17. Lube-oil-level indicator
18. Lube-oil-fill level
19. All lube-oil line connections
20. All lube-oil lines
21. Fuel type and amount
22. All fuel-line connections
23. All fuel lines
24. Fuel filter
25. Coupling and shaft alignment
26. Voltage regulators
27. Battery-charger connections
28. All wiring connections
29. Instrumentation
30. Hazards to personnel
31. Base
32. Nameplates
33. Paint
34. Exhaust-heat recovery unit
35. Switchboard
36. Switchgear

2.29.2 Factory Tests

On engine-generator set tests where the engine and generator are required to be connected and operated together, the load power factor shall be 0.8 power factor. Electrical measurements shall be performed in accordance with IEEE Std 120. Definitions of terms are in accordance with IEEE Std 100. Temperature limits in the rating of electrical equipment and for the evaluation of electrical insulation shall be in

accordance with IEEE Std 1. In the following tests where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. Tests specifically for the generator may be performed utilizing any prime mover.

a. Insulation Resistance for Stator and Exciter Test, IEEE Std 115 and IEEE Std 43, to the performance criteria in NEMA MG 1, Part 22. Generator manufacturer's production line test is acceptable.

b. High Potential Test, in accordance with IEEE Std 115 and NEMA MG 1, test voltage in accordance with NEMA MG 1. Generator manufacturer's production line test is acceptable.

c. Winding Resistance Test, Stator and Exciter, in accordance with IEEE Std 115. Generator manufacturer's production line test is acceptable.

d. Overspeed Vibration Test, in accordance with IEEE Std 115 to the performance criteria in NEMA MG 1. The test shall be performed at 110 percent of rated speed for 5 minutes. The vibration shall be measured at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Vibration amplitude and speed shall be recorded at one minute intervals.

e. Phase Balance Voltage Test, to the performance criteria specified in paragraph GENERATOR. This test can be performed with any prime mover. Generator manufacturer's production line test results are acceptable.

(1) Start and operate the generator at no load.

(2) Adjust a regulated phase voltage (line-to-neutral) to rated voltage.

(3) Read and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(4) Apply 75 percent rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(5) Apply rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(6) Calculate average line-neutral voltage and percent deviation of individual line-neutral voltages from average for each load condition.

f. Current Balance on Stator Winding Test, by measuring the current on each phase of the winding with the generator operating at 100 percent of Rated Output Capacity, with

the load impedance equal for each of the three phases: to the performance criteria specified in paragraph GENERATOR.

g. Voltage Waveform Deviation and Distortion Test in accordance with IEEE Std 115 to the performance criteria specified in paragraph GENERATOR. High-speed recording instruments capable of recording voltage waveform deviation and all distortion, including harmonic distortion shall be used. Representation of results shall include appropriate scales to provide a means to measure and interpret results.

h. Voltage and Frequency Droop Test. Verify that the output voltage and frequency are within the specified parameters as follows:

(1.) With the generator operating at no load, adjust voltage and frequency to rated voltage and frequency. Record the generator output frequency and line-line and line-neutral voltages.

(2.) Increase load to Rated Output Capacity. Record the generator output frequency and line-line and line-neutral voltages.

(3.) Calculate the percent droop for voltage and frequency with the following equations:

$$Voltage\ droop\ percent = \frac{(No - Load\ Volts) - (Rated\ Capacity\ Volts\ )}{(Service - Load\ Volts)} x100$$

$$Frequency\ droop\ percent = \frac{(No - Load\ Hertz) - \ (Rated\ Capacity\ hertz)}{(Service - Load\ hertz)} x100$$

(4.) Repeat steps 1 through 3 two additional times without making any adjustments.

i. Frequency and Voltage Stability and Transient Response. Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Tabular data shall include the following:

1. Ambient temperature (at 15 minute intervals).

2. Generator output current (before and after load changes).

3. Generator output voltage (before and after load changes).

4. Frequency (before and after load changes).

5. Generator output power (before and after load changes).

6. Graphic representations shall include the actual instrument trace of voltage and frequency showing: charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

(1.) Perform and record engine manufacturer's recommended prestarting checks and inspections.

(2.) Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.

(3.) With the unit at no load, apply the Maximum Step Load Increase.

(4.) Apply load in steps equal to the Maximum Step Load Increase until the addition of one more step increase will exceed the Service Load.

(5.) Decrease load to the unit such that addition of the Maximum Step Load Increase will load the unit to 100 percent of Service Load.

(6.) Apply the Maximum Step Load Increase.

(7.) Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.

(8.) Repeat steps 3. through 7.

j. Test Voltage Unbalance with Unbalanced Load (Line-to-Neutral) to the performance criteria specified in paragraph GENERATOR. Prototype test data is acceptable in lieu of the actual test. This test may be performed using any prime mover.

(1.) Start and operate the generator set at rate voltage, no load, rated frequency, and under control of the voltage regulator. Read and

record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(2.) Apply the specified load between terminals L_1-L_2, L_2-L_0, and L_3-L_0 in turn. Record all instrument readings at each line-neutral condition.

(3.) Express the greatest difference between any two of the line-to-line voltages and any two of the line-to-neutral voltages as a percent of rated voltage.

(4.) Compare the largest differences expressed in percent with the maximum allowable difference specified.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION

Installation shall provide clear space for operation and maintenance in accordance with NFPA 70 and IEEE C2. Installation of pipe, duct, conduit, and ancillary equipment shall be configured to facilitate easy removal and replacement of major components and parts of the engine-generator set.

3.2 PIPING INSTALLATION

Piping shall be welded. Connections at valves shall be flanged. Connections at equipment shall be flanged except that connections to the diesel engine may be threaded if the diesel-engine manufacturers standard connection is threaded. Except where otherwise specified, welded flanged fittings shall be utilized to allow for complete dismantling and removal of each piping system from the facility without disconnecting or removing any portion of any other system's equipment or piping. Connections to equipment shall be made with vibration-isolation-type flexible connectors. Piping and tubing shall be supported and aligned to prevent stressing of flexible hoses and connectors. Pipes extending through the roof shall be properly flashed. Piping shall be installed clear of windows, doors and openings, to permit thermal expansion and contraction without damage to joints or hangers, and shall be installed with a 13 mm drain valve with cap at each low point.

3.2.1 Support

Hangers, inserts, and supports shall be of sufficient size to accommodate any insulation and shall conform to MSS SP-58 and MSS SP-69. Supports shall be spaced not more than 2.1 m on center for pipes 50 mm in diameter or less, not more than 3.6 m on center for pipes larger than 50 mm but smaller than 100 mm in diameter, and not more than 5.2 m on center for pipes larger than 100 mm in diameter. Supports shall be provided at pipe bends or change of direction.

3.2.1.1 Ceiling and Roof

Exhaust piping shall be supported with appropriately sized Type 41 single pipe roll and threaded rods; all other piping shall be supported with appropriately sized Type 1 clevis and threaded rods.

3.2.1.2 Wall

Wall supports for pipe shall be made by suspending the pipe from appropriately sized Type 33 brackets with the appropriate ceiling and roof pipe supports.

3.2.2 Flanged Joints

Flanges shall be Class 125 type, drilled, and of the proper size and configuration to match the equipment and diesel engine connections. Flanged joints shall be gasketed and made up square and tight.

3.2.3 Cleaning

After fabrication and before assembly, piping interiors shall be manually wiped clean of debris.

3.2.4 Pipe Sleeves

Pipes passing through construction such as ceilings, floors, or walls shall be fitted with sleeves. Each sleeve shall extend through and be securely fastened in its respective structure and shall be cut flush with each surface. The structure shall be built tightly to the sleeve. The inside diameter of each sleeve shall be minimum 13 mm, and where pipes pass through combustible materials 25 mm larger than the outside diameter of the passing pipe or pipe insulation/covering.

3.3 ELECTRICAL INSTALLATION

Electrical installation shall comply with NFPA 70, IEEE C2, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. For vibration isolation, flexible fittings shall be provided for conduit, and raceways attached to engine-generator sets; metallic conductor cables installed on the engine generator set and from the engine generator set to equipment not mounted on the engine generator set shall be flexible stranded conductor; and terminations of conductors on the engine generator set shall be crimp-type terminals or lugs.

3.4 FIELD PAINTING

Field painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.5 ONSITE INSPECTION AND TESTS

3.5.1 Test Conditions

3.5.1.1 Data

Measurements shall be made and recorded of all parameters necessary to verify that each set meets specified parameters. If the results of any test step are not satisfactory, adjustments, replacements, or repairs shall be made and the step repeated until satisfactory results are obtained. Unless otherwise indicated, data shall be recorded in 15 minute intervals during engine-generator set operation and shall include: readings of all engine-generator set meters and gauges for electrical and power parameters; oil pressure; ambient temperature; and engine temperatures available from meters

and gauges supplied as permanent equipment on the engine-generator set. Electrical measurements shall be performed in accordance with IEEE Std 120. Definitions of terms are in accordance with IEEE Std 100. Temperature limits in the rating of electrical equipment and for the evaluation of electrical insulations shall be in accordance with IEEE Std 1.

3.5.1.2 Power Factor

For all engine-generator set operating tests the load power factor shall be the power factor specified in the engine-generator set parameter schedule.

3.5.1.3 Contractor Supplied Items

The Contractor shall provide equipment and supplies required for inspections and tests including fuel, test instruments, and loadbanks at the specified power factors.

3.5.1.4 Instruments

Readings of panel gauges, meters, displays, and instruments provided as permanent equipment shall be verified during test runs, using test instruments of greater precision and accuracy. Test instrument accuracy shall be within the following: current plus or minus 1.5%, voltage plus or minus 1.5%, real power plus or minus 1.5%, reactive power plus or minus 1.5%, power factor plus or minus 3%, frequency plus or minus 0.5%. Test instruments shall be calibrated by a recognized standards laboratory within 30 days prior to testing.

3.5.1.5 Sequence

The sequence of testing shall be as specified in the approved testing plan unless variance is authorized by the Contracting Officer. Field testing shall be performed in the presence of the Contracting Officer. Tests may be scheduled and sequenced in order to optimize run-time periods; however, the following general order of testing shall be followed: Construction Tests; Inspections; Pre-operational Tests; Safety Run Tests; Performance Tests; and Final Inspection.

3.5.2 Construction Tests

Individual component and equipment functional tests for fuel piping, coolant piping, and lubricating-oil piping, electrical circuit continuity, insulation resistance, circuit protective devices, and equipment not provided by the engine-generator set manufacturer shall be performed prior to connection to the engine-generator set.

3.5.2.1 Piping Test

a. Lube-oil and fuel-oil piping shall be flushed with the same type of fluid intended to flow through the piping, until the outflowing fluid has no obvious sediment or emulsion.

b. Fuel piping which is external to the engine-generator set shall be tested in accordance with NFPA 30. All remaining piping which is external to the engine-generator set shall be pressure tested with air pressure at 150% of the maximum anticipated working pressure, but not less than 1.03 MPa, for a period of 2 hours to prove the

piping has no leaks. If piping is to be insulated, the test shall be performed before the insulation is applied.

3.5.2.2 Electrical Equipment Tests

a. Low-voltage cable insulation integrity tests shall be performed for cables connecting the generator breaker. Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energizing. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

R in megohms = (rated voltage in kV + 1) x 304,800/(length of cable in meters)

R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet)

Each cable failing this test shall be repaired or replaced. The repair cable shall be retested until failures have been eliminated.

3.5.3 Inspections

The following inspections shall be performed jointly by the Contracting Officer and the Contractor, after complete installation of each engine-generator set and its associated equipment, and prior to startup of the engine-generator set. Checks applicable to the installation shall be performed. The results of those which are physical inspections (I) shall be documented by the Contractor and submitted in accordance with paragraph SUBMITTALS. The Contractor shall present manufacturer's data for the inspections designated (D) at the time of inspection. Inspections shall verify that equipment type, features, accessibility, installation and condition are in accordance with the contract specification. Manufacturer's statements shall certify provision of features which cannot be verified visually.

1.	Drive belts.	(I)
2.	Governor type and features.	(I)
3.	Engine timing mark.	(I)
4.	Starting motor.	(I)
5.	Starting aids.	(I)
6.	Coolant type and concentration.	(D)
7.	Radiator drains.	(I)
8.	Block coolant drains.	(I)
9.	Coolant fill level.	(I)
10.	Coolant line connections.	(I)
11.	Coolant hoses.	(I)
12.	Combustion air filter.	(I)
13.	Intake air silencer.	(I)
14.	Lube oil type.	(D)
15.	Lube oil sump drain.	(I)
16.	Lube-oil filter.	(I)
17.	Lube-oil level indicator.	(I)

18. Lube-oil fill level. (I)
19. Lube-oil line connections. (I)
20. Lube-oil lines. (I)
21. Fuel type. (D)
22. Fuel-level. (I)
23. Fuel-line connections. (I)
24. Fuel lines. (I)
25. Fuel filter. (I)
26. Access for maintenance. (I)
27. Voltage regulator. (I)
28. Battery-charger connections. (I)
29. Wiring & terminations. (I)
30. Instrumentation. (I)
31. Hazards to personnel. (I)
32. Base. (I)
33. Nameplates. (I)
34. Paint. (I)
35. Exhaust-heat system. (I)
36. Exhaust muffler. (I)
37. Switchboard. (I)
38. Switchgear. (I)
39. Access provided to controls. (I)
40. Enclosure is weather resistant. (I)
41. Engine & generator mounting bolts (application). (I)

3.5.4 Pre-operational Tests

3.5.4.1 Protective Relays

Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Relay settings shall be implemented in accordance with the installation coordination study. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers shall be field tested in accordance with IEEE C57.13.1.

3.5.4.2 Insulation Test

Generator and exciter circuits insulation resistance shall be tested in accordance with IEEE Std 43. Results of insulation resistance tests shall be recorded. Readings shall be within limits specified by the manufacturer. Mechanical operation, insulation resistance, protective relay calibration and operation, and wiring continuity of assembly shall be verified. Precautions shall be taken to preclude damaging generator components during test.

3.5.4.3 Engine-Generator Connection Coupling Test

When the generator provided is a two-bearing machine, the engine-generator connection coupling shall be inspected and checked by dial indicator to prove that no misalignment has occurred. The dial indicator shall measure variation in radial positioning and axial clearance between the coupling halves. Readings shall be taken at four points, spaced 90 degrees apart. Solid couplings and pin-type flexible couplings shall be aligned within a

total indicator reading of 0.012 to 0.025 mm for both parallel and angular misalignment. For gear-type or grid-type couplings, 0.05 mm will be acceptable.

3.5.5 Safety Run Test

For the following tests, if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries, the associated safety tests shall be repeated.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections.

b. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

c. Activate the manual emergency stop switch and verify that the engine stops.

d. Remove the high and pre-high lubricating oil temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.

e. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine-generator set at no load until the output voltage and frequency stabilize. Monitor the temporarily installed temperature gauges. If either temperature reading exceeds the value required for an alarm condition, activate the manual emergency stop switch.

f. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

g. Remove the high and pre-high coolant temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.

h. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine generator-set at no load until the output voltage and frequency stabilize.

i. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down.

Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

j. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

k. Operate the engine generator-set for at least 2 hours at 75% of Service Load.

l. Verify proper operation and set points of gauges and instruments.

m. Verify proper operation of ancillary equipment.

n. Manually adjust the governor to increase engine speed past the overspeed limit. Record the RPM at which the engine shuts down.

o. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75% of Service Load.

p. Manually adjust the governor to increase engine speed to within 2% of the overspeed trip speed previously determined and operate at that point for 5 minutes. Manually adjust the governor to the rated frequency.

q. Shut down the engine. Remove the time-delay low lube oil pressure alarm bypass and try to start the engine.

r. Attach a manifold to the engine oil system (at the oil pressure sensor port) that contains a shutoff valve in series with a connection for the engine's oil pressure sensor followed by an oil pressure gauge ending with a bleed valve. The engine's oil pressure sensor shall be moved from the engine to the manifold. The manifold shutoff valve shall be open and bleed valve closed.

s. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75% of Service Load.

t. Close the manifold shutoff valve. Slowly allow the pressure in the manifold to bleed off through the bleed valve while watching the pressure gauge. Record the pressure at which the engine shuts down. Catch oil spillage from the bleed valve in a container. Add the oil from the container back to the engine, remove the manifold, and reinstall the engine's oil pressure sensor on the engine.

u. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 100% of Service Load. Record the maximum sound level in each frequency band at a distance of 22.9 m from the end of the exhaust and air intake piping directly along the path of intake and discharge for horizontal piping; or at a radius of 22.9 m from the engine at 45 degrees apart in all directions for vertical piping. If a sound

limiting enclosure is not provided, the muffler and air intake silencer shall be modified or replaced as required to meet the sound limitations of this specification. If the sound limitations can not be obtained by modifying or replacing the muffler and air intake silencer, the Contractor shall notify the Contracting Officers Representative and provide a recommendation for meeting the sound limitations.

3.5.6 Performance Tests

In the following tests, where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. For the following tests, if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries, the associated tests shall be repeated.

3.5.6.1 Continuous Engine Load Run Test

Test the engine-generator set and ancillary systems at service load to demonstrate durability; verify that heat of extended operation does not adversely affect or cause failure in any part of the system; and check all parts of the system. If the engine load run test is interrupted for any reason, the entire test shall be repeated. The engine load run test shall be accomplished principally during daylight hours, with an average ambient temperature of 22 degrees C, during the month of June. After each change in load in the following test, measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the allowable range. Data taken at 15 minute intervals shall include the following:

Electrical: Output amperes, voltage, real and reactive power, power factor, frequency.

Pressure: Lube-oil.

Temperature: Coolant.
Lube-oil.
Exhaust.
Ambient.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections. Include as a minimum checking of coolant fluid, fuel, and lube-oil levels.

b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warmup period.

c. Operate the engine generator-set for 2 hours at 75% of Service Load.

d. Increase load to 100% of Service Load and operate the engine generator-set for 4 hours.

e. For prime rated units, increase load to 110% of Service Load and operate the engine generator-set for 2 hours.

f. Decrease load to 100% of Service Load and operate the engine generator-set for 2 hours or until all temperatures have stabilized.

g. Remove load from the engine-generator set.

3.5.6.2 Voltage and Frequency Droop Test

For the following steps, verify that the output voltage and frequency return to and stabilize within the specified bandwidth values following each load change. Record the generator output frequency and line-line and line-neutral voltages following each load change.

a. With the generator operating at no load, adjust voltage and frequency to rated voltage and frequency.

b. Increase load to 100% of Rated Output Capacity. Record the generator output frequency and line-line and line-neutral voltages.

c. Calculate the percent droop for voltage and frequency with the following equations.

$$\text{Voltage droop \%} = \frac{\text{No-load volts - rated output capacity volts}}{\text{Rated output capacity volts}} \times 100$$

$$\text{Frequency droop \%} = \frac{\text{No load hertz - rated output capacity hertz}}{\text{Rated output capacity volts}} \times 100$$

d. Repeat steps a. through c. two additional times without making any adjustments.

3.5.6.3 Voltage Regulator Range Test

a. While operating at no load, verify that the voltage regulator adjusts from 90% to 110% of rated voltage.

b. Increase load to 100% of Rated Output Capacity. Verify that the voltage regulator adjusts from 90% to 110% of rated voltage.

3.5.6.4 Governor Adjustment Range Test

a. While operating at no load, verify that the governor adjusts from 90% to 110% of rated frequency.

b. Increase load to 100% of Rated Output Capacity. Verify that the governor adjusts from 90% to 110% of rated frequency.

3.5.6.5 Frequency and Voltage Stability and Transient Response

Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify

that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Tabular data shall include the following:

(1.) Ambient temperature (at 15 minute intervals).

(2.) Generator output current (before and after load changes).

(3.) Generator output voltage (before and after load changes).

(4.) Frequency (before and after load changes).

(5.) Generator output power (before and after load changes.

(6.) Graphic representations shall include the actual instrument trace of voltage and frequency showing:

Charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections.

b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.

c. With the unit at no load, apply the Maximum Step Load Increase.

d. Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.

e. Repeat steps c. and d.

3.5.7 Automatic Operation Tests for Stand-Alone Operation

The automatic loading system shall be tested to demonstrate loading and unloading of each engine-generator set. The loads for this test shall utilize the actual loads to be served, and the loading sequence shall be the indicated sequence. Perform this test for a minimum of two successive, successful tests. Data taken shall include the following:

(1.) Ambient temperature (at 15 minute intervals).

(2.) Generator output current (before and after load changes).

(3.) Generator output voltage (before and after load changes).

(4.) Generator output frequency (before and after load changes).

a. Initiate loss of the primary power source and verify automatic sequence of operation.

b. Restore the primary power source and verify sequence of operation.

c. Verify resetting of controls to normal.

3.5.8 Fuel Consumption Tests

Fuel consumption tests to confirm the manufacturer's certified rates shall be performed on engine generator set and the results tabulated and averaged. Fuel consumption tests shall be conducted under the direct supervision of the engine manufacturer's representative. Fuel consumption readings shall be taken at 15 minute intervals, over a minimum period of 1 hour at 50% Service Load, 1 hour at 75% Service Load, and 4 hours at 100% Service Load. Fuel consumption data may be taken during the 75% load test and 100% load tests. Fuel consumption readings at site conditions shall be correlated to the guarantee-baseline conditions. Test report shall contain: readings of the output frequency, voltage, current, power factor, and power; barometric pressure; ambient temperature; intake-air temperature; fuel temperature; the site fuel consumption readings, adjustment calculations, factors, and source references for correlation of actual consumption rate of the guaranteed rate.

a. Start and operate the generator set and allow it to stabilize at rated load, rated voltage and rated frequency. During this period, readings of all instruments including thermal instrumentation shall be recorded at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and rated frequency. However, adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On generator sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to the load, voltage or frequency controls shall be recorded on the data sheet. Unless otherwise specified in the procurement document, stabilization will be consideration to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage or frequency has been made.

b. Perform one of the following procedures:

BALANCE SCALE PROCEDURE.

(1.) Supply fuel from auxiliary container mounted on a balance scale.

(2.) After stabilization has occurred, set the balance weights at any convenient value slightly less than the total weight of the fuel and container.

(3.) Start the stopwatch when the balance weights fall and record the total weight.

(4.) Reduce the balance weight a convenient amount and record the amount of the weights removed.

(5.) Stop the stopwatch when the balance weights fall and record the total weight and the elapsed time.

(6.) Repeat steps (1) thru (2) above until the timed portion of the test exceeds the 2 hours.

(7.) From the total elapsed time and total of the weights removed calculate the fuel consumption in terms of pounds per hour.

(8.) Using the value obtained in step (7) above, compute the rate of fuel consumption per kilowatt hour, as follows:

$$\text{Pounds per kWH} = \frac{\text{Fuel Consumption in Pounds per Hour}}{\text{kW Load}}$$

(9.) Repeat the test for each load condition specified.

(10.) Determine the capacity of the generator set fuel tank in pounds of fuel.

(11.) For each specified load, compute the number of continuous hours the generator set will operate on a full tank of fuel. The following formula shall be used.

$$\text{Operating hours} = \frac{\text{Fuel Tank Capacity (Pounds)}}{\text{Fuel Consumption (Pounds per hour)}}$$

ALTERNATE PROCEDURE FOR WEIGHING FUEL

(1.) Supply fuel from the auxiliary fuel container, mounted on a platform balance, or other weighing device.

(2.) After stabilization has occurred, record weight readings every one-half hour for a period of 2 hours.

(3.) Calculate the average hourly fuel consumption rate in pounds per hour.

(4.) Using the average hourly fuel consumption rate obtained above, compute the rate of fuel consumption per kilowatt hour, as follows:

$$\text{Pounds per kWH} = \frac{\text{Fuel Consumption}}{\text{kW Load}}$$

(5.) Repeat test for each load condition specified.

(6.) Determine the capacity of the generator set fuel tank in pounds of fuel.

(7.) for each specified load test, compute the number of continuous ours the generator set will operate on a full tank of fuel. The following formula shall be used:

$$\text{Operating Hours} = \frac{\text{Fuel Tank Capacity (Pounds)}}{\text{Fuel Consumption (Pounds per Hour)}}$$

ALTERNATE PROCEDURE USING FLOWMETER.

Flowmeters may be used to determine the fuel rate. They usually are calibrated in either gallons per hour, or pounds per hour, for a fuel of a definite specific gravity and temperature.

(1.) After stabilization has occurred record the fuel consumption rate, and continue to record the fuel consumption rate at one-half hour intervals for 2 hours.

(2.) Determine the average of the readings (correct for fuel specific gravity and temperature). This is the fuel consumption rate and should be converted, if necessary, to pounds per hour.

(3.) Using the average value obtained above, calculate the rate of fuel consumption per kilowatt hour.

(4.) Repeat the test for each load condition specified.

(5.) Determine the capacity of the generator set fuel tank in pounds of fuel.

(6.) For each specified load test, compute the number of continuous hours the generator set will operate on a full tank of fuel. The following formula shall be used:

$$\text{Operating Hours} = \frac{\text{Fuel Tank Capacity (Pounds)}}{\text{Fuel Consumption (Pounds per Hour)}}$$

c. Results. Compare the operating hours or the fuel consumption rate per kWH.

3.5.9 Final Testing and Inspection

a. Start the engine, record the starting time, make and record all engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

b. Increase the load in steps no greater than the Maximum Step Load Increase to 100% of Service Load, and operate the engine-generator set for at least 30 minutes. Measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the same range as previous measurements and is within the required range.

c. Remove load and shut down the engine-generator set after the recommended cool down period.

d. Remove the lube oil filter and have the oil and filter examined by the engine manufacturer for excessive metal, abrasive foreign particles, etc. Any corrective action shall be verified for effectiveness by running the engine for 8 hours at Service Load, then re-examining the oil and filter.

e. Remove the fuel filter and examine the filter for trash, abrasive foreign particles, etc.

f. Visually inspect and check engine and generator mounting bolts for tightness and visible damage.

g. Replace air, oil, and fuel filters with new filters.

3.6 POSTED DATA AND INSTRUCTIONS

Posted Data and Instructions shall be posted prior to field acceptance testing of the engine generator set. Two sets of instructions/data shall be typed and framed under weatherproof laminated plastic, and posted side-by-side where directed. First set shall include a one-line diagram, wiring and control diagrams and a complete layout of the system. Second set of shall include the condensed operating instructions describing manufacturer's pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions.

3.7 ONSITE TRAINING

The Contractor shall conduct training course for operating staff as designated by the Contracting Officer. The training period shall consist of a total 4 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance. All operation and maintenance manuals shall bee approved and made available for the training course. All posted instructions shall be approved and posted prior to the beginning date of the training course. The training course schedule shall be coordinated with the Using Service's work schedule, and submitted for approval 14 days prior to beginning date of proposed beginning date of training. The course instructions shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate routine maintenance procedures as described in the operation and maintenance manuals.

3.8 ACCEPTANCE

Final acceptance of the engine-generator set will not be given until the Contractor has successfully completed all tests and all defects in installation material or operation have been corrected.

-- End of Section --

SECTION 26 41 00.00 20

LIGHTNING PROTECTION SYSTEM
04/06

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 C135.30	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)Normal Measurements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2007; AMD 1 2008) National Electrical Code - 2008 Edition
NFPA 780	(2007) Standard for the Installation of Lightning Protection Systems

UNDERWRITERS LABORATORIES (UL)

UL 467	(2007) Standard for Grounding and Bonding Equipment
UL 96	(2005) Standard for Lightning Protection Components
UL 96A	(2007) Standard for Installation Requirements for Lightning Protection Systems
UL Electrical Constructn	(2008) Electrical Construction Equipment Directory

1.1.1 EQUIVALENT REFERENCES

Equipment and material meeting standards that are deemed equivalent (by the Authority Having Jurisdiction) to the above referenced standards may be submitted for approval.

1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to this section with additions and modifications specified herein.

1.2.1 Verification of Dimensions

Contractor shall become familiar with all details of work, verify all dimensions in field, and shall advise Contracting Officer of any discrepancy before performing work. No departures shall be made without prior approval of Contracting Officer.

1.2.2 System Requirements

Materials shall consist of standard products of a manufacturer regularly engaged in production of lightning protection systems and shall be manufacturer's latest UL approved design. Lightning protection system shall conform to NFPA 70, NFPA 780, UL 96 and UL 96A.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overall lightning protection system; G

Each major component; G

SD-06 Test Reports

Grounding system test; G

Lightning protection system inspection;

1.4 QUALITY ASSURANCE

In each standard referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears. Interpret references in these standards to "authority having jurisdiction," or words of similar meaning, to mean Contracting Officer.

1.4.1 Installation Drawings

a. Submit installation shop drawing for the overall lightning protection system. Drawings shall include physical layout of the equipment, mounting details, relationship to other parts of the work, and wiring diagram.

b. Submit detail drawings for each major component to include manufacturer's descriptive and technical literature, catalog cuts, and installation instructions.

1.4.2 UL Listing or Label

Submit proof of compliance. Label of or listing in UL Electrical Construction is acceptable evidence. In lieu of label or listing, submit written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that items have been tested and conform to requirements and testing methods of Underwriters Laboratories.

1.5 SITE CONDITIONS

Contractor will become familiar with details of the work, verify dimensions in the field, and advise Contracting Officer of discrepancies before performing work. Deviations from contract drawings will not be made without prior approval of Contracting Officer.

PART 2 PRODUCTS

2.1 MATERIALS

Do not use a combination of materials that forms an electrolytic couple of such nature that corrosion is accelerated in presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, provide conductors with protective coatings or oversize conductors. Where mechanical hazard is involved, increase conductor size to compensate for hazard or protect conductors by covering them with molding or tubing made of wood or nonmagnetic material. When metallic conduit or tubing is provided, electrically bond conductor to conduit or tubing at the upper and lower ends by clamp type connectors or welds (including exothermic).

2.1.1 Main and Bonding Conductors

NFPA 780 and UL 96 Class I, Class II, or Class II modified materials as applicable.

2.1.2 Copper

Provide copper conductors on nonmetallic stacks that do not weigh less than 144.83 kg per 305 meters, and provide cable such that the size of any strand in the cable is not less than No. 15 AWG. Provide thickness of web or ribbon on stacks that is not less than No. 12 AWG. Provide loop conductors that are comprised of copper conductors not smaller than No. 1/0 AWG.

2.1.3 Aluminum

Do not allow aluminum to contact the earth and do not use in any other manner that will contribute to rapid deterioration of the metal. Observe appropriate precautions at connections with dissimilar metals in accordance with NFPA 70 Article 110-14. Provide aluminum cable conductors for bonding and interconnecting metallic bodies to main cable that are at least equivalent to strength cross-sectional area of a No. 4 AWG aluminum wire. When perforated strips are provided, use strips that are much wider than solid strips. Use a strip width that is at least twice that of the diameter of the perforations. Use an aluminum strip which has a thickness of not less than the diameter of No. 12 AWG and at least 40 mm wide for connecting exposed water pipes.

2.2 COMPONENTS

2.2.1 Air Terminals

Provide terminals in accordance with UL 96, except provide Class II for Class I and Class II applications. Support air terminals more than 610 mm in length by suitable brace, with guides, not less than one-half the height of the terminal.

2.2.2 Ground Rods

Provide ground rods made of copper-clad steel conforming to UL 467. Provide ground rods that are not less than 20 mm in diameter and 3050 mm in length. Do not mix ground rods of copper-clad steel, stainless steel, galvanized ferrous, or solid copper on the job.

2.2.3 Grounding Plates

Provide grounding plates made of copper clad steel conforming to UL 96.

2.2.4 Connections and Terminations

Provide connectors for splicing conductors that conform to UL 96, class as applicable. Conductor connections can be made by clamps or welds (including exothermic). Provide style and size connectors required for the installation.

2.2.5 Connector Fittings

Provide connector fittings for "end-to-end", "Tee", or "Y" splices that conform to NFPA 780.

2.2.6 Lightning Protection Components

Provide bonding plates, air terminal supports, chimney bands, clips, and fasteners that conform to UL 96 classes as applicable.

PART 3 EXECUTION

3.1 INTEGRAL SYSTEM

Lightning protection system consists of air terminals, roof conductors, down conductors, ground connections, grounding electrodes and ground loop conductor. Electrically interconnect lightning protection system to form the shortest distance to ground. Do not use nonconducting parts of the structure as part of the building's lightning protection system. Expose conductors on the structures except where conductors are required to be in protective sleeves. Interconnect secondary conductors with grounded metallic parts within the building. Make interconnections within side-flash distances at or above the level of the grounded metallic parts.

3.1.1 Air Terminals

Air terminal design and support conforming to NFPA 780. Rigidly connect terminals to, and make electrically continuous with, roof conductors by means of pressure connectors or crimped joints of T-shaped malleable metal.

Provide pressure connector or crimped joint with a dowel or threaded fitting to connect ground rod conductor with air terminal. Set air terminals at ends of structures not more than 610 mm from ends of ridges and corners of roofs. Do not exceed 7620 mm in spacing of 610 mm high air terminals on ridges, parapets, and around perimeter of building with flat roofs. When necessary to exceed this spacing, increase specified height of air terminals not less than 50 mm for each 305 mm of increase over 7620 mm. On large flat, or gently sloping roofs, as defined in NFPA 780, place air terminals at points of the intersection of imaginary lines dividing the surface into rectangles having sides not exceeding 15 m in length. Secure air terminals against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces which are permanently and rigidly attached to the building or structure. Metal projections and metal parts of buildings such as smokestacks and other metal objects that are at least 4.763 mm thick and that does not contain hazardous materials, need not be provided with air terminals. However, bond these metal objects to a lightning conductor through a metal conductor of the same unit weight per length as the main conductor. Where metal ventilators are installed, mount air terminals thereon, where practical. Bond air terminals, erected by necessity adjacent to a metal ventilator, to the ventilator near the top and bottom. Where nonmetallic spires, steeples, or ventilators are present, mount air terminals to the side. In addition, where spires or steeples project more than 3050 mm above the building, continue conductor from air terminal to nearest down conductor securely connect thereto.

3.1.2 Roof Conductors

Connect roof conductors directly to the roof or ridge roll. Avoid sharp bends or turns in conductors. Do not make turns of less than 205 mm. Preserve horizontal or downward course on conductors. Rigidly fasten conductors every 915 mm along the roof and down the building to the ground. Rigidly connect metal ventilators to the roof conductor at three places. Make connections electrically continuous. Course roof conductors along contours of flat roofs, ridges, parapets, and edges; and where necessary, over flat surfaces, in such a way as to join each air terminal to all the rest. Connect roof conductors surrounding tank tops, decks, flat surfaces, and flat roofs to form a closed loop.

3.1.3 Down Conductors

Make down conductors electrically continuous from air terminals and roof conductors to grounding electrodes. Course down conductors over outer extreme portions of the building, such as corners, with consideration given to location of ground connections and air terminals. Provide each building or structure not less than two down conductors located as widely separated as practicable, such as at diagonally opposite corners. Rectangular structures having gable, hip, or gambrel roofs more than 33 m long, provide at least one additional down conductor for each additional 15 m of length or fraction thereof. L- or T-shaped structure, provide at least one additional down conductor. Irregularly shaped structures, provide enough conductors so that the average distance between them along the perimeter is not greater than 30 m. Structures exceeding 15 m in height, provide at least one additional down conductor for each additional 18 m of height or fraction thereof, except that this application will not cause down conductors to be placed about the perimeter of the structure at intervals of less than 15 m. Install additional down conductors when necessary to avoid "dead ends" or branch conductors exceeding 5 m in length, ending at air terminals. Equally

and symmetrically spaced down conductors about the perimeter of the structure. Protect conductors where necessary, to prevent physical damage or displacement to the conductor.

3.1.4 Interconnection of Metallic Parts

Connect metal doors, windows, and gutters directly to ground or down conductors using not smaller than No. 6 copper conductor, or equivalent. Where there is probability of unusual wear, mechanical injury, or corrosion, provide conductors with greater electrical capacity than normal or protect the conductor. Provide mechanical ties or pressure connectors between grounds and metal doors and windows.

3.1.5 Ground Connections

Securely connect conductor forming continuations of down conductors from structure to grounding electrode in a manner to ensure electrical continuity between the two. Provide clamp type connections or welds (including exothermic) for continuation. Provide a ground connection for each down conductor. Attach down conductors to ground rods by welding (including exothermic), brazing, or clamping. Provide clamps suitable for direct burial. Protect ground connection from mechanical injury. Bond metal water pipes and other large underground metallic objects together with all grounding mediums. In making ground connections, take advantage of all permanently moist places where practicable, although avoid such places when area is wet with waste water that contains chemical substances, especially those corrosive to metal.

3.1.6 Grounding Electrodes

Provide grounding electrode for each down conductor. Extend driven ground rods into the existing undisturbed earth for a distance of not less 3050 mm. Set ground rods not less than 610 mm nor more than 3050 mm, from the structure. After the completed installation, measure the total resistance to ground using the fall-of-potential method described in IEEE Std 81. Maximum resistance of a driven ground rod shall be 10 ohms, under normally dry conditions when a ground loop is not used. Use a ground loop when two of any three ground rods, driven not less than 3050 mm into the ground, a minimum of 3050 mm apart, and equally spaced around the perimeter, give a combined value exceeding 50 ohms immediately after having driven. For ground loop, provide continuous No. 1/0 bare stranded copper cable or equivalent material having suitable resistance to corrosion. Lay ground loop around the perimeter of the structure in a trench not less than 765 mm below grade, at a distance not less than 610 mm nor more than 3050 mm from the nearest point of the structure. Install a ground loop in earth undisturbed by excavation, not earth fill, and do not locate beneath roof overhang, or wholly under paved areas or roadways where rainfall cannot penetrate to keep soil moist in the vicinity of the cable. Make connections between ground conductors and grounds or ground loop, and between ground loop and grounds electrically continuous. Where so indicated on the plans, provide an alternate method for grounding electrodes in shallow soil by digging trenches radially from the building. Provide 1/0 bare copper cable arranged in a star pattern with the structure at the center for radial systems. Bury the radials at least 765 mm inches below grade external to the structure. Lower ends of down conductors are buried in trenches.

3.1.7 Grounding Plates

Provide a grounding plate for down conductor. Set grounding plates not less than 610 mm nor more than 3050 mm, from the structure. Grounding plate is to be buried as deeply in the existing dirt as local conditions allow, without exceeding 3050 mm in depth.

3.2 APPLICATIONS

3.2.1 Nonmetallic Exterior Walls with Metallic Roof

Bond metal roof sections together which are insulated from each other so that they are electrically continuous. Connect air terminals so that they are electrically continuous with the metal roof as well as the roof conductors and down conductors. Bond ridge cables and roof conductors to the roof at upper and lower edges of roof and at intervals not to exceed 30 m. Bond down conductors to roof conductors and to lower edge of metal roof. Where metal of roof is in small sections, make connections between air terminals and down conductors to at least four sections of the metal roof. Make connections electrically continuous and have a surface contact of at least 1935 square mm.

3.2.2 Metal Roofs with Metal Walls

Bond metal roof and metal walls so that they are electrically continuous and considered as one unit. Connect air terminals to and make them electrically continuous with the metal roof as well as the roof down conductors. Bond all roof conductors and down conductors to metal roof or metal walls at upper and lower edges at intervals not to exceed 30 m. Make all connections electrically continuous and have surface contact of at least 1935 square mm.

3.2.3 Steel Frame Building

Make the steel framework of the building electrically continuous. Electrical continuity may be provided by bolting, riveting, or welding unless another specific method is indicated. Connect air terminals to the structural steel framework at the ridge. Provide short runs of conductors to join air terminals to the metal framework so that proper placing of air terminals is maintained. Separate down conductors from air terminals to ground connections are not required. Where water system enters the building, securely connect structural steel framework and water system at point of entrance by a ground connector. Make connections to pipes by means of ground clamps with lugs. Make connections to structural framework by means of nut and bolt or welding. Make connections between columns and ground connections at bottom of steel columns. Make ground connections to grounds or ground loop runs from not less than one-half of the columns distributed equally around perimeter of structure. When no water system enter the structure, run ground connections from steel columns distributed equally around the perimeter of the structure. Bond metal doors, windows, gutters, and similar metal installation to steel work of the building. Provide a grounding electrode for each ground connection.

3.2.4 Ramps and Covered Passageways

Ramps and covered passageways which are in the zone of protection of a lightning protection system, as defined by NFPA 780, need no additional lightning protection. However, ramps and covered passageways which are

outside the zone of protection of a lightning protection system shall be provided with a lightning protection conforming to the requirements for lightning protection systems for buildings of similar construction. Place a down conductor and a driven ground at one of the corners where the ramp connects to each building or structure. Connect down conductor and driven ground to the ground loop or nearest ground connection of the building or structure. Where buildings or structures and connecting ramps are clad with metal, connect metal of the buildings or structures and metal of the ramp in a manner to ensure electrical continuity, in order to avoid the possibility of a flash-over or spark due to a difference in potential. Make connections electrically continuous and have a surface contact area of at least 1935 square mm.

3.2.5 Tanks and Towers

3.2.5.1 Wooden Tanks and Towers

Electrically interconnect lightning protection system components (such as: air terminals, ridge cables, down conductors, ground connections, and grounds) to form the shortest distance to ground without passing through any nonconducting parts of the structure. Where the roof of the structure ends in a peak, a single air terminal not less than 610 mm high will be regarded as sufficient. When structure does not end in a peak, provide air terminals not less than 610 mm high at intervals not exceeding 7620 m along the perimeter of the structure. When the tank or tower is an adjunct of a building, near or touching the perimeter, extend one of the down conductors directly to a ground connection and connect the other to lightning protection of the building. When tank or tower is set well within the perimeter of the building, connect both down conductors to lightning protection system of the building. When height of the structure exceeds 30 m, cross-connect down conductors midway between the top and bottom. Where buried metal pipes enter tank or tower, connect one down conductor to pipes, approximately 305 mm below grade. Ground metal guy wires or cables set in concrete or attached to buildings or nonconducting supports to a ground rod driven full length into the ground.

3.2.5.2 Metal or Reinforced-Concrete Tanks and Towers

Make metal or reinforcing steel electrically continuous. Electrical continuity may be provided by bolting, riveting, or welding metal and tying or clipping reinforcing bars, unless a specific method is noted on the drawings. Air terminals and down conductors are required except on bolted, riveted, or welded 4.75 mm minimum steel plate tanks. Ground connections and grounding electrodes are not required on metal tanks that are electrically continuous with a metallic underground pipe system. On other structures, provide two ground connections approximately 3.14 rad apart at the base of the structure. Connect each buried metal pipe entering the tank or tower to one ground connection approximately 305 mm below finished grade. Ground metal guy wires on tanks and towers. Metal guy wires or cables attached to steel anchor rods set in earth will be considered as grounded. Ground metal guy wires or cables set in concrete or attached to buildings or nonconducting supports to a ground rod driven full length into the ground.

3.2.6 Stacks

Ground metal guy wires for stacks. Metal guy wires or cables attached to steel anchor rods set in earth will be considered as sufficiently well

grounded. However, ground metal guy wires or cables attached to anchor rods set in concrete or attached to buildings or nonconducting supports to a ground rod driven full length into the ground.

3.2.6.1 Metal Stacks

Make metal smokestacks electrically continuous and to ground. Heavy-duty metal stacks having a metal thickness of 4.75 mm or greater do not require air terminals or down conductors. Otherwise, provide two ground rods driven full length into the earth. Locate ground rods approximately 3.14 rad apart and set ground rods not less than 915 mm nor more than 2440 mm from the nearest point of the stack foundation.

3.2.6.2 Nonmetallic Stacks

On nonmetallic smokestacks constructed of brick, hollow tile, or concrete, make the air terminals solid copper. Distribute uniformly about the rim of the stack at intervals not exceeding 2440 mm and extending at least 765 mm above the rim of stack. Electrically connect air terminal together by means of a metal band or ring to form a closed loop about 610 mm below the top of the stack. Where the stack has a metal crown, connect air terminals to the metal crown. Where stacks have metal lining extending part way up, connect lining to air terminal at its upper end and ground at the bottom. Provide at least two down conductors on opposite sides of the stack leading from the ring or crown at the top to the ground. When the stack is an adjunct of building near or touching the building perimeter, extend one of the conductors directly to a ground connection while the other may be connected to lighting protection system on the building. On stacks exceeding 48 m in height, cross-connect down conductors approximately midway between the top and bottom. Reduce joints in conductors to a minimum and make joints to have the same tension strength as the conductors that are joining. Space fasteners of copper or copper-bronze alloy not over 915 mm apart for vertical conductors and not over 610 mm apart for horizontal conductors. To prevent gases from corroding copper air terminals, provide conductors and fasteners within 7620 mm of the top of stack with continuous coating of hot dipped lead or an equivalent coating. Provide conductors conforming to the requirements for nonmetallic stacks for stacks partly or wholly of reinforced concrete. For nonmetallic stacks, electrically connect reinforcing steel to down conductors at top and bottom of concrete.

3.3 INTERFACE WITH OTHER STRUCTURES

3.3.1 Interconnection of Metal Bodies

Protect metal bodies when not within the zone of protection of air terminal. Bond metal bodies having an area of 0.258 square m or greater or a volume of 0.016387 cubic m or greater to lightning protection system using main size conductors and a bonding plate having a surface contact area of not less than 1935 square mm. Make provisions to guard against the corrosive effect of bonding dissimilar metals. Bond metal bodies at their closest point to the lightning protection system using bonding conductors and fittings. Independently ground any metal body that exceeds 1525 mm in any dimension, that is situated wholly within a building, and that does not at any point come within 1830 mm of a lightning conductor or metal connected to a lightning protection system.

3.3.2 Fences

Except as specified below, metal fences that are electrically continuous with metal posts extending at least 610 mm into the ground require no additional grounding. Ground other fences on each side of every gate at gate posts, at corner posts, and at end posts. Bond gate to adjacent fence post utilizing flexible copper grounding braid with sufficient slack to permit 3.14 rad opening of the gate. Provide flexible copper ground braid which has an ampacity equivalent to that of the fence ground wire specified herein. Provide ground rods every 305 to 457 m for grounding fences when fences are located in isolated places, and every 152 to 228 m when in proximity (30 m or less) to public roads, highways, and buildings. Provide connection to ground from the post where it is metal and is electrically continuous with the fencing using removable ground clamps on the fence posts and split-bolt connectors suitable for dissimilar metals on the fence fabric and barbed wire. Make connections to ground from the horizontal metal strand using split-bolt connectors suitable for dissimilar metals on the fence fabric and barbed wire. Ground metal fences at or near points 45 m on each side of medium and high voltage, (meaning in excess of 600 volts,) overhead line crossings. Ground metal fences at 45 m intervals where high and medium voltage lines are directly overhead and run parallel to the fence.

3.3.3 Exterior Overhead Pipe Lines

Properly ground overhead pipes, conduits, and cable trays on the exterior of the building that enter a building, preferably to building grounds at points where pipes enter the building. Where a separate ground is provided, bond the pipes to the building ground at points where the pipes are closest to the ground connections. In addition, bond pipes to any metallic masses that are within 1830 mm of the pipe.

3.4 RESTORATION

Where sod has been removed, place sod as soon as possible after completing the backfilling. Restore to original condition the areas disturbed by trenching, storing of dirt, cable laying, and other work. Include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging or mulching in any restoration. Maintain disturbed surfaces and replacements until final acceptance.

3.5 FIELD QUALITY CONTROL

3.5.1 Grounding System Test

Test the grounding system to ensure continuity and that resistance to ground is not in excess of 10 ohms. Test the ground rod for resistance to ground before making connections to the rod. Tie the grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Include in the written report: locations of ground rods, resistance, and soil conditions at the time that measurements were made. Submit results of each test to the Contracting Officer.

3.5.2 Lightning Protection System Inspection

Make visual inspections to verify that there are no loose connections which may result in high resistance joints, and that conductors and system components are securely fastened to their mounting surfaces and are protected against accidental mechanical displacement.

-- End of Section --

SECTION 26 51 00

INTERIOR LIGHTING
07/07

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.

ASTM INTERNATIONAL (ASTM)

ASTM A 1008/A 1008M	(2006a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

IESNA HB-9	(2000; Errata 2004; Errata 2005) IES Lighting Handbook

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2005) National Electrical Safety Code
IEEE C62.41	(1991; R 1995) Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 100	(2000) The Authoritave Dictionary of IEEE Standards Terms

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA C78.1381	(1998) Electric Lamps - 250-Watt, 70 Watt, M85 Metal-Halide Lamps
NEMA C78.81	(2005) Electric Lamps - Double-capped Fluorescent Lamps Dimensional and Electrical Characteristics
NEMA C82.1	(2004) Electric Lamp Ballasts - Line Frequency Fluorescent Lamp Ballasts
NEMA C82.11	(2002) High-Frequency Fluorescent Lamp Ballasts
NEMA C82.2	(2002) Methods of Measurement of Fluorescent Lamp Ballasts

NEMA ICS 6	(2006) Standard for Industrial Controls and Systems Enclosures
NEMA LL 1	(1997; R 2002) Procedures for Linear Fluorescent Lamp Sample Preparation and the TCLP Extraction

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2006) Life Safety Code, 2006 Edition
NFPA 70	(2005; TIA 2005) National Electrical Code
NFPA 90A	(2002; Errata 2003; Errata 2005) Standard for the Installation of Air Conditioning and Ventilating Systems

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System

UNDERWRITERS LABORATORIES (UL)

UL 1598	(2004; Rev thru May 2006) Luminaires
UL 20	(2004) Standard for General-Use Snap Switches
UL 924	(2001; R 2005e8) Standard for Emergency Lighting and Power Equipment
UL 935	(2001; Rev thru Feb 2006) Standard for Fluorescent-Lamp Ballasts

1.1.1 EQUIVALENT REFERENCES

Equipment and material meeting standards that are deemed equivalent (by the Authority Having Jurisdiction) to the above referenced standards may be submitted for approval.

1.2 RELATED REQUIREMENTS

Materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in this section.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

b. Average life is the time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

c. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

Data, drawings, and reports shall employ the terminology, classifications, and methods prescribed by the IESNA HB-9, as applicable, for the lighting system specified.

SD-03 Product Data

Fluorescent lighting fixtures;

Fluorescent electronic ballasts;

Fluorescent lamps;

Incandescent lighting fixtures;

Incandescent lamps;

Exit signs;

Emergency lighting equipment;

Environmental Data

Energy Efficiency

SD-04 Samples

Lighting fixtures, complete with lamps and ballasts;

SD-06 Test Reports

Operating test

Submit test results as stated in paragraph entitled "Field Quality Control."

1.5 QUALITY ASSURANCE

1.5.1 Fluorescent Electronic Ballasts

Submit ballast catalog data as required in the paragraph entitled "Fluorescent Lamp Electronic Ballasts" contained herein. As an option, submit the fluorescent fixture manufacturer's electronic ballast specification information in lieu of the actual ballast manufacturer's catalog data. This information shall include published specifications and sketches, which covers the information required by the paragraph entitled

"Fluorescent Lamp Electronic Ballasts" herein. This information may be supplemented by catalog data if required, and shall contain a list of vendors with vendor part numbers.

1.5.2 Lighting Fixtures, Complete With Lamps and Ballasts

Submit one sample of each fixture type for inspection, review, and approval. The sample shall be retained for comparison against the remainder of the fixtures. The sample may be used in the final fixture installation.

1.5.3 Regulatory Requirements

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. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.4 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6.1 Electronic Ballast Warranty

Furnish the electronic ballast manufacturer's warranty. The warranty period shall not be less than 5 years from the date of manufacture of the electronic ballast. Ballast assembly in the lighting fixture, transportation, and on-site storage shall not exceed 12 months, thereby permitting 4 years of the ballast 5 year warranty to be in service and energized. The warranty shall state that the malfunctioning ballast shall be exchanged by the manufacturer and promptly shipped to the using Government facility. The replacement ballast shall be identical to, or an improvement upon, the original design of the malfunctioning ballast.

1.7 OPERATIONAL SERVICE

Coordinate with manufacturer for maintenance agreement. Collect information from the manufacturer about maintenance agreement options, and submit to Contracting Officer. Services shall reclaim materials for recycling and/or reuse. Services shall not landfill or burn reclaimed materials. Indicate procedures for compliance with regulations governing disposal of mercury. When such a service is not available, local recyclers shall be sought after to reclaim the materials.

PART 2 PRODUCTS

2.1 FLUORESCENT LIGHTING FIXTURES

UL 1598. Fluorescent fixtures shall have electronic ballasts.

2.1.1 Fluorescent Lamp Electronic Ballasts

The electronic ballast shall as a minimum meet the following characteristics:

a. Ballast shall comply with UL 935, NEMA C82.11, NFPA 70, and CEC Title 24 unless specified otherwise. Ballast shall be 100% electronic high frequency type with no magnetic core and coil components. Ballast shall provide transient immunity as recommended by IEEE C62.41. Ballast shall be designed for the wattage of the lamps used in the indicated application. Ballasts shall be designed to operate on the voltage system to which they are connected.

b. Power factor shall be 0.95 (minimum).

c. Ballast shall operate at a frequency of 20,000 Hertz (minimum). Ballast shall be compatible with and not cause interference with the operation of occupancy sensors or other infrared control systems. Provide ballasts operating at or above 40,000 Hertz where available.

d. Ballast shall have light regulation of plus or minus 10 percent lumen output with a plus or minus 10 percent input voltage regulation. Ballast shall have 10 percent flicker (maximum) using any compatible lamp.

e. Ballast factor shall be between 0.85 (minimum) and 1.00 (maximum). Current crest factor shall be 1.7 (maximum).

f. Ballast shall be UL listed Class P with a sound rating of "A."

g. Ballast shall have circuit diagrams and lamp connections displayed on the ballast.

h. Ballasts shall be instant start unless otherwise indicated. Instant start ballasts shall operate lamps in a parallel circuit configuration that permits the operation of remaining lamps if one or more lamps fail or are removed.

i. Ballasts for compact fluorescent fixtures shall be programmed start.

j. Ballasts for T-5 and smaller lamps shall have end-of-life protection circuits as required by NEMA C78.81 and NEMA C78.901 as applicable.

k. Ballast shall be capable of starting and maintaining operation at a minimum of -17 degrees C unless otherwise indicated.

l. Electronic ballast shall have a full replacement warranty of 5 years from date of manufacture as specified in paragraph entitled "Electronic Ballast Warranty" herein.

2.1.1.1 T-8 Lamp Ballast

a. Total harmonic distortion (THD): Shall be 20 percent (maximum).

b. Input wattage.

1. 32 watts (maximum) when operating one F32T8 lamp

2. 62 watts (maximum) when operating two F32T8 lamps

c. Ballast efficacy factor.

1. 2.54 (minimum) when operating one F32T8 lamp

2. 1.44 (minimum) when operating two F32T8 lamps

d. A single ballast may be used to serve multiple fixtures if they are continuously mounted and factory manufactured for that installation with an integral wireway.

2.1.2 Fluorescent Lamp Electronic Dimming Ballast

2.1.2.1 T-8 Lamp Ballast

Input wattage, for indicated lamp quantity shall be:

a. 35 watts (maximum) when operating one F32T8 lamp.

b. 70 watts (maximum) when operating two F32T8 lamps.

c. 104 watts (maximum) when operating three F32T8 lamps.

2.1.3 Fluorescent Lamps

a. T-8 rapid start low mercury lamps shall be rated 32 watts (maximum), 2800 initial lumens (minimum), CRI of 75 (minimum), color temperature of

3500 K, and an average rated life of 20,000 hours. Low mercury lamps shall have passed the EPA Toxicity Characteristic Leachate Procedure (TCLP) for mercury by using the lamp sample preparation procedure described in NEMA LL 1.

Average rated life is based on 3 hours operating per start.

2.2 INCANDESCENT LIGHTING FIXTURES

Use of incandescent lamps and fixtures is prohibited, unless specifically indicated otherwise. UL 1598.

2.2.1 Incandescent Lamps

Provide the number, type, and wattage indicated.

2.3 SWITCHES

2.3.1 Toggle Switches

Provide toggle switches as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.4 EXIT SIGNS

UL 924, NFPA 70, and NFPA 101. Exit signs shall be self-powered type. Exit signs shall use no more than 5 watts.

2.4.1 Self-Powered LED Type Exit Signs (Battery Backup)

Provide with automatic power failure device, integral self-testing module and fully automatic high/low trickle charger in a self-contained power pack. Battery shall be sealed electrolyte type, shall operate unattended, and require no maintenance, including no additional water, for a period of not less than 5 years. LED exit sign shall have emergency run time of 1 1/2 hours (minimum). The light emitting diodes shall have rated lamp life of 70,000 hours (minimum).

2.5 EMERGENCY LIGHTING EQUIPMENT

UL 924, NFPA 70, and NFPA 101. Provide lamps in wattage indicated. Provide accessories required for remote-mounted lamps where indicated. Remote-mounted lamps shall be as indicated.

2.5.1 Fluorescent Emergency System

Each system shall consist of an automatic power failure device, test switch operable from outside of the fixture, pilot light visible from outside the fixture, and fully automatic solid-state charger in a self-contained power pack. Provide self-testing module integral to the fixture. Charger shall be either trickle, float, constant current or constant potential type, or a combination of these. Battery shall be sealed electrolyte type with capacity as required to supply power to the number of lamps shown for each system for 90 minutes at a minimum of 1100 lumens per lamp output. Battery shall operate unattended and require no maintenance, including no additional water, for a period of not less than 5 years. Emergency ballasts provided with fixtures containing solid-state ballasts shall be fully compatible with

the solid-state ballasts. Furnish spare emergency ballast based on 10 percent of the number of emergency ballast provided for the project.

2.6 SELF-TESTING MODULE

Self-testing module for exit signs and emergency lighting equipment shall perform the following functions:

a. Continuous monitoring of charger operation and battery voltage with visual indication of normal operation and of malfunction.

b. Monthly discharge cycling of battery with monitoring of transfer circuit function, battery capacity and emergency lamp operation with visual indication of malfunction. The battery capacity test may be conducted by using a synthetic load.

c. Manual test switch to simulate a discharge test cycle.

d. Module shall have low voltage battery disconnect (LVD) and brown-out protection circuit.

2.7 SUPPORT HANGERS FOR LIGHTING FIXTURES IN SUSPENDED CEILINGS

2.7.1 Wires

ASTM A 641/A 641M, galvanized regular coating, soft temper, 2.68 mm in diameter.

2.7.2 Wires, for Humid Spaces

ASTM A 580/A 580M, composition 302 or 304, annealed stainless steel 2.68 mm in diameter.

ASTM B 164, UNS NO4400, annealed nickel-copper alloy 2.68 mm in diameter.

2.8 EQUIPMENT IDENTIFICATION

2.8.1 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.

2.8.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. All luminaires shall be clearly marked for operation of specific lamps and ballasts according to proper lamp type. The following lamp characteristics shall be noted in the format "Use Only _____":

a. Lamp diameter code (T-8), tube configuration, base type, and nominal wattage for fluorescent and compact fluorescent luminaires.

b. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.

c. Start type (rapid start) for fluorescent and compact fluorescent luminaires.

d. ANSI ballast type (M98, M57, etc.) for HID luminaires.

e. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

All markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Ballasts shall have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.9 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.1.1 Lamps

Lamps of the type, wattage, and voltage rating indicated shall be delivered to the project in the original cartons and installed just prior to project completion. Lamps installed and used for working light during construction shall be replaced prior to turnover to the Government if more than 15 percent of their rated life has been used. Lamps shall be tested for proper operation prior to turn-over and shall be replaced if necessary with new lamps from the original manufacturer. Provide 10 percent spare lamps of each type from the original manufacturer.

3.1.2 Lighting Fixtures

Set lighting fixtures plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures, and secure in accordance with manufacturers' directions and approved drawings. Installation shall meet requirements of NFPA 70. Mounting heights specified or indicated shall be to the bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures. Obtain approval of the exact mounting for lighting fixtures on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Recessed and semi-recessed fixtures shall be independently supported from the building structure by a minimum of four wires per fixture and located near each corner of each fixture. Ceiling grid clips are not allowed as an alternative to independently supported light fixtures. Round fixtures or fixtures smaller in size than the ceiling grid shall be independently supported from the building structure by a minimum of four wires per fixture spaced approximately equidistant around the fixture. Do not support fixtures by ceiling acoustical panels. Where fixtures of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support such fixtures independently and provide at

least two 19 mm metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture. Provide wires for lighting fixture support in this section.

3.1.3 Suspended Fixtures

Suspended fixtures shall be provided with 0.79 rad swivel hangers so that they hang plumb and shall be located with no obstructions within the 0.79 rad range in all directions. The stem, canopy and fixture shall be capable of 0.79 rad swing. Pendants, rods, or chains 1.2 meters or longer excluding fixture shall be braced to prevent swaying using three cables at 2.09 rad separation. Suspended fixtures in continuous rows shall have internal wireway systems for end to end wiring and shall be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Aligning splines shall be used on extruded aluminum fixtures to assure hairline joints. Steel fixtures shall be supported to prevent "oil-canning" effects. Fixture finishes shall be free of scratches, nicks, dents, and warps, and shall match the color and gloss specified. Pendants shall be finished to match fixtures. Aircraft cable shall be stainless steel. Canopies shall be finished to match the ceiling and shall be low profile unless otherwise shown. Maximum distance between suspension points shall be 3.1 meters or as recommended by the manufacturer, whichever is less.

3.1.4 Exit Signs and Emergency Lighting Units

Wire exit signs and emergency lighting units ahead of the switch to the normal lighting circuit located in the same room or area.

3.2 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

-- End of Section --

SECTION 26 56 00

EXTERIOR LIGHTING
07/06

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.

ALLIANCE FOR TELECOMMUNICATIONS INDUSTRY SOLUTIONS (ATIS)

ATIS O5.1	(2002; 2004s; Supple A 2003; Supple B 2003; Supple C 2004) Specifications and Dimensions (for Wood Poles)

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO LTS-4	(2006) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B 108	(2006) Standard Specification for Aluminum-Alloy Permanent Mold Castings

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

IESNA HB-9	(2000; Errata 2004; Errata 2005) IES Lighting Handbook

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C136.10	(1996) American National Standard for Roadway Lighting Equipment-Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing
IEEE C2	(2005) National Electrical Safety Code
IEEE Std 100	(2000) The Authoritave Dictionary of IEEE Standards Terms

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA C136.3	(2005) Roadway and Area Lighting Equipment Luminaire Attachments
NEMA C78.43	(2005) Standard for Electric Lamps - Single-Ended Metal-Halide Lamps
NEMA C82.4	(2002) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005; TIA 2005) National Electrical Code

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System

UNDERWRITERS LABORATORIES (UL)

UL 1029	(1994; Rev thru Feb 2006) Standard for Safety High-Intensity-Discharge Lamp Ballasts
UL 1598	(2004; Rev thru May 2006) Luminaires
UL 773	(1995; Rev thru Mar 2002) Standard for Plug-In Locking Type Photocontrols for Use with Area Lighting
UL 773A	(2006) Nonindustrial Photoelectric Switches for Lighting Control

1.1.1 EQUIVALENT REFERENCES

Equipment and material meeting standards that are deemed equivalent (by the Authority Having Jurisdiction) to the above referenced standards may be submitted for approval.

1.2 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

b. Average life is the time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

c. Groundline section is that portion between 305 mm above and 610 mm below the groundline.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Luminaire drawings;

Poles;

SD-03 Product Data

Environmental Data

Energy Efficiency

Luminaires;

Lamps;

Ballasts;

Lighting contactor;

Time switch;

Photocell switch;

Concrete poles;

Aluminum poles;

Steel poles;
Fiberglass poles;

Brackets

SD-04 Samples

Luminaires;

Submit one sample of each luminaire type, complete with lamp and ballast. Sample will be returned to the Contractor for installation in the project work.

SD-05 Design Data

Design Data for luminaires;

SD-08 Manufacturer's Instructions\

Concrete poles

Submit instructions prior to installation.

Fiberglass poles

Submit instructions prior to installation.

1.4 QUALITY ASSURANCE

1.4.1 Drawing Requirements

1.4.1.1 Luminaire Drawings

Include dimensions, effective projected area (EPA), accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and computerized candlepower distribution data shall accompany shop drawings.

1.4.1.2 Poles

Include dimensions, wind load determined in accordance with AASHTO LTS-4, pole deflection, pole class, and other applicable information.

1.4.2 Design Data for Luminaires

a. Distribution data according to IESNA classification type as defined in IESNA HB-9.

b. Computerized horizontal illumination levels in lux at ground level, taken every 3050 mm. Include average maintained lux level and maximum and minimum ratio.

c. Amount of shielding on luminaires.

1.4.3 Regulatory Requirements

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. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.4 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Concrete Poles

Do not store poles on ground. Support poles so they are at least 305 mm above ground level and growing vegetation.

1.5.2 Fiberglass Poles

Do not store poles on ground. Support poles so they are at least 305 mm above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

1.5.3 Aluminum or Steel Poles

Do not store poles on ground. Support poles so they are at least 305 mm above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

1.6 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.7 OPERATIONAL SERVICE

Coordinate with manufacturer for maintenance agreement. Collect information from the manufacturer about maintenance agreement options, and submit to Contracting Officer. Services shall reclaim materials for recycling and/or reuse. Services shall not landfill or burn reclaimed materials. Indicate procedures for compliance with regulations governing disposal of mercury. When such a service is not available, local recyclers shall be sought after to reclaim the materials.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in Section 26 51 00 INTERIOR LIGHTING.

2.2 LUMINAIRES

UL 1598. Provide luminaires as indicated. Provide luminaires complete with lamps of number, type, and wattage indicated. Details, shapes, and dimensions are indicative of the general type desired, but are not intended to restrict selection to luminaires of a particular manufacturer. Luminaires of similar designs, light distribution and brightness characteristics, and of equal finish and quality will be acceptable as approved.

2.2.1 Lamps

2.2.1.1 High-Pressure Sodium (HPS) Lamps

NEMA ANSLG C78.42. Wattage as indicated. HPS lamps shall have average rated life of 16,000 hours (minimum) for 35 watt lamps and 24,000 hours (minimum) for all higher wattage lamps. 150 watt lamps, if required, shall be 55 volt lamps. Lamps shall have Luminaire Efficiency Ratings (LER) as follows:

a. Upward efficiency of 0%

1. 150-399 watts: minimum 58 LER for closed fixture; minimum 68 for open fixture

2. 400-999 watts: minimum 63 LER for closed fixture; minimum 84 for open fixture

b. Upward efficiency of 1%-10%

1. 150-399 watts: minimum 64 LER for closed fixture; minimum 63 for open fixture

2. 400-999 watts: minimum 82 LER for closed fixture; minimum 89 for open fixture

3. 1000+ watts: minimum 109 LER for open fixture

c. Upward efficiency of 11% to 20%

1. 150-399 watts: minimum 78 LER for open fixture

2. 400-999 watts: minimum 94 for open fixture

d. Upward efficiency greater than 20%

1. 150-399 watts: minimum 75 LER for closed fixture; minimum 77 for open fixture

2.2.2 Ballasts for High-Intensity-Discharge (HID) Luminaires

UL 1029 and NEMA C82.4, and shall be constant wattage autotransformer (CWA) or regulator, high power-factor type (minimum 90%). Provide single-lamp ballasts which shall have a minimum starting temperature of minus 30 degrees C. Ballasts shall be:

a. Designed to operate on voltage system to which they are connected.

b. Constructed so that open circuit operation will not reduce the average life.

HID ballasts shall have a solid-state igniter/starter with an average life in the pulsing mode of 10,000 hours at the intended ambient temperature. Igniter case temperature shall not exceed 90 degrees C.

2.3 PHOTOCELL SWITCH

UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell rated 220 volts ac, 50 Hz with single-throw contacts designed to fail to the ON position. Switch shall turn on at or below 32 lux and off at 43 to 107 lux. A time delay shall prevent accidental switching from transient light sources.

a. In a high-impact-resistant, noncorroding and nonconductive molded plastic housing with a fixture mounted, locking-type receptacle conforming to IEEE C136.10 and rated 1800 VA, minimum.

b. In a cast weatherproof aluminum housing with adjustable window slide, rated 1800 VA, minimum.

c. In a U.V. stabilized polycarbonate housing with swivel arm and adjustable window slide, rated 1800 VA, minimum.

d. Integral to the luminaire, rated 1000 VA, minimum.

2.4 POLES

Provide poles designed for wind loading of 161 km/hr determined in accordance with AASHTO LTS-4 while supporting luminaires and all other appurtenances indicated. The effective projected areas of luminaires and appurtenances used in calculations shall be specific for the actual products provided on each pole. Poles shall be anchor-base type designed for use with underground supply conductors. Poles shall have oval-shaped handhole having a minimum clear opening of 65 by 130 mm. Handhole cover shall be secured by stainless steel captive screws. Metal poles shall have an internal grounding connection accessible from the handhole near the bottom of each pole. Scratched, stained, chipped, or dented poles shall not be installed.

2.6.1 Concrete Poles

Provide concrete poles conforming to ASTM C 1089. Cross-sectional shape shall be round or multi-sided.

2.6.1.1 Steel Reinforcing

Prestressed concrete pole shafts shall be reinforced with steel prestressing members. Design shall provide internal longitudinal loading by either pretensioning or post tensioning of longitudinal reinforcing members.

2.6.1.2 Tensioned Reinforcing

Primary reinforcement steel used for a prestressed concrete pole shaft shall be tensioned between 60 to 70 percent of its ultimate strength. The amount of reinforcement shall be such that when reinforcement is tensioned to 70 percent of its ultimate strength, the total resultant tensile force does not exceed the minimum section compressive strength of the concrete.

2.6.1.3 Coating and Sleeves for Reinforcing Members

Where minimum internal coverage cannot be maintained next to required core openings, such as handhole and wiring inlet, reinforcing shall be protected with a vaporproof noncorrosive sleeve over the length without the 13 mm ½ inch concrete coverage. Each steel reinforcing member which is to be post-tensioned shall have a nonmigrating slipper coating applied prior to the addition of concrete to ensure uniformity of stress throughout the length of such member.

2.6.1.4 Strength Requirement

As an exception to the requirements of ASTM C 1089, poles shall be naturally cured to achieve a 28-day compressive strength of 48.23 MPa 7000 psi. Poles shall not be subjected to severe temperature changes during the curing period.

2.6.1.5 Shaft Preparation

Completed prestressed concrete pole shaft shall have a hard, smooth, nonporous surface that is resistant to soil acids, road salts, and attacks of water and frost, and shall be clean, smooth, and free of surface voids and internal honeycombing. Poles shall not be installed for at least 15 days after manufacture.

2.6.2 Aluminum Poles

Provide aluminum poles manufactured of corrosion resistant aluminum alloys conforming to AASHTO LTS for Alloy 6063-T6 or Alloy 6005-T5 for wrought alloys and Alloy 356-T4 (3,5) for cast alloys. Poles shall be seamless extruded or spun seamless type with minimum 4.8 mm wall thickness. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Tops of shafts shall be fitted with a round or tapered cover. Base shall be anchor bolt mounted, made of cast 356-T6 aluminum alloy in accordance with ASTM B 108/B 108M and shall be machined to receive the lower end of shaft. Joint between shaft and base shall be welded. Base cover shall be cast 356-T6 aluminum alloy in accordance with ASTM B 108/B 108M. Hardware, except anchor bolts, shall be either 2024-T4 anodized aluminum alloy or stainless steel. Manufacturer's standard provision shall be made for protecting the finish during shipment and installation. Minimum protection shall consist of spirally wrapping each pole shaft with protective paper secured with tape, and shipping small parts in boxes.

2.6.3 Steel Poles

AASHTO LTS. Provide steel poles having minimum 11-gage steel with minimum yield/strength of 331 MPa (48,000 psi) 48,000 psi and hot-dipped galvanized in accordance with ASTM A 123/A 123M factory finish. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Pole shall be direct anchor bolt mounted type. Poles shall have tapered tubular members, either round in cross section or polygonal. Pole

shafts shall be one piece. Poles shall be welded construction with no bolts, rivets, or other means of fastening except as specifically approved. Pole markings shall be approximately 900 to 1270 mm 3 to 4 feet above grade and shall include manufacturer, year of manufacture, top and bottom diameters, and length. Base covers for steel poles shall be structural quality hot-rolled carbon steel plate having a minimum yield of 248 MPa (36,000 psi) 36,000 psi.

2.6.5 Fiberglass Poles

ANSI C136.20. Designed specifically for supporting luminaires and having factory-formed cable entrance and handhole. Resin color shall be dark bronze and pigment shall provide uniform coloration throughout entire wall thickness. Finish surface shall be pigmented polyurethane having a minimum dry film thickness of 0.038 mm. Polyurethane may be omitted if the surface layer of the pole is inherently ultraviolet inhibited. Minimum fiberglass content shall be 65 percent with resin and pigment comprising the other 35 percent material content.

2.5 BRACKETS AND SUPPORTS

NEMA C136.3, NEMA C136.13, and ANSI C136.21, as applicable. Pole brackets shall be not less than 31.75 mm aluminum secured to pole. Slip-fitter or pipe-threaded brackets may be used, but brackets shall be coordinated to luminaires provided, and brackets for use with one type of luminaire shall be identical. Brackets for pole-mounted street lights shall correctly position luminaire no lower than mounting height indicated. Mount brackets not less than 7320 mm above street. Special mountings or brackets shall be as indicated and shall be of metal which will not promote galvanic reaction with luminaire head.

2.6 POLE FOUNDATIONS

Anchor bolts shall be steel rod having a minimum yield strength of 344.5 MPa (50,000 psi); the top 305 mm of the rod shall be galvanized in accordance with ASTM A 153/A 153M. Concrete shall be as specified in Section 03 30 00.00 40 CAST-IN-PLACE CONCRETE.

2.7 EQUIPMENT IDENTIFICATION

2.7.1 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.

2.7.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. Luminaires shall be clearly marked for operation of specific lamps and ballasts according to proper lamp type. The following lamp characteristics shall be noted in the format "Use Only _____":

a. Lamp diameter code (T-8), tube configuration, base type, and nominal wattage for fluorescent and compact fluorescent luminaires.

b. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.

c. Start type (rapid start) for fluorescent and luminaires.

d. ANSI ballast type (M98, M57, etc.) for HID luminaires.

e. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

Markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Ballasts shall have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.8 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.1.1 Concrete Poles

Install according to pole manufacturer's instructions.

3.1.2 Fiberglass Poles

Install according to pole manufacturer's instructions.

3.1.4 Aluminum or Steel Poles

Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 1.57 rad (90 degrees) at the bottom end. Provide ornamental covers to match pole and galvanized nuts and washers for anchor bolts. Concrete for anchor bases, polyvinyl chloride (PVC) conduit ells, and ground rods shall be as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION . Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location. After installation, paint exposed surfaces of steel poles with two finish coats of exterior oil paint of a color as indicated.

3.1.5 Pole Setting

Depth shall be as indicated. Poles in straight runs shall be in a straight line. Dig holes large enough to permit the proper use of tamper to the full depth of the hole. Place backfill in the hole in 150 mm 6 inch maximum layers and thoroughly tamp. Place surplus earth around the pole in a conical shape and pack tightly to drain water away.

3.1.1 Photocell Switch Aiming

Aim switch according to manufacturer's recommendations. Mount switch on or beside each luminaire when switch is provided in cast weatherproof aluminum housing with swivel arm.

3.1.2 Grounding

Ground noncurrent-carrying parts of equipment including metal poles, luminaires, mounting arms, brackets, and metallic enclosures as specified in Section 33 70 02.00 10 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

3.1.3 Field Applied Painting

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

-- End of Section --

SECTION 28 31 64.00 10

FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE
04/06

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 S3.41	(1990; R 2001) Audible Emergency Evacuation Signal (ASA 96)

FM GLOBAL (FM)

FM P7825a	(2005) Approval Guide Fire Protection

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 1221	(2006; Errata 2006) Installation, Maintenance and Use of Emergency Services Communications Systems
NFPA 70	(2005; TIA 2005) National Electrical Code
NFPA 72	(2006) National Fire Alarm Code
NFPA 90A	(2002; Errata 2003; Errata 2005) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 1242	(2006; Rev thru Jun 2006) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 268	(2006) Standard for Smoke Detectors for Fire Alarm Signaling Systems
UL 268A	(1998; Rev thru Apr 2006) Smoke Detectors for Duct Application
UL 38	(2005) Standard for Signaling Boxes for Fire Alarm Systems

UL 464	(2003; Rev thru Oct 2003) Standard for Audible Signal Appliances
UL 521	(1999; Rev thru Jul 2005) Heat Detectors for Fire Protective Signaling Systems
UL 6	(2004e13) Standard for Electrical Rigid Metal Conduit-Steel
UL 797	(2004) Standard for Electrical Metallic Tubing -- Steel
UL 864	(2003; Rev thru Mar 2006) Control Units and Accessories for Fire Alarm Systems

1.1.1 EQUIVALENT REFERENCES

Equipment and material meeting standards that are deemed equivalent (by the Authority Having Jurisdiction) to the above referenced standards may be submitted for approval.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

Detail drawings, prepared and signed by a Registered Professional Engineer or a NICET Level 4 Fire Alarm Technician, as specified.

SD-03 Product Data

Storage Batteries

Substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component and each panel component, and the battery recharging period shall be included.

Low Battery Voltage

Voltage drop calculations for notification appliance circuits to indicate that sufficient voltage is available for proper appliance operation.

Special Tools and Spare Parts

Spare parts data for each different item of material and equipment specified, not later than 3 months prior to the date of beneficial occupancy. Data shall include a complete list of parts and

supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after 1 year of service.

Technical Data and Computer Software;

Technical data which relates to computer software.

Training

Lesson plans, operating instructions, maintenance procedures, and training data, furnished in manual format, for the training courses. The operations training shall familiarize designated government personnel with proper operation of the fire alarm system. The maintenance training course shall provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

Testing

Detailed test procedures, prepared and signed by a Registered Professional Engineer or a NICET Level 4 Fire Alarm Technician, for the fire detection and alarm system 60 days prior to performing system tests.

SD-06 Test Reports

Testing; G

Test reports, in booklet form, showing field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall document readings, test results and indicate the final position of controls. The Contractor shall include the NFPA 72 Certificate of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.

SD-07 Certificates

Equipment

Certified copies of current approvals or listings issued by an independent test lab if not listed by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.

Qualifications

Proof of qualifications for required personnel. The installer shall submit proof of experience for the Professional Engineer, fire alarm technician, and the installing company.

1.3 GENERAL REQUIREMENTS

1.3.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that can provide service within 24 hours of notification.

1.3.2 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a noncorrosive and nonheat-sensitive plate which is securely attached to the equipment.

1.3.3 Keys and Locks

Locks shall be keyed alike. Four keys for the system shall be provided.

1.3.4 Tags

Tags with stamped identification number shall be furnished for keys and locks.

1.3.5 Verification of Dimensions

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

1.3.6 Compliance

The fire detection and alarm system and the central reporting system shall be configured in accordance with NFPA 72; exceptions are acceptable as directed by the Contracting Officer. The equipment furnished shall be compatible and be UL listed, FM approved, or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

1.3.7 Qualifications

1.3.7.1 Engineer and Technician

a. Registered Professional Engineer with verification of experience and at least 4 years of current experience in the design of the fire protection and detection systems.

b. National Institute for Certification in Engineering Technologies (NICET) qualifications as an engineering technician in fire alarm systems program with verification of experience and current NICET certificate.

c. The Registered Professional Engineer may perform all required items under this specification. The NICET Fire Alarm Technician shall perform only the items allowed by the specific category of certification held.

d. Alternative qualifications may be considered for the fire alarm technician. Contractor shall submit proof of equivalency to NICET certification with proof of experience.

1.3.7.2 Installer

The installing Contractor shall provide the following: Fire Alarm Technicians with a minimum of 2 years of experience shall be utilized to assist in the installation and terminate fire alarm devices, cabinets and panels. An electrician shall be allowed to install wire or cable and to install conduit for the fire alarm system. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.3.7.3 Design Services

Installations requiring designs or modifications of fire detection, fire alarm, or fire suppression systems shall require the services and review of a qualified fire protection engineer. For the purposes of meeting this requirement, a qualified fire protection engineer is defined as an individual meeting one of the following conditions:

a. An engineer having a Bachelor of Science or Masters of Science Degree in Fire Protection Engineering from an accredited university engineering program, plus a minimum of 2 years' work experience in fire protection engineering.

b. A registered professional engineer (P.E.) in fire protection engineering.

c. A registered PE in a related engineering discipline and member grade status in the National Society of Fire Protection Engineers.

d. An engineer with a minimum of 10 years' experience in fire protection engineering and member grade status in the National Society of Fire Protection Engineers.

1.3.8 Detail Drawings

The Contractor shall submit detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical detectors. The Contractor shall check the layout based on the actual detectors to be installed and make any necessary revisions in the detail drawings. The detail drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Detailed point-to-point wiring diagram shall be prepared and signed by a Registered Professional Engineer or a NICET Level 4 Fire Alarm Technician showing points of connection. Diagram shall include connections between system devices, appliances, control panels, supervised devices, and equipment that is activated or controlled by the panel.

1.4 SYSTEM DESIGN

1.4.1 Operation

The fire alarm and detection system shall be a complete, supervised fire alarm reporting system. The system shall be activated into the alarm mode by actuation of any alarm initiating device. The system shall remain in the alarm mode until the initiating device is reset and the fire alarm control panel is reset and restored to normal. Alarm initiating devices shall be connected to initiating device circuits (IDC), Style B, to signal line circuits (SLC), Style 4, in accordance with NFPA 72. Alarm notification appliances shall be connected to notification appliance circuits (NAC), Style Y in accordance with NFPA 72. A looped conduit system shall be provided so that if the conduit and all conductors within are severed at any point, all IDC, NAC and SLC will remain functional. Textual, audible, and visual appliances and systems shall comply with NFPA 72. Fire alarm system components requiring power, except for the control panel power supply, shall operate on 24 Volts dc. Addressable system shall be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits and shall provide the following features:

a. Sufficient memory to perform as specified and as shown for addressable system.

b. Individual identity of each addressable device for the following conditions: alarm; trouble; open; short; and appliances missing/failed remote detector - sensitivity adjustment from the panel for smoke detectors.

c. Capability of each addressable device being individually disabled or enabled from the panel.

d. Each SLC shall be sized to provide 40 percent addressable expansion without hardware modifications to the panel.

1.4.2 Operational Features

The system shall have the following operating features:

a. Monitor electrical supervision of IDC.

b. Monitor electrical supervision of the primary power (ac) supply, battery voltage, placement of alarm zone module (card, PC board) within the control panel, and transmitter tripping circuit integrity.

c. A trouble buzzer and trouble LED/LCD (light emitting diode/liquid crystal diode) to activate upon a single break, open, or ground fault condition which prevents the required normal operation of the system. The trouble signal shall also operate upon loss of primary power (ac) supply, low battery voltage, removal of alarm zone module (card, PC board), and disconnection of the circuit used for transmitting alarm signals off-premises. A trouble alarm silence switch shall be provided which will silence the trouble buzzer, but will not extinguish the trouble indicator LED/LCD. Subsequent trouble and supervisory alarms shall sound the trouble signal until silenced. After the system returns to normal operating conditions, the trouble buzzer shall again sound until the silencing switch returns to normal position, unless automatic trouble reset is provided.

d. A one person test mode. Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, without activating the transmitter during the entire process.

e. A transmitter disconnect switch to allow testing and maintenance of the system without activating the transmitter but providing a trouble signal when disconnected and a restoration signal when reconnected.

f. Evacuation alarm silencing switch which, when activated, will silence alarm devices, but will not affect the zone indicating LED/LCD nor the operation of the transmitter. This switch shall be over-ridden upon activation of a subsequent alarm from an unalarmed device and the NAC devices will be activated.

g. Electrical supervision for circuits used for supervisory signal services (i.e., sprinkler systems, valves, etc.). Supervision shall detect any open, short, or ground.

h. Confirmation or verification of all smoke detectors. The control panel shall interrupt the transmission of an alarm signal to the system control panel for a factory preset period. This interruption period shall be adjustable from 1 to 60 seconds and be factory set at 20 seconds. Immediately following the interruption period, a confirmation period shall be in effect during which time an alarm signal, if present, will be sent immediately to the control panel. Fire alarm devices other than smoke detectors shall be programmed without confirmation or verification.

i. The fire alarm control panel shall provide supervised addressable relays for HVAC shutdown. An override at the HVAC panel shall not be provided.

j. Provide one person test mode - Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, without activating the transmitter during the entire process.

k. The fire alarm control panel shall provide the required monitoring and supervised control outputs needed to accomplish elevator recall.

l. The fire alarm control panel shall monitor and control the fire sprinkler system, or other fire protection extinguishing system.

m. The control panel and field panels shall be software reprogrammable to enable expansion or modification of the system without replacement of hardware or firmware. Examples of required changes are: adding or deleting devices or zones; changing system responses to particular input signals; programming certain input signals to activate auxiliary devices.

n. Zones for IDC shall be arranged as indicated on the contract drawings.

1.4.3 Alarm Functions

An alarm condition on a circuit shall automatically initiate the following functions:

a. Transmission of a signal over the station fire reporting system. The signal shall be common for any device.

b. Visual indications of the alarmed devices on the fire alarm control panel display.

c. Continuous sounding or operation of alarm notification appliances throughout the building as required by ANSI S3.41.

d. Deactivation of the air handling units serving the alarmed area.

1.4.4 Primary Power

Operating power shall be provided as required by paragraph Power Supply for the System. Transfer from normal to emergency power or restoration from emergency to normal power shall be fully automatic and not cause transmission of a false alarm. Loss of ac power shall not prevent transmission of a signal via the fire reporting system upon operation of any initiating circuit.

1.4.5 Battery Backup Power

Battery backup power shall be through use of rechargeable, sealed-type storage batteries and battery charger. Furnish one (1) set of backup storage batteries.

1.5 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt, dust, and any other contaminants.

PART 2 PRODUCTS

2.1 CONTROL PANEL

Control Panel shall comply with the applicable requirements of UL 864. Panel shall be modular, installed in a surface mounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered, and orderly assembled panel containing components and equipment required to provide the specified operating and supervisory functions of the system. The panel shall have prominent rigid plastic, phenolic or metal identification plates for LED/LCDs, zones, SLC, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. The LED/LCD displays shall be located on the exterior of the cabinet door or be visible through the cabinet door. Control panel switches shall be within the locked cabinet. A suitable means (single operation) shall be provided for testing the control panel visual indicating devices (meters or LEDs/LCDs). Meters and LEDs shall be plainly visible when the cabinet door is closed. Signals and LEDs/LCDs shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system. Loss of power, including batteries, shall not require the manual reloading of a program. Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying

primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals. Visual annunciation shall be provided for LED/LCD visual display as an integral part of the control panel and shall identify with a word description and id number each device. Cabinets shall be provided with ample gutter space to allow proper clearance between the cabinet and live parts of the panel equipment. If more than one modular unit is required to form a control panel, the units shall be installed in a single cabinet large enough to accommodate units. Cabinets shall be painted red.

2.1.1 Circuit Connections

Circuit conductors entering or leaving the panel shall be connected to screw-type terminals with each conductor and terminal marked for identification.

2.1.2 Addressable Control Module

The control module shall be capable of operating as a relay (dry contact form C) for interfacing the control panel with other systems, and to control door holders or initiate elevator fire service. The module shall be UL listed as compatible with the control panel. The indicating device or the external load being controlled shall be configured as a Style Y notification appliance circuits. The system shall be capable of supervising, audible, visual and dry contact circuits. The control module shall have both an input and output address. The supervision shall detect a short on the supervised circuit and shall prevent power from being applied to the circuit. The control model shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. The control module shall contain an integral LED that flashes each time the control module is polled.

2.1.3 Addressable Initiating Device Circuits Module

The initiating device being monitored shall be configured as a Style B initiating device circuits. The system shell be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or loss of polling. The module shall be UL listed as compatible with the control panel. The monitor module shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. Monitor module shall contain an integral LED that flashes each time the monitor module is polled. Pull stations with a monitor module in a common backbox are not required to have an LED.

2.2 STORAGE BATTERIES

Storage batteries shall be provided and shall be 24 Vdc sealed, lead-calcium type requiring no additional water. The batteries shall have ample capacity, with primary power disconnected, to operate the fire alarm system for a period of 72 hours. Following this period of battery operation, the batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 15 minutes. Batteries shall be located at the bottom of the panel. Batteries shall be provided with overcurrent protection in accordance with NFPA 72. Separate battery cabinets shall have a lockable, hinged cover similar to the fire alarm panel. The lock shall be keyed the same as the

fire alarm control panel. Cabinets shall be painted to match the fire alarm control panel. Provide spare battery of same capacity for each fire alarm panel.

2.3 BATTERY CHARGER

Battery charger shall be completely automatic, 24 Vdc with high/low charging rate, capable of restoring the batteries from full discharge (18 Volts dc) to full charge within 48 hours. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly, if a high rate switch is provided. Charger shall be located in control panel cabinet or in a separate battery cabinet.

2.4 ADDRESSABLE MANUAL FIRE ALARM STATIONS

Addressable manual fire alarm stations shall conform to the applicable requirements of UL 38. Manual stations shall be connected into signal line circuits. Stations shall be installed on surface mounted outlet boxes. Manual stations shall be mounted at 1220 mm. Stations shall be single action type. Stations shall be finished in red, with raised letter operating instructions of contrasting color. Stations requiring the breaking of glass or plastic panels for operation are not acceptable. Stations employing glass rods are not acceptable. The use of a key or wrench shall be required to reset the station. Gravity or mercury switches are not acceptable. Switches and contacts shall be rated for the voltage and current upon which they operate. Addressable pull stations shall be capable of being field programmed, shall latch upon operation and remain latched until manually reset. Stations shall have a separate screw terminal for each conductor. Surface mounted boxes shall be matched and painted the same color as the fire alarm manual stations.

2.5 FIRE DETECTING DEVICES

Fire detecting devices shall comply with the applicable requirements of NFPA 72, NFPA 90A, UL 268, UL 268A, and UL 521. The detectors shall be provided as indicated. Detector base shall have screw terminals for making connections. No solder connections will be allowed. Detectors located in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD. Addressable fire detecting devices, except flame detectors, shall be dynamically supervised and uniquely identified in the control panel. All fire alarm initiating devices shall be individually addressable, except where indicated. Installed devices shall conform to NFPA 70 hazard classification of the area where devices are to be installed.

2.5.1 Heat Detectors

Heat detectors shall be designed for detection of fire by fixed temperature. Heat detector spacing shall be rated in accordance with UL 521.

2.5.1.1 Fixed Temperature Detectors

Detectors shall be designed for surface outlet box mounting and supported independently of wiring connections. Detectors shall be designed to detect high heat. The detectors shall have a specific temperature setting of 57.2 degrees C. The UL 521 test rating for the fixed temperature detectors shall be rated for 4.57 by 4.57 m.

2.5.2 Smoke Detectors

Smoke detectors shall be designed for detection of abnormal smoke densities. Smoke detectors shall be photoelectric type. Detectors shall contain a visible indicator LED/LCD that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be the plug-in type in which the detector base contains terminals for making wiring connections.

2.5.2.1 Duct Detectors

Duct-mounted photoelectric smoke detectors shall be furnished and installed where indicated and in accordance with NFPA 90A. Units shall consist of a smoke detector as specified in paragraph Photoelectric Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. Detectors shall have a manual reset. Detectors shall be rated for air velocities that include air flows between 2.5 and 20 m/s. Detectors shall be powered from the fire alarm panel. Sampling tubes shall run the full width of the duct. The duct detector package shall conform to the requirements of NFPA 90A, UL 268A, and shall be UL listed for use in air-handling systems. The control functions, operation, reset, and bypass shall be controlled from the fire alarm control panel. Lights to indicate the operation and alarm condition; and the test and reset buttons shall be visible and accessible with the unit installed and the cover in place. Detectors mounted above 1.83 m and those mounted below 1.83 m that cannot be easily accessed while standing on the floor, shall be provided with a remote detector indicator panel containing test and reset switches. Remote lamps and switches as well as the affected fan units shall be properly identified in etched plastic placards. Detectors shall have auxiliary contacts to provide control, interlock, and shutdown functions. The detectors shall be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

2.6 NOTIFICATION APPLIANCES

2.6.1 Alarm Horns

Horns shall be surface mounted, with the matching mounting back box surface mounted single grille and vibrating type suitable for use in an electrically supervised circuit. Horns shall produce a sound rating of at least 85 dBA at 3.05 m. Horns used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.

2.6.2 Visual Notification Appliances

Visual notification appliances shall conform to the applicable requirements of UL 1971 and the contract drawings. Appliances shall have clear high intensity optic lens, xenon flash tubes, and output white light. Strobe flash rate shall be between 1 to 3 flashes per second and a minimum of 75 candela. Strobe shall be surface mounted.

2.6.3 Combination Audible/Visual Notification Appliances

Combination audible/visual notification appliances shall provide the same requirements as individual units except they shall mount as a unit in standard backboxes. Units shall be factory assembled. Any other audible

notification appliance employed in the fire alarm systems shall be approved by the Contracting Officer.

2.7 FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT

2.7.1 Conduit

Conduit and fittings shall comply with NFPA 70, UL 6, UL 1242, and UL 797.

2.7.2 Wiring

Wiring shall conform to NFPA 70. Wiring for 220 Vac power shall be No. $4mm^2$ minimum. The SLC wiring shall be copper cable in accordance with the manufacturers requirements. Wiring for fire alarm dc circuits shall be No. 16 AWG minimum. Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays. Wiring shall conform to NFPA 70. System field wiring shall be solid copper and installed in metallic conduit or electrical metallic tubing, except that rigid plastic conduit may be used under slab-on-grade. Conductors shall be color coded. Conductors used for the same functions shall be similarly color coded. Wiring code color shall remain uniform throughout the circuit. Pigtail or T-tap connections to initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited. T-tapping using screw terminal blocks is allowed for style 4 addressable systems.

2.7.3 Special Tools and Spare Parts

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment shall be furnished to the Contracting Officer. Two spare fuses of each type and size required shall be furnished. Two percent of the total number of each different type of detector, but no less than two each, shall be furnished. Spare fuses shall be mounted in the fire alarm panel.

PART 3 EXECUTION

3.1 INSTALLATION

All work shall be installed as shown, and in accordance with NFPA 70 and NFPA 72, and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified. Smoke detectors shall not be installed until construction is essentially complete and the building has been thoroughly cleaned.

3.1.1 Power Supply for the System

A single dedicated circuit connection for supplying power from a branch circuit to each building fire alarm system shall be provided. The power shall be supplied as shown on the drawings. The power supply shall be equipped with a locking mechanism and marked in red with the words "FIRE ALARM CIRCUIT CONTROL".

3.1.2 Wiring

Conduit size for wiring shall be in accordance with NFPA 70. Wiring for the fire alarm system shall not be installed in conduits, junction boxes, or

outlet boxes with conductors of lighting and power systems. Not more than two conductors shall be installed under any device screw terminal. The wires under the screw terminal shall be straight when placed under the terminal then clamped in place under the screw terminal. The wires shall be broken and not twisted around the terminal. Circuit conductors entering or leaving any mounting box, outlet box enclosure, or cabinet shall be connected to screw terminals with each terminal and conductor marked in accordance with the wiring diagram. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors in the system is prohibited. Wiring within any control equipment shall be readily accessible without removing any component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.

3.1.3 Control Panel

The control panel and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 300 mm nor more than 2000 mm above the finished floor. Manually operable controls shall be between 900 and 1100 mm above the finished floor. Panel shall be installed to comply with the requirements of UL 864.

3.1.4 Detectors

Detectors shall be located and installed in accordance with NFPA 72. Detectors shall be connected into signal line circuits or initiating device circuits as indicated on the drawings. Detectors shall be at least 300 mm from any part of any lighting fixture. Detectors shall be located at least 900 mm from diffusers of air handling systems. Each detector shall be provided with appropriate mounting hardware as required by its mounting location. Detectors which mount in open space shall be mounted directly to the end of the stubbed down rigid conduit drop. Conduit drops shall be firmly secured to minimize detector sway. Where length of conduit drop from ceiling or wall surface exceeds 900 mm, sway bracing shall be provided.

3.1.5 Notification Appliances

Notification appliances shall be mounted 2003 mm above the finished floor or 150 mm below the ceiling, whichever is lower.

3.1.6 Annunciator Equipment

Annunciator equipment shall be mounted where indicated on the drawings.

3.2 OVERVOLTAGE AND SURGE PROTECTION

3.2.1 Power Line Surge Protection

All equipment connected to alternating current circuits shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground).

3.3 GROUNDING

Grounding shall be provided by connecting to building ground system.

3.4 TESTING

The Contractor shall notify the Contracting Officer at least 10 days before the preliminary and acceptance tests are to be conducted. The tests shall be performed in accordance with the approved test procedures in the presence of the Contracting Officer. The control panel manufacturer's representative shall be present to supervise tests. The Contractor shall furnish instruments and personnel required for the tests.

3.4.1 Preliminary Tests

Upon completion of the installation, the system shall be subjected to functional and operational performance tests including tests of each installed initiating and notification appliance, when required. Tests shall include the meggering of system conductors to determine that the system is free from grounded, shorted, or open circuits. The megger test shall be conducted prior to the installation of fire alarm equipment. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional. After completing the preliminary testing the Contractor shall complete and submit the NFPA 72, Certificate of Completion.

3.4.2 Acceptance Test

Acceptance testing shall not be performed until the Contractor has completed and submitted the Certificate of Completion. Testing shall be in accordance with NFPA 72. The recommended tests in NFPA 72 shall be considered mandatory and shall verify that previous deficiencies have been corrected. The Contractor shall complete and submit the NFPA 72, Inspection and Testing Form. The test shall include all requirements of NFPA 72 and the following:

a. Test of each function of the control panel.

b. Test of each circuit in both trouble and normal modes.

c. Tests of each alarm initiating devices in both normal and trouble conditions.

d. Tests of each control circuit and device.

e. Tests of each alarm notification appliance.

f. Tests of the battery charger and batteries.

g. Complete operational tests under emergency power supply.

h. Visual inspection of wiring connections.

i. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.

j. Ground fault.

k. Short circuit faults.

l. Stray voltage.

m. Loop resistance.

3.5 TRAINING

Training course shall be provided for the operations and maintenance staff. The course shall be conducted in the building where the system is installed or as designated by the Contracting Officer. The training period for systems operation shall consist of 1 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The training period for systems maintenance shall consist of 2 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The instructions shall cover items contained in the operating and maintenance instructions. In addition, training shall be provided on performance of expansions or modifications to the fire detection and alarm system. The training period for system expansions and modifications shall consist of at least 1 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests.

-- End of Section --

SECTION 31 00 00

EARTHWORK
07/06

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 T 180	(2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop
AASHTO T 224	(2001; R 2004) Correction for Coarse Particles in the Soil Compaction Test

ASTM INTERNATIONAL (ASTM)

ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 33	(2003) Standard Specification for Concrete Aggregates
ASTM D 1140	(2000) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2002e1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 2434	(1968; R 2006) Permeability of Granular Soils (Constant Head)
ASTM D 2487	(2006) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(2005) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(2005) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

ASTM D 422	(1963; R 2002e1) Particle-Size Analysis of Soils
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2003) Safety -- Safety and Health Requirements

1.2 DEFINITIONS

1.2.1 Satisfactory Materials

Satisfactory materials comprise any materials classified by ASTM D 2487 as GW, GP, GM, SW, SP, SM, SW-SM, and SC. Satisfactory materials for grading comprise stones less than 200 mm, except for fill material for pavement and building areas which comprise stones less than 75 mm in any dimension.

1.2.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include trash; refuse; man-made fills and backfills containing debris from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. Notify the Contracting Officer when encountering any contaminated materials.

1.2.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are non-plastic. Perform testing, required for classifying materials, in accordance with ASTM D 4318, ASTM C 136, ASTM D 422, and ASTM D 1140.

1.2.4 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum dry density obtained by the test procedure presented in ASTM D 1557 abbreviated as a percent of laboratory maximum dry density. Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 19.0 mm sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 19.0 mm sieve as a percentage of the maximum density in accordance with AASHTO T 180 and corrected with AASHTO T 224. To maintain the same percentage of coarse material, use the "remove and replace" procedure as described in NOTE 8 of Paragraph 7.2 in AASHTO T 180.

For soils that are too coarse for testing by any of the methods listed above, compaction will be based on non-movement of the material under the compaction equipment and a specified number of passes of the compaction equipment.

1.2.5 Hard/Unyielding Materials

Hard/Unyielding materials comprise weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock". These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

1.2.6 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement. Removal of hard material will not be considered rock excavation because of intermittent drilling that is performed merely to increase production.

1.2.8 Unstable Material

Unstable materials are too wet for compaction and are too wet to properly support the utility pipe, conduit, or appurtenant structure.

1.2.9 Select Granular Material

Select granular material consisting of free draining materials classified as GW, GP, SW, SP, by ASTM D 2487 where indicated. Material gradation and minimum coefficient of permeability determined in accordance with ASTM D 2434 shall correspond with design requirements for the application specified.

1.2.10 Expansive Soils

Expansive soils are defined as soils that have a plasticity index equal to or greater than 30 and liquid limit exceeding 50 percent when tested in accordance with ASTM D 4318.

1.2.11 Nonfrost Susceptible (NFS) Material

Nonfrost susceptible materials are clean coarse aggregates having less than 5 percent passing the 0.075 mm size sieve, and with not more than 3 percent by weight finer than 0.02 mm grain size.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information Only (FIO) and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

1.6 SUBSURFACE DATA

The contractor shall confirm subsurface conditions and parameters necessary for the work by geotechnical investigation.

1.7 CLASSIFICATION OF EXCAVATION

No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

1.8 DEWATERING WORK PLAN

Submit procedures for accomplishing dewatering work.

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR OFFSITE SOILS

Test offsite soils brought in for use as backfill for compliance with the definition as a satisfactory material from a composite sample of material from the borrow site, with at least three tests from each borrow site. Do not bring material onsite until tests have been approved by the Contracting Officer.

2.2 MATERIAL FOR RIP-RAP

Provide Bedding material and rock conforming to these requirements for construction indicated.

2.2.1 Bedding Material

Provide bedding material consisting of sand, gravel, or crushed rock, well graded, with a maximum particle size of 50 mm. Compose material of tough, durable particles. Allow fines passing the 75 micrometers standard sieve with a plasticity index less than six.

2.4.3 Rock

Provide rock fragments sufficiently durable to ensure permanence in the structure and the environment in which it is to be used. Use rock fragments free from cracks, seams, and other defects that would increase the risk of deterioration from natural causes. Provide fragments sized so that no individual fragment exceeds a weight of 68 kg and that no more than 10 percent of the mixture, by weight, consists of fragments weighing 0.91 kg or less each. Provide rock with a minimum specific gravity of 2.7. Do not permit the inclusion of more than trace 1 percent quantities of dirt, sand, clay, and rock fines.

2.5 CAPILLARY WATER BARRIER

Provide capillary water barrier of clean, poorly graded crushed rock, crushed gravel, or uncrushed gravel placed beneath a building slab with a 20 mil vapor barrier to cut off the capillary flow of pore water to the area immediately below. Conform to ASTM C 33 for fine aggregate grading with a maximum of 3 percent by weight passing ASTM D 1140, 75 micrometers sieve.

2.6 PIPE BEDDING MATERIAL

Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Backfill to top of pipe shall be compacted to 95 percent

of ASTM D 1557 maximum dry density. Plastic piping shall have bedding to spring line of pipe. Provide ASTM D 2321 materials as follows:

a. Class I: Angular, 6 to 40 mm, graded stone, including a number of fill materials that have regional significance such as crushed stone.

b. Class II: Coarse sands and gravels with maximum particle size of 40 mm, including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D 2487.

2.7 SEWAGE ABSORPTION TRENCHES

2.7.1 Porous Fill

Backfill material consisting of clean crushed rock or gravel having a gradation such that 100 percent passes the 50 mm sieve and zero percent passes the 12.5 mm sieve.

2.7.2 Cover

Geotextile conforming to Specification Section 31 05 19 or a layer of straw at least 50 mm thick as indicated.

PART 3 EXECUTION

3.1 STRIPPING OF TOPSOIL

Where indicated or directed, strip topsoil to a minimum depth of 100 mm. Keep topsoil separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 50 mm in diameter, and other materials.

3.2 GENERAL EXCAVATION

Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations needed to construct the site as indicated. Perform the grading in accordance with the typical sections shown and the tolerances specified in paragraph FINISHING. Transport satisfactory excavated materials and place in fill or embankment within the limits of the work. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials as directed. Dispose surplus satisfactory excavated material not required for fill or embankment in areas approved for surplus material storage or designated waste areas. Dispose unsatisfactory excavated material in waste or spoil areas. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times. Excavate material required for fill or embankment in excess of that produced by excavation within the grading limits from approved areas selected by the Contractor as specified.

3.2.1 Ditches, Gutters, and Channel Changes

Finish excavation of ditches, gutters, and channel changes by cutting accurately to the cross sections, grades, and elevations required. Backfill

the excessive open ditch or gutter excavation with satisfactory, thoroughly compacted, material or with suitable stone or cobble to approved grades. Maintain excavations free from leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.2.2 Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. Construct storm drainage features at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity. Provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

3.2.3 Dewatering

Control groundwater flowing toward or into excavations to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. Do not permit French drains, sumps, ditches or trenches within 0.9 m of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Take control measures by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, maintain the water level continuously, below the working level. Operate dewatering system continuously until construction work below existing water levels is complete. Submit performance records weekly. Measure and record performance of dewatering system at same time each day by use of observation wells or piezometers installed in conjunction with the dewatering system.

3.2.4 Pipe Trenches

Excavate to the dimension indicated. Grade bottom of trenches to provide uniform support for each section of pipe after pipe bedding placement. Tamp if necessary to provide a firm pipe bed. Recesses shall be excavated to accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth of at least 150 mm below the bottom of the pipe.

3.2.5 Structures

Make excavations to the lines, grades, and elevations shown, or as directed. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations. Clean rock or other hard foundation material of loose debris and cut to a firm, level, stepped, or serrated surface. Remove loose disintegrated rock and thin strata. Do not disturb the bottom of the excavation when concrete or masonry is to be placed in an excavated area.

Do not excavate to the final grade level until just before the concrete or masonry is to be placed.

3.3 SELECTION OF BORROW MATERIAL

Select borrow material to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Obtain borrow material from approved sources. Unless otherwise provided in the contract, the Contractor is responsible for obtaining the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling from the owners. Unless specifically provided, do not obtain borrow within the limits of the project site without prior written approval. Consider necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon related operations to the borrow excavation.

3.4 OPENING AND DRAINAGE OF EXCAVATION AND BORROW PITS

The Contractor is responsible for notifying the Contracting Officer sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken. Except as otherwise permitted, excavate borrow pits and other excavation areas providing adequate drainage. Transport overburden and other spoil material to designated spoil areas or otherwise dispose of as directed. Provide neatly trimmed and drained borrow pits after the excavation is completed. Ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.5 GRADING AREAS

Where indicated, divide work into grading areas within which satisfactory excavated material will be placed in embankments, fills, and required backfills. Place and grade stockpiles of satisfactory, unsatisfactory and wasted materials as specified. Keep stockpiles in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber-tired equipment, the ground surface at stockpile locations; separately stockpile excavated satisfactory and unsatisfactory materials. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, remove and replace such material with satisfactory material from approved sources.

3.6 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Do not excavate to final grade until just before concrete is to be placed. Only use excavation methods that will leave the foundation rock in a solid and unshattered condition. Roughen the level surfaces, and cut the sloped surfaces, as indicated, into rough steps or benches to provide a satisfactory bond. Protect shales from slaking and all surfaces from erosion resulting from ponding or water flow.

3.7 GROUND SURFACE PREPARATION

3.7.1 General Requirements

Remove and replace unsatisfactory material with satisfactory materials, as directed by the Contracting Officer, in surfaces to receive fill or in excavated areas. Scarify the surface to a depth of 150 mm before the fill is started. Plow, step, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that the fill material will bond with the existing material. When subgrades are less than the specified density, break up the ground surface to a minimum depth of 150 mm, pulverizing, and compacting to the specified density. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 300 mm and compact it as specified for the adjacent fill.

3.7.2 Frozen Material

Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

3.8 UTILIZATION OF EXCAVATED MATERIALS

Dispose unsatisfactory materials removed from excavations into waste disposal or spoil areas. Use satisfactory material removed from excavations, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. Do not waste any satisfactory excavated material without specific written authorization. Dispose of satisfactory material, authorized to be wasted, in designated areas approved for surplus material storage or designated waste areas as directed. Clear and grub newly designated waste areas on Government-controlled land before disposal of waste material thereon. Stockpile and use durable coarse rock from excavations for constructing slopes or embankments adjacent to streams, or sides and bottoms of channels and for protecting against erosion. Do not dispose excavated material to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

3.9 EMBANKMENTS

3.9.1 Earth Embankments

Construct earth embankments from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 75 mm. Place the material in successive horizontal layers of loose material not more than 300 mm in depth. Spread each layer uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, plow, disk, or otherwise brake up each layer; moisten or aerate as necessary; thoroughly mix; and compact to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum dry density for cohesionless materials. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements are identical with those requirements specified in paragraph SUBGRADE PREPARATION. Finish

compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.10 SUBGRADE PREPARATION

3.10.1 Proof Rolling

Finish proof rolling on an exposed subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade. Proof roll the subgrade with six passes of a dump truck loaded with 6 cubic meters of soil or a 13.6 metric ton pneumatic-tired roller. Operate the roller or truck in a systematic manner to ensure the number of passes over all areas, and at speeds between 4 to 5.5 km/hour. When proof rolling, provide one-half of the passes made with the roller in a direction perpendicular to the other passes. Notify the Contracting Officer a minimum of 3 days prior to proof rolling. Perform proof rolling in the presence of the Contracting Officer. Undercut rutting or pumping of material as directed by the Contracting Officer and replace with properly compacted satisfactory material.

3.10.2 Construction

Shape subgrade to line, grade, and cross section, and compact as specified. Include plowing, disking, and any moistening or aerating required to obtain specified compaction for this operation. Remove soft or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed. Excavate rock encountered in the cut section to a depth of 150 mm below finished grade for the subgrade. Bring up low areas resulting from removal of unsatisfactory material or excavation of rock to required grade with satisfactory materials, and shape the entire subgrade to line, grade, and cross section and compact as specified. After rolling, do not show deviations for the surface of the subgrade for roadways greater than 13 mm when tested with a 4 m straightedge applied both parallel and at right angles to the centerline of the area. Do not vary the elevation of the finish subgrade more than 13 mm from the established grade and cross section.

3.10.3 Compaction

Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Except for paved areas and railroads, compact each layer of the embankment to at least 95 percent of laboratory maximum dry density determined in accordance with ASTM D 1557.

3.10.3.1 Subgrade for Pavements

Compact subgrade for pavements to at least 95 percent of the laboratory maximum dry density for the depth below the surface of the pavement shown. When more than one soil classification is present in the subgrade, thoroughly blend, reshape, and compact the top 203 mm of subgrade.

3.10.3.2 Subgrade for Shoulders

Compact subgrade for shoulders to at least 95 percent of the laboratory maximum dry density for the full depth of the shoulder.

3.11 SHOULDER CONSTRUCTION

Construct shoulders of satisfactory excavated or borrow material or as otherwise shown or specified. Construct shoulders immediately after adjacent paving is complete. In the case of rigid pavements, do not construct shoulders until permission of the Contracting Officer has been obtained. Compact the entire shoulder area to at least the percentage of maximum density as specified in paragraph SUBGRADE PREPARATION above, for specific ranges of depth below the surface of the shoulder. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Finish shoulder construction in proper sequence in such a manner that adjacent ditches will be drained effectively and that no damage of any kind is done to the adjacent completed pavement. Align the completed shoulders true to grade and shaped to drain.

3.12 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the required lines, grades, and cross sections or elevations. Provide the degree of finish for graded areas within 30 mm of the required grades and elevations except that the degree of finish for subgrades specified in paragraph SUBGRADE PREPARATION. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed from settlement or washing to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

3.12.1 Subgrade and Embankments

During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do no disturb the finished subgrade by traffic or other operation. The Contractor is responsible for protecting and maintaining the finished subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on the finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy, spongy, or frozen subgrade.

3.12.2 Capillary Water Barrier

Place a capillary water barrier under concrete floor and area-way slabs grade directly on the subgrade and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.12.3 Grading In and Around Structures

Construct areas within 3 m of each building and structure line true-to-grade, shape to drain and in accordance with these specifications. Maintain free of trash and debris until final inspection has been completed and the work has been accepted.

3.13 FILLING AND BACKFILLING

Fill and backfill to contours, elevations, and dimensions indicated. Compact each lift before placing overlaying lift.

3.13.1 Backfill and Fill Material Placement

Place in 150 mm lifts. Do not place over wet or frozen areas. Place backfill material adjacent to structures as the structural elements are completed and accepted. Backfill against concrete only when approved. Place and compact material to avoid loading upon or against the structure.

3.13.2 Select Granular Material Placement

Place in 150 mm lifts. Do not place over wet or frozen areas. Backfill adjacent to structures shall be placed as structural elements are completed and accepted. Backfill against concrete only when approved. Place and compact material to avoid loading upon or against structure.

3.13.3 Backfill and Fill Material Placement Over Pipes and at Walls

Backfilling shall not begin until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade and shall include backfill for outside grease interceptors. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 600 mm above sewer lines and 300 mm above other utility lines shall be free from stones larger than 25 mm in any dimension. Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; the area remaining shall be compacted in layers not more than 100 mm in compacted thickness with power-driven hand tampers suitable for the material being compacted. Backfill shall be placed carefully around pipes or tanks to avoid damage to coatings, wrappings, or tanks. Backfill shall not be placed against foundation walls prior to 7 days after completion of the walls. As far as practicable, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall.

3.13.4 Porous Fill Placement

Place in 100 mm lifts with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.13.5 Trench Backfilling

Backfill as rapidly as construction, testing, and acceptance of work permits. Place and compact backfill under structures and paved areas in 150 mm lifts to top of trench and in 150 mm lifts to 300 mm over pipe outside structures and paved areas.

3.14 RIP-RAP CONSTRUCTION

Construct rip-rap on bedding material or geotextile filter.

3.14.1 Preparation

Trim and dress indicated areas to conform to cross sections, lines and grades shown within a tolerance of 30 mm.

3.14.2 Filter Placement

If bedding material is used as the filter, spread the material uniformly to a thickness of at least 75 mm on prepared subgrade as indicated. Compaction of bedding is not required. Finish bedding to present even surface free from mounds and windrows. Place geotextile filter in accordance with Specification Section 31 00 00.

3.14.3 Stone Placement

Place rock for rip-rap on prepared filter material to produce a well graded mass with the minimum practicable percentage of voids in conformance with lines and grades indicated. Distribute larger rock fragments, with dimensions extending the full depth of the rip-rap throughout the entire mass and eliminate "pockets" of small rock fragments. Rearrange individual pieces by mechanical equipment or by hand as necessary to obtain the distribution of fragment sizes specified above.

3.15 TESTING

Perform testing by a Corps validated commercial testing laboratory. If the Contractor elects to establish testing facilities, do not permit work requiring testing until the Contractor's facilities have been inspected, Corps validated and approved by the Contracting Officer. Determine field in-place density in accordance with ASTM D 1556 or ASTM D 2922. When ASTM D 2922 is used, check the calibration curves and adjust using only the sand cone method as described in ASTM D 1556. ASTM D 2922 results in a wet unit weight of soil to determine the moisture content of the soil when using this method ASTM D 3017. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D 3017; check the calibration of both the density and moisture gauges at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, remove the material, replace and recompact to meet specification requirements. Perform tests on recompacted areas to determine conformance with specification requirements. Appoint a registered professional civil engineer to certify inspections and test results. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

3.15.1 Fill and Backfill Material Gradation

One test per 20 cubic meters stockpiled or in-place source material. Determine gradation of fill and backfill material in accordance with ASTM C 136.

3.15.2 In-Place Densities

a. One test per 140 square meters, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.

b. One test per 45 square meters, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

c. One test per 50 linear meters, or fraction thereof, of each lift of embankment or backfill for roads.

3.15.3 Check Tests on In-Place Densities

If ASTM D 2922 is used, check in-place densities by ASTM D 1556 as directed by the Contracting Officer.

3.15.4 Moisture Contents

In the stockpile, excavation, or borrow areas, perform a minimum of two tests per day per type of material or source of material being placed during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and approved by the Contracting Officer.

3.15.5 Optimum Moisture and Laboratory Maximum Density

Perform tests for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 50 cubic meters of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

3.15.6 Tolerance Tests for Subgrades

Perform continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION during construction of the subgrades.

3.16 DISPOSITION OF SURPLUS MATERIAL

Remove from Government property as directed by the Contracting Officer.

-- End of Section --

SECTION 31 05 19

GEOTEXTILE
04/06

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 D 4354	(1999; R 2004) Sampling of Geosynthetics for Testing
ASTM D 4355	(2005) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491	(1999; R 2004e1) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(2004) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 2003) Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(2004) Determining Apparent Opening Size of a Geotextile
ASTM D 4759	(2002) Determining the Specification Conformance of Geosynthetics
ASTM D 4833	(2000e1) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4873	(2002) Identification, Storage, and Handling of Geosynthetic Rolls and Samples

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-03 Product Data

Thread

A minimum of 7 days prior to scheduled use, proposed thread type for sewn seams along with data sheets showing the physical properties of the thread.

Manufacturing Quality Control Sampling and Testing

A minimum of 7 days prior to scheduled use, manufacturer's quality control manual.

SD-04 Samples

Quality Assurance Samples and Tests

Samples for quality assurance testing; 7 days shall be allotted in the schedule to allow for testing.

SD-07 Certificates

Geotextile

A minimum of 7 days prior to scheduled use, manufacturer's certificate of compliance stating that the geotextile meets the requirements of this section. For needle punched geotextiles, the manufacturer shall also certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers. The certificate of compliance shall be attested to by a person having legal authority to bind the geotextile manufacturer.

1.3 DELIVERY, STORAGE AND HANDLING

Delivery, storage, and handling of geotextile shall be in accordance with ASTM D 4873.

1.3.1 Delivery

The Contracting Officer shall be notified a minimum of 24 hours prior to delivery and unloading of geotextile rolls. Rolls shall be packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. If quality assurance samples are collected, rolls shall be immediately rewrapped with the plastic wrapping. Geotextile or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Each roll shall be labeled with the manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

1.3.2 Storage

Rolls of geotextile shall be protected from construction equipment, chemicals, sparks and flames, temperatures in excess of 71 degrees C, or any other environmental condition that may damage the physical properties of the geotextile. To protect geotextile from becoming saturated, rolls shall either be elevated off the ground or placed on a sacrificial sheet of plastic in an area where water will not accumulate.

1.3.3 Handling

Geotextile rolls shall be handled and unloaded with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

PART 2 PRODUCTS

2.1 RAW MATERIALS

2.1.1 Geotextile

Geotextile shall be the type and class required for the intended application and shall exhibit properties conforming to design requirements. Geotextile shall be a pervious sheet of polymeric material and shall consist of long-chain synthetic polymers composed of at least 95 percent by weight polyolefins, polyesters, or polyamides. The use of woven slit film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character) will not be allowed. Stabilizers and/or inhibitors shall be added to the base polymer, as needed, to make the filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure. Regrind material, which consists of edge trimmings and other scraps that have never reached the consumer, may be used to produce the geotextile. Post-consumer recycled material shall not be used. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. Minimum average roll properties shall be specified in accordance with ASTM D 4759 and shall include the properties listed below. Where applicable, property values represent minimum average roll values (MARV) in the weakest principal direction. Values for AOS represent maximum average roll values.

2.1.2 Thread

Sewn seams shall be constructed with high-strength polyester, nylon, or other approved thread type. Thread shall have ultraviolet light stability equivalent to the geotextile and the color shall contrast with the geotextile.

2.2 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

The Manufacturer shall be responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request. Manufacturing quality control sampling and testing shall be performed in accordance with the manufacturer's approved quality control manual. As a minimum, geotextiles shall be randomly sampled for testing in accordance with ASTM D 4354, Procedure A. Acceptance of geotextile shall be in accordance with ASTM D 4759. Tests not meeting the design requirements shall result in the rejection of applicable rolls.

PART 3 EXECUTION

3.1 QUALITY ASSURANCE SAMPLES AND TESTS

3.1.1 Quality Assurance Samples

The Contractor shall provide assistance to the Contracting Officer in the collection of quality assurance samples. Samples shall be collected upon delivery to the site for quality assurance testing at the request of the Contracting Officer and in accordance with ASTM D 4354, Procedure B. Lot size for quality assurance sampling shall be considered to be the shipment quantity of the product or a truckload of the product, whichever is smaller. The unit size shall be considered one roll of geotextile at a frequency of one per 10,000 square meters. Samples shall be identified with a waterproof marker by manufacturer's name, product identification, lot number, roll number, and machine direction. The date and a unique sample number shall also be noted on the sample. The outer layer of the geotextile roll shall be discarded prior to sampling a roll. Samples shall then be collected by cutting the full-width of the geotextile sheet a minimum of 1 meter long in the machine direction. Rolls which are sampled shall be immediately resealed in their protective covering.

3.1.2 Quality Assurance Tests

The Contractor shall provide quality assurance samples to an Independent Laboratory. Samples will be tested to verify that geotextile meets the requirements. Test method ASTM D 4355 shall not be performed on the collected samples. Geotextile product acceptance shall be based on ASTM D 4759. Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

3.2 INSTALLATION

3.2.1 Subgrade Preparation

The surface underlying the geotextile shall be smooth and free of ruts or protrusions which could damage the geotextile. Subgrade materials and compaction requirements shall be in accordance with Section 31 00 00.

3.2.2 Placement

The Contractor shall notify the Contracting Officer a minimum of 24 hours prior to installation of geotextile. Geotextile rolls which are damaged or contain imperfections shall be repaired or replaced as directed. The geotextile shall be laid flat and smooth so that it is in direct contact with the subgrade. The geotextile shall also be free of tensile stresses, folds, and wrinkles. On slopes steeper than 10 horizontal on 1 vertical, the geotextile shall be laid with the machine direction of the fabric parallel to the slope direction.

3.3 SEAMS

3.3.1 Overlap Seams

Geotextile panels shall be continuously overlapped a minimum of 300 mm at all longitudinal and transverse joints. Where seams must be oriented across the slope, the upper panel shall be lapped over the lower panel. If approved, sewn seams may be used instead of overlapped seams.

3.3.2 Sewn Seams

Factory and field seams shall be continuously sewn on all slopes steeper than 1 vertical on 4 horizontal. The stitch type used shall be a 401

locking chain stitch or as recommended by the manufacturer. For factory seams which are sewn, the Contractor shall provide at least a 2-meter sample of sewn seam before the geotextile is installed. For seams that are field sewn, the seams shall be sewn using the same equipment and procedures as will be used for the production seams. If seams are sewn in both the machine and cross machine direction, samples of seams from both directions shall be provided. Quality Assurance seam samples shall be provided to the Government at the request of the Contracting Officer. Seam strength shall meet the minimum requirements. The thread at the end of each seam run shall be tied off to prevent unraveling. Skipped stitches or discontinuities shall be sewn with an extra line of stitching with a minimum of 450 mm of overlap.

3.4 PROTECTION

The geotextile shall be protected during installation from clogging, tears, and other damage. Damaged geotextile shall be repaired or replaced as directed. Adequate ballast (e.g. sand bags) shall be used to prevent uplift by wind. The geotextile shall not be left uncovered for more than 14 days after installation.

3.5 REPAIRS

Torn or damaged geotextile shall be repaired. Clogged areas of geotextile shall be removed. Repairs shall be performed by placing a patch of the same type of geotextile over the damaged area. The patch shall extend a minimum of 300 mm beyond the edge of the damaged area. Patches shall be continuously fastened using approved methods. The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired. Geotextile rolls which cannot be repaired shall be removed and replaced. Repairs shall be performed at no additional cost to the Government

3.6 PENETRATIONS

Engineered penetrations of the geotextile shall be constructed by methods recommended by the geotextile manufacturer.

3.7 COVERING

Geotextile shall not be covered prior to inspection and approval by the Contracting Officer. Cover material shall be placed in a manner that prevents soil from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geotextile, and prevents wrinkles from folding over onto themselves. On side slopes, cover material shall be placed from the bottom of the slope upward. Cover material shall not be dropped onto the geotextile from a height greater than 1 m. No equipment shall be operated directly on top of the geotextile without approval of the Contracting Officer. Equipment with ground pressures less than 50 kPa shall be used to place the first lift over the geotextile. A minimum of 300 mm of cover material shall be maintained between full-scale construction equipment and the geotextile. Equipment placing cover material shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 2.2 m/s.

-- End of Section --

SECTION 32 11 16

AGGREGATE BASE COURSE
08/08

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 T 180	(2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop
AASHTO T 224	(2001; R 2004) Correction for Coarse Particles in the Soil Compaction Test

ASTM INTERNATIONAL (ASTM)

ASTM C 117	(2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	(2006)Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 29/C 29M	(2007) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2002e1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 2167	(1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method

ASTM D 2487	(2006) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 422	(1963; R 2002e1) Particle-Size Analysis of Soils
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 6938	(2007a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D 75	(2003) Standard Practice for Sampling Aggregates
ASTM E 11	(2004) Wire Cloth and Sieves for Testing Purposes

1.2 SUBMITTALS

Government approval is required for submittals with a FIO designation; submittals not having a FIO designation are for Contractor Quality Control approval. For information only. When used, a designation following the FIO designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment
List of proposed equipment to be used in performance of construction work, including descriptive data.

1.3 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved testing laboratory. Tests shall be performed at the specified frequency. No work requiring testing will be permitted until the testing laboratory has been inspected and approved. The materials shall be tested to establish compliance with the specified requirements.

1.3.1 Sampling

Samples for laboratory testing shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.3.2 Tests

1.3.2.1 Sieve Analysis

Sieve analysis shall be made in conformance with ASTM C 117 and ASTM C 136. Particle-size analysis of the soils shall be completed in conformance with ASTM D 422. Sieves shall conform to ASTM E 11.

1.3.2.2 Liquid Limit and Plasticity Index

Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318.

1.3.2.3 Moisture-Density Determinations

The laboratory maximum dry density and optimum moisture shall be determined in accordance with ASTM D 1557.

1.3.2.4 Field Density Tests

Density shall be field measured in accordance with ASTM D 1556. For the method presented in ASTM D 1556, the base plate, as shown in the drawing, shall be used.

1.3.2.5 Wear Test

Wear tests shall be made in conformance with ASTM C 131.

1.3.3 Testing Frequency

1.3.3.1 Initial Tests

One of each of the following tests shall be performed on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements prior to installation.

a. Sieve Analysis including 0.02 mm size material

b. Liquid limit and plasticity index

c. Moisture-density relationship

d. Wear

1.3.3.2 in-Place Tests

One of each of the following tests shall be performed on samples taken from the placed and compacted sub base. Samples shall be taken and tested at the rates indicated.

a. Density tests shall be performed on every lift of material placed and at a frequency of one set of tests for every 500 square meters, or portion thereof, of completed area.

b. Sieve Analysis shall be performed on every lift of material placed and at a frequency of one sieve analysis for every 1000 square meters, or portion thereof, of material placed.

c. Liquid limit and plasticity index tests shall be performed at the same frequency as the sieve analysis.

d. The thickness of each course shall be measured at intervals providing at least one measurement for each 500 square meters or part thereof. The thickness measurement shall be made by test holes, at least 75 mm 3 inches in diameter through the course.

1.3.4 Approval of Material

The source of the material shall be selected 30 days prior to the time the material will be required in the work. Tentative approval will be based on initial test results. Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and compacted course.

1.4 WEATHER LIMITATIONS

Construction shall be done when the atmospheric temperature is above 2 degrees C. When the temperature falls below 2 degrees C, the Contractor shall protect all completed areas by approved methods against detrimental effects of freezing. Completed areas damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

1.5 EQUIPMENT

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 AGGREGATE BASE COURSE

ABC coarse aggregate shall not show more than 50 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C 131. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. In the portion retained on each sieve specified, the crushed aggregates shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the piece. When two fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as two fractured faces. Crushed gravel shall be manufactured from gravel particles 50 percent of which, by weight, are retained on the maximum size sieve listed in TABLE 1.

TABLE 1. GRADATION OF AGGREGATES
Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation	No. 2
50.0 mm	----

37.5 mm	100
25.0 mm	60-100
12.5 mm	30-65
4.75 mm	20-50
2.00 mm	15-40
0.425 mm	5-25
0.075 mm	0-8

2.2 SOURCE QUALITY CONTROL

Prior to production and delivery of aggregates, take at least one initial sample in accordance with ASTM D 75. Collect each sample by taking three incremental samples at random from source material to make a composite sample of not less than 22 kg. Repeat sampling procedure when source of material is changed or when deficiencies or variations from specified grading of materials are found in testing.

PART 3 EXECUTION

3.1 OPERATIONS OF AGGREGATE SOURCES

Clearing, stripping and excavating shall be the responsibility of the Contractor. The aggregate sources shall be operated to produce the quantity and quality of materials meeting these specifications requirements in the specified time limit. Aggregate sources on private lands shall be conditioned in agreement with local laws and authorities.

3.2 STOCKPILING MATERIAL

Prior to stockpiling of material, storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Aggregates shall be stockpiled on the cleared and leveled areas designated by the Contracting Officer to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

3.3 PREPARATION OF UNDERLYING MATERIAL

Prior to constructing the subbase or select-material subbase or rigid pavement base course, the underlying course or subgrade shall be cleaned of all foreign substances. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. Ruts, or soft yielding spots, in the underlying courses, subgrade areas having inadequate compaction, and deviations of the surface from the specified requirements, shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses or subgrades containing sands or gravels, as defined in ASTM D 2487, the surface shall be stabilized prior to placement of the overlying course. Stabilization shall be accomplished by mixing the overlying course material into the underlying course, and compacting by approved methods. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the overlying course is placed.

3.4 GRADE CONTROL

The finished and completed course shall conform to the lines, grades, and cross sections shown. The lines, grades, and cross sections shown shall be maintained by means of line and grade stakes placed by the Contractor at the work site.

3.5 MIXING AND PLACING MATERIALS

The materials shall be mixed and placed to obtain uniformity of the material at the water content specified. The Contractor shall make such adjustments in mixing or placing procedures or in equipment as may be directed to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to insure a satisfactory subbase course.

3.6 LAYER THICKNESS

The compacted thickness of the completed course shall be as indicated. When a compacted layer of 150 mm is specified, the material may be placed in a single layer; when a compacted thickness of more than 150 mm is required, no layer shall be thicker than 150 mm 6 inches nor be thinner than 75 mm when compacted.

3.7 COMPACTION

Each layer of the material shall be compacted as specified with approved compaction equipment. Water content shall be maintained during the compaction procedure to within plus or minus 1 percent of optimum water content, as determined from laboratory tests, as specified in paragraph SAMPLING AND TESTING. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers.
Compaction of the subbase or select-material subbase shall continue until each layer is compacted through the full depth to at least 100 percent of laboratory maximum density. Compaction of the base course shall continue until each layer is compacted through the full depth to at least 95 percent of laboratory maximum density. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory subbase course. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

3.8 PROOF ROLLING

Areas designated on the drawings to be proof rolled shall receive an application of 20 coverages with a heavy pneumatic-tired roller having four or more tires abreast, each tire loaded to a minimum of 13.6 metric tons and inflated to a minimum of 1.034 MPa. A coverage is defined as the application of one tire print over the designated area. In the areas designated, proof rolling shall be applied to the top layer of the subbase course. Water content of the top layer of the subbase course shall be maintained such that the water content is within plus or minus 1 percent of optimum water content, as determined from laboratory tests, as specified in paragraph SAMPLING AND TESTING. Any material in the subbase courses or underlying

materials indicated to be unsatisfactory by the proof rolling shall be removed, dried, and recompacted, or removed and replaced with satisfactory materials.

3.9 EDGES

Approved material shall be placed along the edges of the subbase and base course in such quantity as will compact to the thickness of the course being constructed. When the course is being constructed in two or more layers, at least a 300 mm width of the shoulder shall be rolled and compacted simultaneously with the rolling and compacting of each layer of the subbase course, as directed.

3.10 SMOOTHNESS TEST

The surface of the top layer shall show no deviations in excess of 10 mm when tested with a 3.66 m straightedge. Measurements shall be taken in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at 15 meter intervals. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

3.11 THICKNESS CONTROL

The completed thickness of the course(s) shall be in accordance with the thickness and grade indicated on the drawings. The completed course shall not be more than 13 mm deficient in thickness nor more than 13 mm above or below the established grade. Where any of these tolerances are exceeded, the Contractor shall correct such areas by scarifying, adding new material of proper gradation or removing material, and compacting, as directed. Where the measured thickness is 13 mm or more thicker than shown, the course will be considered as conforming with the specified thickness requirements plus 13 mm. The average job thickness shall be the average of the job measurements as specified above but within 6 mm of the thickness shown.

3.12 MAINTENANCE

The completed course shall be maintained in a satisfactory condition until accepted.

-- End of Section --

SECTION 32 15 00

AGGREGATE SURFACE COURSE
04/06

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 C 117	(2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	(2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2002e1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 2167	(1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2922	(2005) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(2005) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3740	(2004a) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 422	(1963; R 2002e1) Particle-Size Analysis of Soils
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D 75	(2003) Standard Practice for Sampling Aggregates
ASTM E 11	(2004) Wire Cloth and Sieves for Testing Purposes

1.2 UNIT PRICES

1.2.1 Measurement

The quantity of aggregate surface course used for construction of parking areas and aggregate sidewalks completed and accepted as determined by the Contracting Officer shall be measured in cubic meters.

1.2.2 Payment

Quantities of aggregate surface course for parking areas and sidewalks, as measured above, will be paid for at the respective contract unit prices. Payment will constitute full compensation for the construction and completion of the aggregate surface course, including furnishing all labor and incidentals necessary to complete the work required by this section.

1.3 DEGREE OF COMPACTION

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 abbreviated herein as present laboratory maximum density.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment

List of proposed equipment to be used in performance of construction work including descriptive data.

1.5 EQUIPMENT

All plant, equipment, and tools used in the performance of the work covered by this section will be subject to approval by the Contracting Officer before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, and meeting the grade controls, thickness controls, and smoothness requirements set forth herein.

1.6 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved commercial testing laboratory or by the Contractor, subject to approval. If the Contractor elects to

establish its own testing facilities, approval of such facilities will be based on compliance with ASTM D 3740. No work requiring testing will be permitted until the Contractor's facilities have been inspected and approved.

1.6.1 Sampling

Sampling for material gradation, liquid limit, and plastic limit tests shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.6.2 Testing

1.6.2.1 Gradation

Aggregate gradation shall be made in conformance with ASTM C 117, ASTM C 136, and ASTM D 422. Sieves shall conform to ASTM E 11.

1.6.2.2 Liquid Limit and Plasticity Index

Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318.

1.6.3 Approval of Materials

The source of the material to be used for producing aggregates shall be selected 14 days prior to the time the material will be required in the work. Approval of sources not already approved by the Corps of Engineers will be based on an inspection by the Contracting Officer. Tentative approval of materials will be based on appropriate test results on the aggregate source. Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and compacted surface course.

1.7 WEATHER LIMITATIONS

Aggregate surface courses shall not be constructed when the ambient temperatures is below 2 degrees C and on subgrades that are frozen or contain frost. It shall be the responsibility of the Contractor to protect, by approved method or methods, all areas of surfacing that have not been accepted by the Contracting Officer. Surfaces damaged by freeze, rainfall, or other weather conditions shall be brought to a satisfactory condition by the Contractor.

PART 2 PRODUCTS

2.1 AGGREGATES

Aggregates shall consist of clean, sound, durable particles of natural gravel, crushed gravel, crushed stone, sand, slag, soil, or other approved materials processed and blended or naturally combined. Aggregates shall be free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign materials. The Contractor shall be responsible for obtaining materials that meet the specification and can be used to meet the grade and smoothness requirements specified herein after all compaction and proof rolling operations have been completed.

2.1.1 Coarse Aggregates

The material retained on the 4.75 mm sieve shall be known as coarse aggregate. Coarse aggregates shall be reasonably uniform in density and quality. The coarse aggregate shall have a percentage of wear not to exceed 50 percent after 500 revolutions as determined by ASTM C 131. The amount of flat and/or elongated particles shall not exceed 20 percent. A flat particle is one having a ratio of width to thickness greater than three; an elongated particle is one having a ratio of length to width greater than three. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the requirements set forth herein.

2.1.2 Fine Aggregates

The material passing the 4.75 mm sieve shall be known as fine aggregate. Fine aggregate shall consist of screenings, sand, soil, or other finely divided mineral matter that is processed or naturally combined with the coarse aggregate.

2.1.3 Gradation Requirements for Surface Courses

Gradation requirements specified in TABLE I shall apply to the completed aggregate surface. It shall be the responsibility of the Contractor to obtain materials that will meet the gradation requirements after mixing, placing, compacting, and other operations. TABLE I shows permissible gradings for granular material used in aggregate surface roads and airfields. Sieves shall conform to ASTM E 11.

TABLE I. GRADATION FOR AGGREGATE SURFACE COURSES

Sieve Designation	Parking or Road No. 1 or	Parking or Road No. 2	Sidewalk No. 3 or	Sidewalk No. 4
25.0 mm	100	100	100	100
9.5 mm	50-85	60-100	--	--
4.75 mm	35-65	50-85	55-100	70-100
2.00 mm	25-50	40-70	40-100	55-100
0.425 mm	15-30	24-45	20-50	30-70
0.075 mm	8-15	8-15	8-15	8-15

2.1.4 Gradation Requirements for Base Courses

The previous base course shall be of such nature that it can be compacted readiliy to a firm, stable base and shall conform to one of the following sizes:

TABLE II. GRADATION FOR AGGREGATE BASE COURSES

Sieves	Size Numbers No. 1	No. 2	No. 3
50.0 mm	100	--	--
37.5 mm	70-100	100	--
25.0 mm	45-80	60-100	100
12.5 mm	30-60	30-65	40-70
4.75 mm	20-50	20-50	20-50

2.0 mm	15-40	15-40	15-40
425 micrometers	0-25	0-25	0-25

2.2 LIQUID LIMIT AND PLASTICITY INDEX REQUIREMENTS

The portion of the completed aggregate surface course passing the 0.425 mm sieve shall have a maximum liquid limit of 35 and a plasticity index of 4 to 9.

PART 3 EXECUTION

3.1 OPERATION OF AGGREGATE SOURCES

Clearing, stripping, and excavating shall be the responsibility of the Contractor. The aggregate sources shall be operated to produce the quantity and quality of materials meeting these specification requirements in the specified time limit. Upon completion of the work, the aggregate sources on Government property shall be conditioned to drain readily and be left in a satisfactory condition. Aggregate sources on private lands shall be conditioned in agreement with local laws or authorities.

3.2 STOCKPILING MATERIALS

Prior to stockpiling the material, the storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Aggregates shall be stockpiled in such a manner that will prevent segregation. Aggregates and binders obtained from different sources shall be stockpiled separately.

3.3 PREPARATION OF UNDERLYING COURSE SUBGRADE

The subgrade shall be cleaned of all foreign substances. At the time of surface course construction, the subgrade shall contain no frozen material. Ruts or soft yielding spots in the subgrade areas having inadequate compaction and deviations of the surface from the requirements set forth herein shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade and recompacting. The completed subgrade shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the surface course is placed.

3.4 GRADE CONTROL

During construction, the lines and grades including crown and cross slope indicated for the aggregate surface course shall be maintained by means of line and grade stakes placed by the Contractor.

3.5 MIXING AND PLACING MATERIALS

The materials shall be mixed and placed to obtain uniformity of the material and a uniform optimum water content for compaction. The Contractor shall make adjustments in mixing, placing procedures, or in equipment to obtain the true grades, to minimize segregation and degradation, to obtain the desired water content, and to ensure a satisfactory surface course.

3.6 LAYER THICKNESS

The aggregate material shall be placed in layers of uniform thickness. When a compacted layer of 150 mm or less is specified, the material may be placed in a single layer; when a compacted thickness of more than 150 mm is required, no layer shall exceed 150 mm nor be less than 75 mm when compacted.

3.7 COMPACTION

Each layer of the aggregate surface course shall be compacted with approval compaction equipment. The water content during the compaction procedure shall be maintained at optimum or at the percentage specified by the Contracting Officer. In locations not accessible to the rollers, the mixture shall be compacted with mechanical tampers. Compaction shall continue until each layer through the full depth is compacted to at least 100 percent of laboratory maximum density. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked to produce a satisfactory material.

3.8 PROOF ROLLING

Proof rolling of the areas designated shall be in addition to compaction specified above and shall consist of application of 30 passes with a heavy rubber-tired roller having four tires abreast with each tire loaded to 13,600 kg and tires inflated to 1000 kPa. In the areas designated, proof rolling shall be applied to the top lift of layer on which surface course is laid and to each layer of the base course. Water content of the lift of the layer on which the surface course is placed and each layer of the aggregate surface course shall be maintained at optimum or at the percentage directed from the start of compaction to the completion of a proof rolling. Materials in the aggregate surface course or underlying materials indicated unacceptable by the proof rolling shall be removed and replaced, as directed, with acceptable materials.

3.9 SMOOTHNESS TEST

The surface of each layer shall not show any deviations in excess of 10 mm when tested with a 3 m straightedge applied both parallel with and at right angles to the centerline of the area to be paved. Deviations exceeding this amount shall be corrected by the Contractor by removing material, replacing with new material, or reworking existing material and compacting, as directed.

3.10 THICKNESS CONTROL

The completed thickness of the aggregate surface course shall be within 13 mm, plus or minus, of the thickness indicated on plans. The thickness of the aggregate surface course shall be measured at intervals in such manner that there will be a thickness measurement for at least each 500 square meters of the aggregate surface course. The thickness measurement shall be made by test holes at least 75 mm in diameter through the aggregate surface course. When the measured thickness of the aggregate surface course is more than 13 mm deficient in thickness, the Contractor, at no additional expense to the Government, shall correct such areas by scarifying, adding mixture of proper gradation, reblading, and recompacting, as directed. Where the measured thickness of the aggregate surface course is more than 13 mm

thicker than that indicated, it shall be considered as conforming with the specified thickness requirements plus 13 mm. The average job thickness shall be the average of the job measurements determined as specified above, but shall be within 6 mm of the thickness indicated. When the average job thickness fails to meet this criterion, the Contractor shall, at no additional expense to the Government, make corrections by scarifying, adding or removing mixture of proper gradation, and reblading and recompacting, as directed.

3.11 DENSITY TESTS

Density shall be measured in the field in accordance with ASTM D 1556.

3.12 WEAR TEST

Wear tests shall be made in conformance with ASTM C 131.

3.13 MAINTENANCE

The aggregate surface course shall be maintained in a condition that will meet all specification requirements until accepted.

-- End of Section --

SECTION 32 31 13.00 20

CHAIN LINK FENCES AND GATES
04/06

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 A 116	(2005) Standard Specification for Metallic-Coated, Steel Woven Wire Fence Fabric
ASTM A 121	(2004) Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
ASTM A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 176	(1999; R 2004) Standard Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
ASTM A 392	(2003) Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A 478	(1997; R 2002) Standard Specification for Chromium-Nickel Stainless Steel Weaving and Knitting Wire
ASTM A 491	(2003) Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM A 702	(1989; R 2006) Standard Specification for Steel Fence Posts and Assemblies, Hot Wrought
ASTM A 780	(2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A 824	(2001) Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use With Chain Link Fence
ASTM C 94/C 94M	(2006) Standard Specification for Ready-Mixed Concrete
ASTM D 4541	(2002) Pull-Off Strength of Coatings Using Portable Adhesion Testers

ASTM F 1043	(2004) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(2004) Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures
ASTM F 1184	(2003) Industrial and Commercial Horizontal Slide Gates
ASTM F 626	(1996a; R 2003) Standard Specification for Fence Fittings
ASTM F 883	(2004) Padlocks
ASTM F 900	(2003) Industrial and Commercial Swing Gates

UNDERWRITERS LABORATORIES (UL)

UL 752	(2005; Rev thru Dec 2006) Bullet-Resisting Equipment

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-07 Certificates

Chain Link Fence
Barbed Wire
Barbed (Razor) Type Concertina Wire

Statement, signed by an official authorized to certify on behalf of the manufacturer, attesting that the chain link fence and component materials meet the specified requirements.

PART 2 PRODUCTS

2.1 FENCE FABRIC

Fence fabric shall conform to the following:

2.1.1 Chain Link Fence Fabric

ASTM A 392, Class 1, zinc-coated galvanized steel wire with minimum coating weight of 370 grams of zinc per square meter of coated surface. Fabric shall be fabricated of 9 gauge wire woven in 50 mm mesh. Fabric height shall be as shown. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.

2.1.2 Barbed (Razor) Type Concertina Wire

Concertina wire is razor wire that is formed in large coils which can be expanded like a concertina. Each coil actually consists of two oppositely wound helices which support each other against crushing while allowing easy longitudinal movement.

Concertina Barbed Wire shall be ISO9001 certified of the best quality high carbon steel strip. It shall contain antisepsis, anti-aging, durable razor blades.

The concertina wire shall have the following dimensions in millimeters:
1) wire diameter 0.6±0.05;
2) barb width 10±1;
3) barb length 15±1;
4) barb spacing of 50±1.

The wire and blade materials shall be either galvanized or stainless steel. The outside diameter shall be 600-700mm with 86 loops in 14M and cross coil type.

2.2 GATES

As applicable and except as specified elsewhere, gates shall be in accordance with the following requirements, ASTM F 900 and/or ASTM F 1184. Gate shall be the type and configuration shown. Gate frames shall conform to strength and coating requirements of ASTM F 1083 for Group IA, steel pipe, with external coating Type A, nominal pipe size (NPS) 1-1/2. Gate frames shall conform to strength and coating requirements of ASTM F 1043, for Group IC, steel pipe with external coating Type A or Type B, nominal pipe size (NPS) 1-1/2. Gate fabric shall be as specified for chain link fabric. Gate leaves more than 2.44 m wide shall have intermediate members and diagonal truss rods or shall have tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than 2.44 m wide shall have truss rods or intermediate braces. Intermediate braces shall be provided on all gate frames with an electro-mechanical lock. Gate fabric shall be attached to the gate frame by method standard with the manufacturer except that welding will not be permitted. Except as specified otherwise, latches, hinges, stops, keepers, rollers, and other hardware items shall be furnished as required for the operation of the gate. Latches shall be arranged for padlocking so that the padlock will be accessible from both sides of the gate. Stops shall be provided for holding the gates in the open position. For high security applications, each end member of gate frames shall be extended sufficiently above the top member to carry three strands of barbed wire in horizontal alignment with barbed wire strands on the fence.

2.3 POSTS

2.3.1 Metal Posts for Chain Link Fence

ASTM F 1083, zinc-coated. Group IA, with external coating Type A steel hot dipped zinc coated galvanized welded pipe. Sizes shall be as shown on the drawings. Line posts and terminal (corner, gate, and pull) posts selected shall be of the same designation throughout the fence. Gate post shall be for the gate type specified subject to the limitation specified in ASTM F 900 and/or ASTM F 1184.

2.4 BRACES AND RAILS

ASTM F 1083, zinc-coated, Group IA, steel pipe, size NPS 1-1/4. Group IC steel pipe, zinc-coated, shall meet the strength and coating requirements of ASTM F 1043. Group II, formed steel sections, size 42 mm, conforming to ASTM F 1043, may be used as braces and rails if Group II line posts are furnished. Use rails only if/as shown.

2.5 WIRE

2.5.1 Tension Wire

Tension wire shall be Type I or Type II, Class 4 coating, in accordance with ASTM A 824.

2.6 ACCESSORIES

ASTM F 626. Ferrous accessories shall be zinc or aluminum coated. Truss rods shall be furnished for each terminal post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment. Barbed wire support arms shall be the V arm type and of the design required for the post furnished. Tie wire for attaching fabric to rails, braces, and posts shall be 9 gauge steel wire and match the coating of the fence fabric. Tie wires for attaching fabric to tension wire on high security fences shall be 1.6 mm stainless steel. The tie wires shall be a double loop and 165 mm in length. Miscellaneous hardware coatings shall conform to ASTM A 153/A 153M unless modified.

2.7 CONCRETE

ASTM C 94/C 94M, using 19 mm maximum size aggregate, and having minimum compressive strength of 28 MPa at 28 days. Grout shall consist of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

2.8 PADLOCKS

Padlocks shall conform to ASTM F 883, Type PO1, Options A, B, and G, Grade 6. EPB, Size 44 mm. All padlocks shall be keyed alike.

PART 3 EXECUTION

3.1 INSTALLATION

Fence, gates, barbed wire and concertina wire shall be installed as indicated and otherwise to the lines and grades indicated. Wall posts and line posts shall be spaced equidistant at intervals not exceeding 3 m. Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Fabric shall be continuous between terminal posts; however, runs between terminal posts shall not exceed 152.4 m. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A 780.

3.2 EXCAVATION

As applicable, post holes shall be cleared of loose material. Waste material shall be spread where directed. The ground surface irregularities shall be eliminated to the extent necessary to maintain a 50 mm clearance between the bottom of the fabric and finish grade.

3.3 POST INSTALLATION

3.3.1 Posts for Chain Link Fence

Post sizes shall be as shown on drawings. Post footings, where applicable, shall be no less that 250 mm in diameter and below the area's frost depth level usually not less that 800 mm. Posts shall be set plumb and in alignment. For posts set in ground, except where solid rock is encountered, posts shall be set in concrete to the depth indicated on the drawings. Where solid rock is encountered with no overburden, posts shall be set to a minimum depth of 457 mm in rock. Where solid rock is covered with an overburden of soil or loose rock, posts shall be set to the minimum depth indicated on the drawing unless a penetration of 457 mm in solid rock is achieved before reaching the indicated depth, in which case depth of penetration shall terminate. All portions of posts set in rock shall be grouted. Portions of posts not set in rock shall be set in concrete from the rock to ground level. Posts set in concrete shall be set in holes not less than the diameter shown on the drawings. Diameters of holes in solid rock shall be at least 25 mm greater than the largest cross section of the post. Concrete and grout shall be thoroughly consolidated around each post, shall be free of voids and finished to form a dome. Concrete and grout shall be allowed to cure for 72 hours prior to attachment of any item to the posts. Group II line posts may be mechanically driven, for temporary fence construction only, if rock is not encountered. Driven posts shall be set to a minimum depth of 914 mm and shall be protected with drive caps when being set. Fence post rigidity shall be tested by applying a 222.4 newtons force on the post, perpendicular to the fabric, at 1.52 m above ground; post movement measured at the point where the force is applied shall be less than or equal to 19 mm from the relaxed position; every tenth post shall be tested for rigidity; when a post fails this test, further tests on the next four posts on either side of the failed post shall be made; all failed posts shall be removed, replaced, and retested at the Contractor's expense.

3.4 RAILS

3.4.1 Top Rail

Top rail (if/as shown) shall be supported at each post to form a continuous brace between terminal posts. Where required, sections of top rail shall be joined using sleeves or couplings that will allow expansion or contraction of the rail. Top rail, if required for high security fence, shall be installed as indicated on the drawings.

3.4.2 Bottom Rail

The bottom rail (if/as shown) shall be bolted to double rail ends and double rail ends shall be securely fastened to the posts. Bolts shall be peened to prevent easy removal. Bottom rail shall be installed before chain link fabric.

3.5 BRACES AND TRUSS RODS

Braces and truss rods shall be installed as indicated and in conformance with the standard practice for the fence furnished. Horizontal (compression) braces and diagonal truss (tension) rods shall be installed on fences over 1.83 m in height. A center brace or 2 diagonal truss rods shall be installed on 3.66 m fences. Braces and truss rods shall extend from terminal posts to line posts. Diagonal braces shall form an angle of approximately 40 to 50 degrees with the horizontal. No bracing is required on fences 1.83 m high or less if a top rail is installed.

3.6 TENSION WIRES

Tension wires shall be installed along the top and bottom of the fence line and attached to the terminal posts of each stretch of the fence. Top tension wires shall be installed within the top 305 mm of the installed fabric. Bottom tension wire shall be installed within the bottom 152 mm of the installed fabric. Tension wire shall be pulled taut and shall be free of sag.

3.7 CHAIN LINK FABRIC

Chain link fabric shall be installed on the side of the post indicated. Fabric shall be attached to terminal posts with stretcher bars and tension bands. Bands shall be spaced at approximately 381 mm intervals. The fabric shall be installed and pulled taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fabric shall be fastened to line posts at approximately 381 mm intervals and fastened to all rails and tension wires at approximately 305 mm intervals. Fabric shall be cut by untwisting and removing pickets. Splicing shall be accomplished by weaving a single picket into the ends of the rolls to be joined. The bottom of the installed fabric shall be 50 mm plus or minus 13 mm above the wall or ground or as shown. After the fabric installation is complete, the fabric shall be exercised by applying a 222 newtons push-pull force at the center of the fabric between posts; the use of a 133 newtons pull at the center of the panel shall cause fabric deflection of not more than 63.5 mm when pulling fabric from the post side of the fence; every second fence panel shall meet this requirement; all failed panels shall be re-secured and retested at the Contractor's expense.

3.8 GATE INSTALLATION

Gates shall be installed at the locations shown. Hinged gates shall be mounted to swing as indicated. Latches, stops, and keepers shall be installed as required. Slide or Lift gates shall be installed as recommended by the manufacturer. Padlocks shall be attached to gates or gate posts with chains. Hinge pins, and hardware shall be welded or otherwise secured to prevent removal.

3.9 TOLERANCES

Posts shall be straight and plumb within a vertical tolerance of 6 millimeter after the fabric has been stretched. Fencing and gates shall be true to line with no more than 15 millimeter deviation from the established centerline between line posts. Defects shall be repaired as directed.

-- End of Section --

SECTION 33 11 00

WATER DISTRIBUTION
10/06

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 WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(2004) Hypochlorites
AWWA C110/A21.10	(2003) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C151/A21.51	(2002; Errata 2002) Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C153/A21.53	(2006) Ductile-Iron Compact Fittings for Water Service
AWWA C500	(2002; R 2003) Metal-Seated Gate Valves for Water Supply Service
AWWA C504	(2006) Standard for Rubber-Seated Butterfly Valves
AWWA C508	(2001) Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS
AWWA C509	(2001) Resilient-Seated Gate Valves for Water Supply Service
AWWA C600	(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C605	(2005) Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
AWWA C606	(2004) Grooved and Shouldered Joints
AWWA C651	(2005; Errata 2005) Standard for Disinfecting Water Mains
AWWA C800	(2005) Underground Service Line Valves and Fittings
AWWA C900	(1997) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through

	12 In. (100 mm Through 300 mm), for Water Distribution
AWWA C905	(1997) Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings 14 In. Through 48 In. (350 mm through 1,200 mm)
AWWA C909	(2002) Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 IN through 12 IN (100 mm Through 300 mm), for Water Distribution
AWWA M23	(2002) Manual: PVC Pipe - Design and Installation
AWWA M9	(1995) Manual: Pressure Pipe

ASME INTERNATIONAL (ASME)

ASME B16.1	(2005) Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125 and 250
ASME B16.3	(1998) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(1998) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B18.2.2	(1987; R 2005) Square and Hex Nuts (Inch Series)
ASME B18.5.2.1M	(2006) Metric Round Head Short Square Neck Bolts
ASME B18.5.2.2M	(1982; R 2005) Metric Round Head Square Neck Bolts

ASTM INTERNATIONAL (ASTM)

ASTM A 307	(2004e1) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 48/A 48M	(2003) Standard Specification for Gray Iron Castings
ASTM A 536	(1984; R 2004) Standard Specification for Ductile Iron Castings
ASTM A 563	(2004a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 563M	(2006) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A 746	(2003) Standard Specification for Ductile Iron Gravity Sewer Pipe

ASTM C 150	(2005) Standard Specification for Portland Cement
ASTM C 94/C 94M	(2006) Standard Specification for Ready-Mixed Concrete
ASTM D 1599	(2005) Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings
ASTM D 1784	(2006a) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(2005) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(2006) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(2004e1) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2855	(1996; R 2002) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3139	(1998; R 2005) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM F 1483	(1998) Oriented Poly(Vinyl Chloride), PVCO, Pressure Pipe
ASTM F 477	(2002e1) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

1.3 DESIGN REQUIREMENTS

1.3.1 Water Distribution Mains

Provide water distribution mains indicated as 100 mm diameter pipe sizes of polyvinyl chloride (PVC) plastic pipe.

1.3.2 Water Service Lines

Provide water service lines or 19 mm, 25 mm, 38 mm, 75 mm diameter from water distribution main to building service at a point approximately 1.5 m from building. Water service lines shall be polyvinyl chloride (PVC) plastic pipe. Provide water service line appurtenances as specified.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-03 Product Data

Piping Materials

Water distribution main piping, fittings, joints, valves, and coupling

Water service line piping, fittings, joints, valves, and coupling

Valve boxes

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on and rubber-gasketed bell-and-spigot joints. Include information concerning gaskets with submittal for joints and couplings.

SD-05 Design Data

Design calculations of water piping

SD-06 Test Reports

Bacteriological Disinfection;

Test results from commercial laboratory verifying disinfection

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, and valves free of dirt and debris.

1.5.2 Handling

Handle pipe, fittings, valves, and other accessories in a manner to ensure delivery to the trench in sound undamaged condition. Take special care to avoid injury to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Do not place any other material or pipe inside a pipe or fitting after the coating has been applied. Carry, do not drag pipe to the trench. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Government. Store rubber gaskets that are not to be installed immediately, under cover out of direct sunlight.

1.5.2.1 Miscellaneous Plastic Pipe and Fittings

Handle Polyvinyl Chloride (PVC) pipe and fittings in accordance with the manufacturer's recommendations. Store plastic piping and jointing materials that are not to be installed immediately under cover out of direct sunlight. Storage facilities shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325.

PART 2 PRODUCTS

2.1 WATER DISTRIBUTION MAIN MATERIALS

2.1.1 Piping Materials

2.1.1.2 Polyvinyl Chloride (PVC) Plastic Piping

a. Pipe and Fittings: Pipe, AWWA C900, shall be plain end or gasket bell end, Pressure Class 200 (DR 14) with cast-iron-pipe-equivalent OD.

b. Fittings for PVC pipe: Fittings shall be gray iron or ductile iron, AWWA C110/A21.10 or AWWA C153/A21.53, and have cement-mortar lining, AWWA C104/A21.4, standard thickness. Fittings with push-on joint ends shall conform to the same requirements as fittings with mechanical-joint ends, except that bell design shall be modified, as approved, for push-on joint suitable for use with PVC plastic pipe specified in this paragraph. Iron fittings and specials shall be cement-mortar lined in accordance with AWWA C104/A21.4.

c. Joints and Jointing Material: Joints for pipe shall be push-on joints, ASTM D 3139. Joints between pipe and metal fittings, valves, and other accessories shall be push-on joints ASTM D 3139, or compression-type joints/mechanical joints, ASTM D 3139 and AWWA C111/A21.11. Provide each joint connection with an elastomeric gasket suitable for the bell or coupling with which it is to be used. Gaskets for push-on joints for pipe, ASTM F 477. Gaskets for push-on joints and compression-type joints/mechanical joints for joint connections between pipe and metal fittings, valves, and other accessories, AWWA C111/A21.11, respectively, for push-on joints and mechanical joints. Mechanically coupled joints using a sleeve-type mechanical coupling, as specified in paragraph entitled

"Sleeve-Type Mechanical Couplings," may be used as an optional jointing method in lieu of push-on joints on plain-end PVC plastic pipe, subject to the limitations specified for mechanically coupled joints using a sleeve-type mechanical coupling and to the use of internal stiffeners as specified for compression-type joints in ASTM D 3139.

2.1.2 Valves and Other Water Main Accessories

2.1.2.1 Gate Valves on Buried Piping

AWWA C500, AWWA C509, or UL 262. Unless otherwise specified, valves conforming to: (1) AWWA C500 shall be nonrising stem type with double-disc gates and mechanical-joint ends or push-on joint ends as appropriate for the adjoining pipe, (2) AWWA C509 shall be nonrising stem type with mechanical-joint ends or resilient-seated gate valves 80 to 300 mm in size, and (3) UL 262 shall be inside-screw type with operating nut, double-disc or split-wedge type gate, designed for a hydraulic working pressure of 1380 kPa, and shall have mechanical-joint ends or push-on joint ends as appropriate for the pipe to which it is joined. Valves shall open by counterclockwise rotation of the valve stem. Stuffing boxes shall have 0-ring stem seals. Stuffing boxes shall be bolted and constructed so as to permit easy removal of parts for repair.

2.1.2.2 Gate Valves Aboveground Location

AWWA C500, AWWA C509, or UL 262. Unless otherwise specified, valves conforming to: (1) AWWA C500 shall be nonrising stem type with double-discorsolid-wedge gates and flanged ends, (2) AWWA C509 shall be nonrising stem type with flanged ends, and (3) UL 262 shall be inside-screw type, shall have double-disc or split-wedge type gate and flanged ends, and shall be designed for a hydraulic working pressure of 1380 kPa. Materials for UL 262 valves shall conform to the reference standards specified in AWWA C500. Valves shall be of one manufacturer.

2.1.2.3 Check Valves

Swing-check type, AWWA C508 or UL 312. Valves conforming to: (1) AWWA C508 shall have iron or steel body and cover and flanged ends, and (2) UL 312 shall have cast iron or steel body and cover, flanged ends, and designed for a working pressure of 1040 kPa. Materials for UL 312 valves shall conform to the reference standards specified in AWWA C508. Valves shall have clear port opening. Flanges shall be Class 125 conforming to ASME B16.1.

2.1.2.4 Rubber-Seated Butterfly Valves

Rubber-seated butterfly valves shall conform to the performance requirements of AWWA C504. Wafer type valves conforming to the performance requirements of AWWA C504 in all respects, but not meeting laying length requirements will be acceptable if supplied and installed with a spacer providing the specified laying length. All tests required by AWWA C504 shall be met.

2.1.2.5 Vacuum and Air Relief Valves

Vacuum and air relief valves shall be of a type that will release air and prevent the formation of a vacuum. The valves shall automatically release air when the lines are being filled with water and shall admit air into the

line when water is being withdrawn in excess of the inflow. Valves shall be iron body with bronze trim and stainless steel float.

2.1.2.6 Valve Boxes

Provide a valve box for each gate valve on buried piping. Valve boxes shall be of cast iron of a size suitable for the valve on which it is to be used and shall be adjustable. Cast-iron boxes shall have a minimum cover and wall thickness of 5 mm. The least diameter of the shaft of the box shall be 135 mm. Cast-iron box shall have a heavy coat of bituminous paint.

2.1.2.7 Tracer Wire for Nonmetallic Piping

Provide bare copper or aluminum wire not less than 2.5 mm in diameter in sufficient length to be continuous over each separate run of nonmetallic pipe.

2.2 WATER SERVICE LINE MATERIALS

2.2.1 Piping Materials

2.2.1.3 Plastic Piping

Plastic pipe and fittings shall bear the seal of the National Sanitation Foundation (NSF) for potable water service. Plastic pipe and fittings shall be supplied from the same manufacturer.

a. Polyvinyl Chloride (PVC) Plastic Piping with Screw Joints: ASTM D 1785, Schedule 80. Fittings, ASTM D 2466 or ASTM D 2467. Pipe and fittings shall be of the same PVC plastic material and shall be one of the following pipe/fitting combinations, as marked on the pipe and fitting, respectively: PVC 1120/PVC I; PVC 1220/PVC 12; PVC 2120/PVC II; PVC 2116/PVC II. Solvent cement for jointing, ASTM D 2564. Pipe couplings, when used shall be tested as required by ASTM D 2464.

b. Polyvinyl Chloride (PVC) Plastic Piping with Elastomeric-Gasket Joints:

   Pipe shall conform to dimensional requirements of ASTM D 1785 Schedule 80, with joints meeting the requirements of 1.03 MPa (150 psi) working pressure, 1.38 MPa (200 psi) hydrostatic test pressure, unless otherwise shown or specified.

c. Polyvinyl Chloride (PVC) Plastic Piping with Solvent Cement Joints:

   Pipe shall conform to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 1.03 MPa (150 psi) working pressure and 1.38 MPa (200 psi) hydrostatic test pressure.

2.2.2 Disinfection

Chlorinating materials shall conform to the following:

Hypochlorite, Calcium and Sodium: AWWA B300.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES

3.1.1 General Requirements for Installation of Pipelines

These requirements shall apply to all pipeline installation except where specific exception is made in the "Special Requirements..." paragraphs.

3.1.1.1 Location of Water Lines

Do not lay water line closer horizontally than 3.0 m from any sewer line. Where water lines cross under gravity sewer lines, encase sewer line fully in concrete for a distance of at least 3.0 m on each side of the crossing, unless sewer line is made of pressure pipe with rubber-gasketed joints and no joint is located within 900 mm horizontally of the crossing. Lay water lines which cross sewer force mains and inverted siphons at least 600 mm above these sewer lines; when joints in the sewer line are closer than 900 mm horizontally from the water line, encase these joints in concrete. Do not lay water lines in the same trench with gas lines, fuel lines or electric wiring. Copper tubing shall not be installed in the same trench with ferrous piping materials. Where nonferrous metallic pipe, e.g. copper tubing, cross any ferrous piping, provide a minimum vertical separation of 300 mm between pipes.

a. Water Piping Installation Parallel With Sewer Piping

(1) Normal Conditions: Lay water piping at least 3.0 m horizontally from a sewer or sewer manhole whenever possible. Measure the distance edge-to-edge.

(2) Unusual Conditions: When local conditions prevent a horizontal separation of 3.0 m, the water piping may be laid closer to a sewer or sewer manhole provided that:

(a) The bottom (invert) of the water piping shall be at least 450 m above the top (crown) of the sewer piping.

(b) Where this vertical separation cannot be obtained, the sewer piping shall be constructed of AWWA-approved water pipe and pressure tested in place without leakage prior to backfilling. Approved waste water disposal method shall be utilized.

(c) The sewer manhole shall be of watertight construction and tested in place.

b. Installation of Water Piping Crossing Sewer Piping

(1) Normal Conditions: Water piping crossing above sewer piping shall be laid to provide a separation of at least 450 mm between the bottom of the water piping and the top of the sewer piping.

(2) Unusual Conditions: When local conditions prevent a vertical separation described above, use the following construction:

(a) Sewer piping passing over or under water piping shall be constructed of AWWA-approved ductile iron water piping, pressure tested in place without leakage prior to backfilling.

(b) Water piping passing under sewer piping shall, in addition, be protected by providing a vertical separation of at least 450 mm between the bottom of the sewer piping and the top of the water piping; adequate structural support for the sewer piping to prevent excessive deflection of the joints and the settling on and breaking of the water piping; and that the length, minimum 6.1 m, of the water piping be centered at the point of the crossing so that joints shall be equidistant and as far as possible from the sewer piping.

c. Sewer Piping or Sewer Manholes: No water piping shall pass through or come in contact with any part of a sewer manhole.

3.1.1.2 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.1.1.3 Pipe Laying and Jointing

Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, and accessories, and maintain in a clean condition. Provide proper facilities for lowering sections of pipe into trenches. Do not under any circumstances drop or dump pipe, fittings, valves, or any other water line material into trenches. Cut pipe in a neat workmanlike manner accurately to length established at the site and work into place without springing or forcing. Replace by one of the proper length any pipe or fitting that does not allow sufficient space for proper installation of jointing material. Blocking or wedging between bells and spigots will not be permitted. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying. Grade the pipeline in straight lines; avoid the formation of dips and low points. Support pipe at proper elevation and grade. Secure firm, uniform support. Wood support blocking will not be permitted. Lay pipe so that the full length of each section of pipe and each fitting will rest solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings. Provide anchors and supports where necessary for fastening work into place. Make proper provision for expansion and contraction of pipelines. Keep trenches free of water until joints have been properly made. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Do not lay pipe when conditions of trench or weather prevent installation. Depth of cover over top of pipe shall not be less than 820 mm.

3.1.1.4 Installation of Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.

3.1.1.5 Penetrations

Pipe passing through walls and structures shall be provided with ductile-iron or Schedule 40 steel wall sleeves. Annular space between walls and

sleeves shall be filled with rich cement mortar. Annular space between pipe and sleeves shall be filled with mastic.

3.1.1.6 Flanged Pipe

Flanged pipe shall only be installed above ground or with the flanges in valve pits.

3.1.2 Special Requirements for Installation of Water Mains

3.1.2.2 Installation of PVC Plastic Water Main Pipe

Installation of PVC Plastic Water Main Pipe and Associated Fittings: Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines"; with the requirements of UBPPA UNI-B-3 for laying of pipe, joining PVC pipe to fittings and accessories, and setting of hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."

a. Jointing: Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to metal fittings, valves, and other accessories, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use an approved lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of UBPPA UNI-B-3 for laying the pipe and the recommendations in AWWA M23, Chapter 7, "Installation," for pipe joint assembly. Assemble push-on joints for connection to fittings, valves, and other accessories in accordance with the requirements of UBPPA UNI-B-3 for joining PVC pipe to fittings and accessories and with the applicable requirements of AWWA C600 for joint assembly. Make compression-type joints/mechanical joints with the gaskets, glands, bolts, nuts, and internal stiffeners previously specified for this type joint; assemble in accordance with the requirements of UBPPA UNI-B-3 for joining PVC pipe to fittings and accessories, with the applicable requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer using internal stiffeners as previously specified for compression-type joints.

b. Offset: Maximum offset in alignment between adjacent pipe joints shall be as recommended by the manufacturer and approved by the Contracting Officer, but shall not exceed 5 degrees.

c. Pipe Anchorage: Provide concrete thrust blocks (reaction backing) for pipe anchorage . Thrust blocks shall be in accordance with the requirements of UBPPA UNI-B-3 for reaction or thrust blocking and plugging of dead ends, except that size and positioning of thrust

blocks shall be as indicated. Use concrete, ASTM C 94/C 94M, having a minimum compressive strength of 15 MPa at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

d. Fittings: Install in accordance with AWWA C605.

3.1.2.3 Installation of Valves

a. Installation of Valves: Install gate valves, AWWA C500 and UL 262, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C500. Install gate valves, AWWA C509, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C509. Install gate valves on PVC water mains in accordance with the recommendations for appurtenance installation in AWWA M23, Chapter 7, "Installation." Make and assemble joints to gate valves as specified for making and assembling the same type joints between pipe and fittings.

3.1.3 Installation of Water Service Piping

3.1.3.1 Location

Connect water service piping to the building service where the building service has been installed.

3.1.3.2 Service Line Connections to Water Mains

Connect service lines to the main by a corporation stop and gooseneck and install a service stop below the frost line. Connect service lines to ductile-iron water mains in accordance with AWWA C600 for service taps. Connect service lines to PVC plastic water mains in accordance with UBPPA UNI-B-8 and the recommendations of AWWA M23, Chapter 9, "Service Connections."

3.1.4 Special Requirements for Installation of Water Service Piping

3.1.4.1 Installation of Plastic Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" and with the applicable requirements of ASTM D 2774 and ASTM D 2855. Handle solvent cements used to join plastic piping in accordance with ASTM F 402.

a. Jointing: Make solvent-cemented joints for PVC plastic piping using the solvent cement previously specified for this material; assemble joints in accordance with ASTM D 2855. Make plastic pipe joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

b. Plastic Pipe Connections to Appurtenances: Connect plastic pipe service lines to corporation stops and gate valves in accordance with the recommendations of the plastic pipe manufacturer.

3.1.5 Disinfection

Prior to disinfection, obtain Contracting Officer approval of the proposed method for disposal of waste water from disinfection procedures. Disinfect new water piping and existing water piping affected by Contractor's operations in accordance with AWWA C651. Fill piping systems with solution containing minimum of 50 parts per million of available chlorine and allow solution to stand for minimum of 24 hours. Flush solution from the systems with domestic water until maximum residual chlorine content is within the range of 0.2 and 0.5 parts per million, or the residual chlorine content of domestic water supply. Obtain at least two consecutive satisfactory bacteriological samples from new water piping, analyze by a certified laboratory, and submit the results prior to the new water piping being placed into service. Disinfection of systems supplying nonpotable water is not required.

3.2 FIELD QUALITY CONTROL

3.2.1 Field Tests and Inspections

Prior to hydrostatic testing, obtain Contracting Officer approval of the proposed method for disposal of waste water from hydrostatic testing. The Contracting Officer will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests, and provide labor, equipment, and incidentals required for testing. The Contractor shall produce evidence, when required, that any item of work has been constructed in accordance with the drawings and specifications. Do not begin testing on any section of a pipeline where concrete thrust blocks have been provided until at least 5 days after placing of the concrete.

3.2.2 Testing Procedure

Test water mains and water service lines in accordance with the applicable specified standard, except for the special testing requirements given in paragraph entitled "Special Testing Requirements." Test ductile-iron water mains in accordance with the requirements of AWWA C600 for hydrostatic testing. The amount of leakage on ductile-iron pipelines with mechanical-joints or push-on joints shall not exceed the amounts given in AWWA C600; no leakage will be allowed at joints made by any other method. Test PVC plastic water mains and water service lines made with PVC plastic water main pipe in accordance with the requirements of UBPPA UNI-B-3 for pressure and leakage tests. The amount of leakage on pipelines made of PVC plastic water main pipe shall not exceed the amounts given in UBPPA UNI-B-3 Test water service lines in accordance with applicable requirements of AWWA C600 for hydrostatic testing. No leakage will be allowed at copper tubing joints (soldered, compression type, brazed), plastic pipe joints flanged joints and screwed joints.

3.2.3 Special Testing Requirements

For pressure test, after the pipe is laid, the joints completed, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 1 hour to a hydrostatic pressure test of 1.38 MPa (200 psi). Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, hydrants and valves shall be

carefully examined during the partially opened trench test. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, joints, fittings, hydrants and valves discovered following this pressure test shall be removed and replaced and retested until the test results are satisfactory..

3.3 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

-- End of Section --

SECTION 33 16 15

WATER STORAGE STEEL TANKS - ELEVATED DESIGN
04/06

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	(2005; Supp 1) Minimum Design Loads for Buildings and Other Structures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(2004) Hypochlorites
AWWA C104/A21.4	(2003) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105/A21.5	(2005) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/A21.10	(2003) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2000) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2005) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C150/A21.50	(2002; Errata 2003) Thickness Design of Ductile-Iron Pipe
AWWA C151/A21.51	(2002; Errata 2002) Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C500	(2002; R 2003) Metal-Seated Gate Valves for Water Supply Service
AWWA C504	(2006) Standard for Rubber-Seated Butterfly Valves
AWWA C508	(2001) Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS
AWWA C600	(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances

AWWA C652	(2002) Disinfection of Water-Storage Facilities
AWWA D100	(2005) Welded Steel Tanks for Water Storage
AWWA D103	(1997) Factory-Coated Bolted Steel Tanks for Water Storage

ASME INTERNATIONAL (ASME)

ASME B16.3	(1998) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B40.100	(2006) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A 197/A 197M	(2000; R 2006) Standard Specification for Cupola Malleable Iron
ASTM A 48/A 48M	(2003) Standard Specification for Gray Iron Castings
ASTM A 53/A 53M	(2006a) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

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

MSS SP-80	(2003) Bronze Gate, Globe, Angle and Check Valves

NSF INTERNATIONAL (NSF)

NSF 61	(2005; Addendum 2005) Drinking Water System Components - Health Effects

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PS Guide 17.00	(1982; E 2004) Guide for Selecting Urethane Painting Systems
SSPC Paint 104	(1982; E 2004) Paint Specification No. 104 White or Tinted Alkyd Paint
SSPC Paint 21	(1982; E 2004) Paint Specification No. 21 White or Colored Silicone Alkyd Paint (Type I, High Gloss and Type II, Medium Gloss)
SSPC Paint 25	(1997; 2004e1) Paint Specification No. 25 Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel Type I and Type II

U.S. BUREAU OF RECLAMATION (BOR)

BOR Paint Mnl (1976) Paint Manual

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-P-24441 (Rev C; Supp 1; Am 1) Paint, Epoxy-Polyamide

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Tank Installation;

Detail and erection drawings, before proceeding with any fabrication. The drawings shall be complete with details of steel, pipe, and with details of the assembling of items required for the complete installation. Standard welding symbols as recommended by the American Welding Society shall be used. Details of welded joints referenced on the drawings shall be included.

SD-03 Product Data

Tank, Controls and Instrumentation, Valves, and Piping; G

The contractor shall provide manufacturer's standard catalog, installation manuals, operation and maintenance manuals, descriptive data and technical literature, performance charts and curves, and catalog cuts.

SD-06 Test Reports; G

Each coating manufacturer's technical data, application instructions, Material Safety Data Sheets (MSDS), and certificate for compliance for VOC content.

The contractor shall provide the following: Six copies of each test containing the information described below (items 1-7) in bound letter-sized booklets, individual reports shall be provided for the storage tank tests, the piping tests, the system performance tests, the high level alarm test, and the system leak tests. Drawings shall be folded blue lines, with the title block visible. 1) The date the tests were performed. 2) A list of equipment used, with calibration certifications. 3) A copy of measurements taken. 4) The parameters to be verified. 5) The condition specified for the parameter. 6) the inspection results, signed, dated, and certified by the installer. The certification shall state that required procedures were accomplished, that the procedures were conducted in compliance with the plans and specifications. 7) A description of adjustments performed.

Testing, Adjusting, and Balancing;

For all tanks, system controls and instrumentation, valves, and piping, the contractor shall provide the following:1)Two copies of the TAB schematic drawings and report forms, no later than 7 days prior to the start of TAB field measurements 2) A list of any related submittals no later than 7 days prior to the start of TAB field measurements 3) Proposed procedures for TAB, submitted with the TAB schematic drawings and report forms 4) Proposed date and time to begin system readiness check 5) Proposed date and time to begin field measurement, making adjustments, etc. for the TAB report, submitted with the system readiness check report 6) Proposed date and time to begin the TAB verification, submitted with the TAB report 7) A copy of completed checklists for each contract in the project scope, each signed by the contractor's representative 8) Two copies of completed TAB reports no later than 7 days after the execution of TAB signed by the contractor's representative.

1.3 GENERAL REQUIREMENTS

1.3.1 Design and Construction Standards

The fabrication and erection of the elevated tank shall be in accordance with the applicable requirements of AWWA D100 or AWWA D103 except as modified herein. No additional thickness for corrosion allowance will be required.

1.3.2 Welding

Qualification of welding procedures, welders, and welding operators shall be in accordance with Section 8.2 of AWWA D100.

1.3.3 Coatings Certification

Coating materials for interior applications and all other materials which will be in normal contact with potable water shall conform to NSF 61. Certification by an independent third-party organization that all interior coatings and materials, that come in contact with potable water, comply with NSF 61 shall be provided.

1.4 DELIVERY, HANDLING AND STORAGE

Deliver paint in unopened containers with unbroken seals and labels showing designated name, specification number, color, directions for use, manufacturer, and date of manufacture, legible and intact at time of use. Handle and store water storage tank systems, components, and parts to prevent distortions and other damage that could affect their structural, mechanical, or electrical integrity. Replace damaged items that cannot be restored to original condition. Store items subject to deterioration by exposure to elements, in a well-drained location, protected from weather, and accessible for inspection and handling.

PART 2 PRODUCTS

2.1 MATERIALS - ELEVATED TANK

Materials shall conform to the following requirements:

2.1.1 Steel

Section 2 of AWWA D100 or Section 2 of AWWA D103.

2.1.2 Shop Fabrication

Section 9 of AWWA D100 or Section 7 of AWWA D103.

2.2 ASSEMBLIES - ELEVATED TANKS

2.2.1 Tank Accessories

Section 7 of AWWA D100 or Section 5 of AWWA D103 and as specified. Additional requirements for accessories are as follows:

2.2.1.1 Manholes and Pipe Connections

Section 7 of AWWA D100 and Section 5 of AWWA D103 represent the minimum requirements.

2.2.1.2 Overflow

The overflow for the tank shall consist of an overflow weir and outside drop pipe, adequately supported. The overflow pipe shall be steel, ASTM A 53/A 53M or equal, and shall terminate 300 to 600 mm above grade and shall be fitted with a flapper valve or screen to prevent ingress of animals and insects.

2.2.1.3 Vent

Vent shall be welded to the cover plate of the center manhole on the roof. Vent will be tank manufacturer's standard type mushroom vent with aluminum bird screen. The free area of the vent shall be determined by the Contractor. Screening for vent shall conform to Section 5.7.2 of AWWA D100 or Section 5.7.2 of AWWA D103which ensures fail-safe operation in the event that screen frosts over and the bottom of the screen shall be sufficiently elevated for snow consideration in the area.

2.2.1.4 Ladders and Safety Devices

Ladders and safety devices shall be provided in accordance with Sections 7.4 and 7.5 of AWWA D100 or Sections 5.4 and 5.5 of AWWA D103. Location of ladders shall be as shown on the drawings. Sections 7.4 and 7.5 of AWWA D100 and Secions 5.4 and 5.5 of AWWA D103 represent the minimum requirement. In addition, safety cage, rest platforms, roof ladder handrails, and other safety devices shall be provided as required by federal or local laws or regulations.

2.2.1.5 Coating for Welded Tanks

Provide exterior and interior coating systems conforming to applicable sections of AWWA.

2.2.1.6 Coating for Bolted Tanks

As supplied by the manufacturer.

2.5 CONCRETE WORK

Concrete work shall conform to Section 03 30 00.00 40 CAST-IN-PLACE CONCRETE.

2.6 CHLORINE

AWWA B300 for hypochlorites, mixed with water to give the solutions required in AWWA C652.

PART 3 EXECUTION

3.1 PREPARATION - HYDROPNEUMATIC TANKS

3.1.1 Pipe Connections

Shall be covered for protection and to prevent entrance of foreign matter during shipment and while awaiting installation.

3.2 FOUNDATIONS

Construct foundations for the elevated tank columns and riser of concrete, reinforced where necessary, and design same in accordance with Section 12 of AWWA D100 or Sections 11 and 8.5 of AWWA D103 for earth with a bearing value to be determined by the Contractor and constructed in conformance with the applicable requirements of Section 03 30 00.00 40 CAST-IN-PLACE CONCRETE, except as shown or specified herein. Factor of safety on overturning of elevated tanks under design wind load shall be 1.33 minimum. When a footing is required, an inverted truncated pyramid of earth with 2 on 1 side slopes above top of footing may be used in determining overturning stability.

3.3 EXCAVATING, FILLING, AND GRADING

Excavating, filling, and grading shall conform to the applicable requirements of Section 31 00 00 EARTHWORK.

3.4 TANK INSTALLATION

Tank installation shall be in accordance with the following requirements as applicable:

3.4.1 Welding

Section 8 of AWWA D100 or Section 6 of AWWA D103.

3.4.2 Erection/Placement

Erect elevated tanks as per Section 10 of AWWA D100 or Section 8 of AWWA D103.

Clean, shim, anchor, and grout hydropneumatic tank in place in the location shown on the drawings. Following installation, connect the hydropneumatic tank to the piping system and install instruments and safety devices as shown on the drawings.

3.4.3 Inspections and Testing

Tank inspection and testing shall be in accordance with Section 11 of AWWA D100 or Section 9 of AWWA D103. Mill and shop inspections are required and shall be performed by an approved commercial inspection agency. The Contractor shall perform the radiographic inspections of the welded tank shell, the hydrostatic test and the vacuum box leak test of the tank bottom. Final hydrostatic and leak tests shall be performed before painting of welded tanks.

3.5 PIPING INSTALLATION (EXCEPT FOR OVERFLOW PIPING)

3.5.1 General Guidelines

Where details of fabrication or installation are not shown on the drawings, installation shall conform to Section 1 and 3 of AWWA C600.

3.5.2 Testing of Valves and Piping

After the elevated tank has been erected and the valves and piping installed, and before field painting is begun, the valves and piping shall be hydrostatically tested in accordance with Section 4 of AWWA C600. The Contractor shall replace with sound material any defective material disclosed by the pressure test, and the test shall be repeated until the test results are satisfactory.

3.6 PAINTING AND COATING OF TANK

Each coating manufacturer's technical data, application instructions, Material Safety Data Sheets (MSDS), and certificate for compliance for VOC content shall be submitted to the Contracting Officer. Application, curing time, mixing and thinning of the coating materials shall be in strict accordance with the manufacturers instructions. The use of thinners shall not alter the required minimum dry thickness or adversely affect the VOC content.

3.6.1 Exterior Surfaces (Welded Tanks)

Surface preparation for steel shall be near-white SSPC-6. A two-component catalyzed epoxy prime and intermediate coat, each a minimum of 0.076 mm thick, followed by a two-component catalyzed aliphatic polyurethane finish coat, a minimum of 0.038 mm thick, conforming to Type V of SSPC PS Guide 17.00 shall be applied. The prime coat shall be a green primer, Formula 150 in accordance with MIL-P-24441. The intermediate coat shall be white Formula 152 in accordance with MIL-P-24441 and may be tinted with pigment color. The finish coat shall be white.

3.6.2 Interior Surfaces (Welded Tanks)

A prime coat at least 0.076 mm thick and a white final coat at least 0.127 mm thick shall be applied. Each coat shall be a two-component catalyzed epoxy in accordance with MIL-PRF-23236. The primer shall contrast with the color of the finish coat. Four coats, each at least 0.038 mm thick, of VR-3 vinyl resin paint in accordance with BOR Paint Mnl shall be applied. The second, third, and fourth coats shall be of contrasting colors.

3.6.3 Bolted Tanks

The tanks shall have a coating applied to both the interior and exterior surfaces in accordance with Section 10 of AWWA D103. Color shall be as approved.

3.7 INSULATION

Provide a sprayed on polyurethane foam factory insulation coating suitable for outdoor applications, or a thermostatically controlled freeze protection system.

3.8 DISINFECTION

The tank and connecting lines thereto shall be disinfected with chlorine before being placed in operation.

3.8.1 Tank

The tank shall be disinfected by the Contractor in accordance with AWWA C652. After the chlorination procedure is completed and before the storage facility is placed in service, the Contracting Officer will collect samples of water in properly sterilized containers for bacteriological testing from the full facility in accordance with Section 7 of AWWA C652. The tank will not be accepted until satisfactory bacteriological results have been obtained.

3.8.2 Piping

The valves and piping shall be disinfected by the Contractor in accordance with Section 33 11 00 WATER DISTRIBUTION.

3.9 INSPECTION AND REPAIR

Prior to tank repair job, perform a detailed inspection of the structure and submit report by a certified inspector.

-- End of Section --

SECTION 33 20 00

WATER WELLS
04/06

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 WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2005) Standard Methods for the Examination of Water and Wastewater
AWWA A100	(2006) Water Wells
AWWA B300	(2004) Hypochlorites
AWWA C200	(1997) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C206	(2003) Field Welding of Steel Water Pipe
AWWA C654	(2003) Disinfection of Wells

ASTM INTERNATIONAL (ASTM)

ASTM A 139/A 139M	(2004) Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and over)
ASTM A 312/A 312M	(2006) Standard Specification for Seamless, Welded, and Heavily Worked Austenitic Stainless Steel Pipes
ASTM A 53/A 53M	(2006a) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 150	(2005) Standard Specification for Portland Cement
ASTM D 1586	(1999) Penetration Test and Split-Barrel Sampling of Soils
ASTM D 1587	(2000) Thin-Walled Tube Sampling of Soils for Geotechnical Purposes

ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2216	(2005) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 2487	(2006) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2488	(2006) Description and Identification of Soils (Visual-Manual Procedure)
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4750	(1987; R 2001) Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)
ASTM D 5079	(2002) Preserving and Transporting Rock Core Samples
ASTM D 5299	(1999) Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities
ASTM D 5521	(1994; E 1998) Development of Ground-Water Monitoring Wells in Granular Aquifers
ASTM F 480	(2002) Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80

U.S. ARMY CORPS OF ENGINEERS (USACE)

CED TR GL-85-3	(1985) Geotechnical Descriptions of Rock and Rock Masses

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes

1.3 GENERAL REQUIREMENTS

The well shall be located where directed, and be constructed in accordance with these specifications. Each well shall be installed to prevent aquifer contamination by the drilling operation and equipment, intra- and inter-aquifer contamination, and vertical seepage of surface water adjacent to the well into the subsurface, especially the well intake zone.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for

Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Diagrams; G, District Office

As-built installation diagram and supporting calculations for each well installed, prepared by the geologist present during well installation operations, within 30 working days of the completion of the well installation procedure.

Pump installation diagrams and calculations shall be submitted by a Professional Engineer.

SD-03 Product Data

Well Installation Plan; G, District Office

A plan as specified in paragraph WELL INSTALLATION PLAN describing the drilling methods, sampling, well construction, well development, and well decommissioning 30 calendar days prior to beginning drilling operations. Mobilization activities may start prior to submittal of the plan. The plan shall be approved and signed by an experienced geologist as specified in paragraph QUALIFICATIONS.

Well Material; G, District Office

Catalog data, and name of supplier, for well screens (to include the screen slot size), casing, riser pipe, filter pack material, bentonite, cement, centralizers, surface protective covers, well vaults, locking caps, airline oil filters for pneumatic drilling, dedicated sampling equipment, pumps, and chemical specifications on drill lubricants, tracers, disinfecting agents, and drill fluid additives, if used. Catalog data shall include any information, written or otherwise, supplied by the manufacturers or suppliers of the above listed items.

Qualifications; G, District Office

Personnel qualification documentation.

Site Conditions; G, District Office

A copy of all permits, licenses, or other legal requirements necessary for execution of the work shall be furnished 10 working days before commencement of the work.

Geophysical Logging; G, District Office

The Contractor shall prepare a graphic boring log to scale showing the required details. The boring log drawing shall be submitted within 10 working days after completion of the test hole. This drawing shall be used for determining the well design, design of the filter pack, well screen location and screen openings.

SD-06 Test Reports

Survey Maps and Notes G, District Office

Survey maps and notes, including a tabulated list of all wells and monuments, copies of all field books, maps showing the locations, and elevations of all wells, datum used (e.g. state plane NAD27, NAD83, UTM, etc.), elevation datum, units of measurement, and all computation sheets shall be submitted within 10 working days after completion of the survey. Also, a diagram showing where on the top of the well the elevation was determined by the surveyor.

Well Development Records; G, District Office

A well development record, for each well, within 10 working days of the completion of development.

Geophysical Logs; G, District Office

Interpreted geophysical logs shall be submitted within 10 working days of the completion of said logging.

Decommissioning/Abandonment Records

A well decommissioning record, for each well, or test hole abandoned, within 10 working days of the completion of the abandonment procedure.

Project Photographs

Before, during, and after completion of the work, the Contractor shall take photographs of each well installation site. Photographs shall also be taken of any rock that is cored at the site.

Water Source

Decontamination and drilling water source analytical test results shall be submitted within 10 working days before beginning drilling operations.

Filter Pack

Filter pack material test results; sieve and chemical analyses, shall be submitted within 10 working days after completion of the test hole.

1.5 WELL INSTALLATION PLAN

The following requirements shall be incorporated into the Contractor's Well Installation Plan and followed in the field. The plan shall include, but shall not be limited to, a discussion of the following:

a. Description of well drilling methods, and installation procedures, including any temporary casing used, placement of filter pack and

seal materials, drill cuttings and fluids disposal, and soil/rock sample disposition.

b. Description of well construction materials, including well screen, riser pipe, centralizers, filter pack and filter pack gradation, cement, and well protective measures.

c. Description of quality control procedures to be used for placement of filter pack and seals in the boring, including depth measurements.

d. Forms to be used for written boring logs, installation diagrams of wells, geophysical logs, well development records, well sampling data records, and any well abandonment records.

g. Description of well development methods to be used.

i. List of personnel assignments for this project, and personnel qualifications.

j. Description of well decommissioning/abandonment procedures.

k. Description of well capacity testing techniques.

l. Description and discussion of geophysical techniques to be employed at the site.

m. Description of permanent pump to be installed, and discussion of pump operating tests to be employed at the site.

n. Description of specific methods to be employed to control potential contamination or pollution arising from well installation activities.

1.6 QUALIFICATIONS

A geologist with at least 3 years experience in soil and rock logging, and well installation, shall be on site and responsible for all geophysical and borehole logging, drilling, well installation, developing and testing activities. Geophysical log interpretation shall be done by a qualified log analyst. The log analyst shall be able to demonstrate competence through background, training, and experience when so called upon. The Contractor shall have a minimum of 10 years of well installation experience.

1.7 TEST HOLES AND OBSERVATION WELLS

1.7.1 Test Holes

Before starting construction of the well, a test hole of at least 100 mm in diameter shall be drilled at the location of the well into the target water bearing stratum (at least 20 meters below the static water table) as directed by the Contracting Officer. Test holes should be drilled in a manner to protect the subsurface from surface contamination. Test holes should be carefully advanced and sampled to determine the presence of the upper aquiclude if one exists. The boring should then be properly cased, grouted, and sealed into the aquiclude before the boring is advanced through the aquiclude into the aquifer. The test hole shall be used to determine

the expected yield from the well, water quality, optimum depth, and to log the strata encountered. Before conducting a capacity test, the well shall be cased, and screened in accordance with these specifications. Test holes shall be logged in accordance with paragraph BOREHOLE LOGS. A temporary casing may be used. If used, the temporary casing shall be seated into the top of the rock or at the top of the stratum being tested whichever is deeper. The test hole may be converted to the permanent well, in accordance with these specifications. If the test hole is not used for the permanent well, the test hole shall be abandoned as specified in paragraph WELL DECOMMISSIONING/ABANDONMENT.

1.7.2 Sampling for Geotechnical Analysis

Samples shall be taken of all materials penetrated by each drilled well/test hole. Soil sampling shall be done with a split or thin-walled tube sampler using standard sampling techniques in accordance with ASTM D 1586 or ASTM D 1587. Samples shall be extracted from their in-situ environment in as near an intact, minimally disturbed condition as technically practical. Samples shall be obtained continuously through the area expected to be screened. The Contractor shall provide sieve analyses of all drive-sampled material. Sieve analyses shall be conducted in accordance with ASTM C 136. The gradation of the natural formation shall be determined by the Contractor through the use of sieve analyses performed on formation samples taken from the areas to be screened. Drive-sampled materials shall be placed in airtight containers and labeled as specified in paragraph SAMPLE CONTAINERS. Representative soil samples s hall be tested for grain-size distribution by mechanical means (sieves down to the 0.075 mm size according to ASTM C 136), moisture content according to ASTM D 2216 and Atterberg limits according to ASTM D 4318. Description and identification of soils shall be done in accordance with ASTM D 2488. Laboratory classification of soils shall be done in accordance with ASTM D 2487. Sampling shall be performed to allow completion of the documents described in paragraph BOREHOLE LOGS.

1.8 GEOPHYSICAL LOGGING

The total depth of each test hole drilled shall be geophysically logged. Geophysical logging shall be documented in accordance with paragraph Geophysical Logs. Log analyses and interpretations shall be made by a person qualified in accordance with paragraph QUALIFICATIONS.

1.9 ABANDONMENT OF WELLS

If the Contractor fails to construct a well of the required capacity, or if the well is abandoned because of loss of tools, or for any other cause, the Contractor shall abandon the hole as specified in paragraph WELL DECOMMISSIONING/ABANDONMENT.

1.10 NOTIFICATION

The Contracting Officer shall be notified 10 days prior to drilling.

1.11 DELIVERY, STORAGE, AND HANDLING

Well materials shall be stored and maintained in a clean, uncontaminated condition throughout the course of the project. Filter pack material shall not be allowed to freeze before installation.

1.12 SITE CONDITIONS

Access requirements to each well site necessary for execution of the work, is the responsibility of the Contractor. Obtaining rights-of-entry is the responsibility of the Government. The Contractor shall visit each proposed well location to observe any condition that may hamper transporting equipment or personnel to the site.

PART 2 PRODUCTS

2.1 CASING

All casing, screen, and other well material shall be of compatible materials to prevent galvanic reaction between components of the completed well.

2.1.1 Steel Casing and Couplings

Steel casing shall be new carbon steel, conforming to ASTM A 139/A 139M Grade B, or standard weight galvanized, black steel pipe, conforming to ASTM A 53/A 53M, or steel pipe conforming to AWWA C200. Joints shall be threaded and coupled.

2.1.2 Plastic Casing and Couplings

Plastic casing pipe and couplings shall be schedule 80, threaded flush joint (or other joint type as approved by the Contracting Officer) and conform to ASTM F 480 and ASTM D 1785.

2.2 WELL SCREENS

Well Screens shall be a minimum of 150 mm nominal diameter, and shall be directly connected to the bottom of the inner casing by an approved method. The length of the screen shall be sufficient to provide an intake area capable of passing not less than the minimum required yield of the well, at an entrance velocity not exceeding 30.5 mm/s. The opening, or slot size of the screen, shall be determined by the Contractor based on analysis of the distribution of the grain size of the aquifer materials encountered during drilling or artificial filter pack if applicable, be compatible with the material surrounding the screen, and shall be submitted for approval as part of the well installation plan. The well screen shall be of sufficient size and design to hold back and support the gravel used in the filter pack envelope and in-situ material surrounding the screen. The screen and all accessories required for satisfactory operation shall be essentially standard products of manufacturers regularly engaged in the production of such equipment. Field constructed screen is not acceptable. "Blanks" in the well screen may be utilized in nonproductive zones, or where centering devices are needed in the screened area, and shall be considered "casing." The bottom section, below the screen, shall be sealed watertight by means of a flush threaded or welded end cap of the same material as the well screen.

2.2.1 Metal Screen

Metal screen shall be of an approved wire-wound type and shall be type 304 stainless steel, conforming to the applicable requirements of AWWA A100. A wire-wound screen manufactured with supporting bars or core of material different from the wire will not be acceptable. Joints shall be made of threaded couplings of the same material as the screens.

2.2.2 Plastic Screen

2.2.2.1 PVC Pipe

PVC pipe shall be approved prior to installation. The PVC pipe must be at least Schedule 80 or SDR 17. All PVC plastic pipe shall conform to ASTM D 1785.

2.2.2.2 Bonding Materials

Bonding materials, proportions and preparation of adhesives, the method of application, and the procedure used for making and curing the connections shall conform to the recommendations of the PVC pipe manufacturer and ASTM F 480. The system for making joints at the well site shall provide a curing period adequate to develop the ultimate strength of the completed joint. Self-tapping screws or other devices for holding adhesive-coated pipe in the couplings during the setting period shall not be utilized. Newly-made joints in the casing shall not be stressed, lowered into the well or submerged in water prior to complete curing of the adhesive.

2.2.2.3 PVC Well Screen

PVC well screen shall be provided with perforations which shall consist of machine-sawed slots which shall have smooth, sharp-edged openings free of burns, chipped edges, or broken pieces on the interior and exterior surfaces of the pipe. The pattern of the openings shall be uniformly spaced around the periphery of the well screen. Compatible slot sizes of screens and filter-pack gradations or surrounding material shall be designed by the Contractor and furnished to the Contracting Officer. The PVC pipe screen strength properties shall be equivalent to those for the PVC casing with which the screen is used.

2.3 FILTER PACK

Filter pack material shall be a product of a commercial sand and gravel supplier, shall be properly sized and graded for the surrounding soil encountered, and shall be composed of clean, round, hard, waterworn siliceous material, free of flat or elongated pieces, organic matter, or other foreign matter. The filter material shall be of a size which will allow the maximum flow of water into the well and prevent the infiltration of sand and silt. The gradation of the filter material shall be such that the uniformity coefficient is not more than 2.5.

2.5 CEMENT GROUT

2.5.1 Cement Grout

Cement grout shall consist of Portland cement conforming to ASTM C 150, Type I or II, sand and water. Cement grout shall be proportioned not to exceed 2 parts, by weight, of sand to 1 part of cement with not more than 23 liters of water per 42.6 kg of Portland cement, with a mixture of such consistency that the well can be properly grouted. No more than 5 percent by weight of bentonite powder may be added to reduce shrinkage.

2.6 PERMANENT PUMP

Permanent pump shall be an approved submersible type with a capacity sufficient to deliver the pumping rates as described in Section 43 21 39 "PUMPS, SUBMERSIBLE, VERTICAL TURBINE, AND HAND OPERATED".

2.7 SAMPLE CONTAINERS

Drill cuttings and driven samples for geotechnical purposes shall be placed in air-tight liter size plastic containers and labeled with the project name, date of sample, well number and depth at which the sample was taken. Both the container and lid shall be labeled in permanent indelible ink. Jars shall be placed in partitioned cardboard boxes. Boxes shall be labeled with project number and well number. Containers and boxes shall be furnished by the Contractor. Core samples shall be preserved and prepared for transport as described in ASTM D 5079. Cored rock samples shall be placed in wooden core boxes as indicated on the drawings. Spacers shall be placed in the proper positions in the core boxes to show the location and actual extent of voids and core losses as clearly as possible. The spacers shall be made of wood or some other relatively light material which is of sufficient strength to withstand jarring and crushing in handling. Spacers shall be of a strongly contrasting color pattern so that core losses will be accented either by direct observation or in photographs. In the smaller sizes, up to and including 150 mm, the spacers shall be the same width as the cores. The outside and the inside of the core box lid shall be labeled with the project name, hole number, date sampled, location, surface elevation, core box number, and interval of depth of core. The information on the label shall be such that it can clearly be read in photographs of the core box. Both ends of the core box shall also be labeled with the hole number and box number. The core shall be placed in the core box starting at the left hand corner on the hinge side and running to the right. Successive cores down the hole shall be placed in successive troughs, starting from the back and working toward the front of the box so that the core can be read in the same manner as a printed page, from left to right, when standing in front of the open box.

PART 3 EXECUTION

3.1 PROTECTION OF EXISTING CONDITIONS

The Contractor shall maintain existing survey monuments and wells, and protect them from damage from equipment and vehicular traffic. Any items damaged by the Contractor shall be repaired by the Contractor. Wells requiring replacement due to Contractor negligence shall be re-installed according to these specifications. Wells scheduled for abandonment shall be protected from damage so that abandonment may be performed according to these specifications. Prior to excavation, the Contractor shall obtain written approval from the local utility companies to drill at each site, to avoid disturbing buried utilities.

3.2 PREPARATION

3.2.1 Decontamination

Contractor shall be responsible to insure all drilling equipment is free of potential contaminants prior to drilling at any site.

3.3 WELL CONSTRUCTION

The drilling method shall be as approved by the Contracting Officer and shall conform to all state and local standards for water well construction. The execution of the work shall be by competent workmen and shall be performed under the direct supervision of an experienced well driller. The drilling method shall prevent the collapse of formation material against the well screen and casing during installation of the well. The inside diameter of any temporary casing used shall be sufficient to allow accurate placement of the screen, riser, centralizer(s), filter pack, seal and grout. Casing pipe, well screens, and joint couplings shall be of compatible materials throughout each well. The well shall be a filter pack well or naturally developed well activated in the water-bearing stratum or stratum based on test hole data. The well shall be drilled straight, plumb, and circular from top to bottom. The well shall be initially drilled from the ground surface to the uppermost level of the water bearing strata or top of rock and the bottom of the outer casing set at this elevation. The hole below the outer casing shall penetrate the water bearing stratum a sufficient depth to produce the required amount of water without causing excessive velocities through the aquifer. During construction of the wells, precautions shall be used to prevent tampering with the well or entrance of foreign material. Runoff shall be prevented from entering the well during construction. If there is an interruption in work, such as overnight shutdown or inclement weather, the well opening shall be closed with a watertight uncontaminated cover. The cover shall be secured in place or weighted down so that it cannot be removed except with the aid of the drilling equipment or through the use of drill tools.

3.3.1 Setting Outer Casing

The outer casing shall not be less than 200 mm in diameter. The hole shall be of sufficient size to leave a concentric annular space of not less than 65 mm and not more than 150 mm between the outside of the outer casing and the walls of the hole. The annular space between the outer casing and the walls of the holes shall be filled with cement grout. Acceptable methods of grouting are detailed in AWWA A100; the approved method shall specify the forcing of grout from the bottom of the space to be grouted towards the surface. A suitable grout retainer, packer, or plug shall be provided at the bottom of the inner casing so that grout will not leak into the bottom of the well. Grouting shall be done continuously to ensure that the entire annular space is filled in one operation. After grouting is completed, drilling operations shall not be resumed for at least 72 hours to allow proper setting of the grout.

3.3.2 Temporary Casing

Temporary well casing of either iron or steel of sufficient length to case to the bottom of all borings shall be available at the construction site. The Contracting Officer will direct the use of a temporary casing to the bottom of the boring during drilling and placement of screen, riser, and filter pack when he believes it is necessary to provide adequate support to the sides of the hole. When the walls of the boring will require support only during development operations a temporary casing will be required to extend only to a depth 1 m below the top of the filter pack. The temporary casing, shall have sufficient thickness to retain its shape and maintain a true section throughout its depth, and may be in sections of any convenient length. The temporary casing shall be such as to permit its removal without disturbing the filter pack, riser, or well screen. The setting of temporary casing shall be such that no cavity will be created outside of it at any

point along its length. In the event the temporary casing should become unduly distorted or bent it should be discarded and a new casing should be used during installation of any additional well.

3.3.3 Construction of Inner Casing and Screen

After the grout has set, the hole below the outer casing shall be reamed at the required diameter, to the required depth, by an approved method which will prevent caving of the hole before or during installation of the filter pack, well screen and inner casing. In lieu of reaming, the entire well may be drilled to the diameter of the filter pack with an annular space between the inner casing and outer casing equal to the thickness of the filter pack. The outer casing shall be increased in size to provide for this space, if this option is elected. The well screen and inner casing shall be firmly attached, and lowered into the hole by a method which will allow for control of the rate of fall of the well screen and inner casing at all times. Well screen and inner casing shall not be dropped or allowed to fall uncontrolled into the hole. The inner casing shall extend up through the outer casing to 0.3 meters above the proposed well house floor elevation. Approved centering devices shall be installed at a spacing of 120 degrees, between the outer casing and inner casing prior to well construction at intervals not exceeding 8 m along the length. If the screen length is greater than 8 meters, a 1 meter length of blank casing shall be placed in the middle of the screen interval for placement of centering devices. Centering devices shall not be placed on the screened interval, or within the bentonite seal, if used.

3.3.4 Construction of Filter Pack (if natural formation not suitable)

After the screen and inner casing have been concentrically set in the hole below the outer casing, the approved filter pack shall be constructed around the screen by filling the entire space between the screen and the wall of the hole in the water bearing stratum with filter pack material. A tremie pipe having an inside nominal diameter of not less than 40 mm shall be lowered to the bottom of the well between the hole and screen. The tremie pipe shall be arranged and connected, at the surface of the ground, to water pumping and graveling equipment so that water and filter material, fed at uniform rates, are discharged as the filter material fills the hole from the bottom up. The tremie pipe shall be raised at a rate that will keep the bottom of the pipe no more than 1 m above the filter material level at all times. If the Contractor desires to use methods of placing filter material other than those specified, the details of the method and equipment proposed shall be submitted to the Contracting Officer, before filter pack placement is begun; however, dumping filter pack material from the surface of the ground and agitating the well in an effort to settle the filter will not be allowed. The filter pack shall be installed continuously and without interruption until the filter pack has been placed to within 10 m above the top of the screen. The depth to the top of the filter pack shall be directly measured, and recorded. Any water added to the filter pack material shall be obtained in accordance with paragraph Water Source. Filter pack material shall be protected from contamination prior to placement by either storing it in plastic lined bags, or in a location protected from the weather and contamination on plastic sheeting. Filter pack material shall not be allowed to freeze before installation. Filter pack material shall be transported to the well site in a manner which prevents contamination by other soils, oils, grease, and other chemicals. Temporary drill casing, if installed, or hollow stem auger, shall be removed simultaneously with the above operation.

Filter pack material shall be placed in no greater than 1 m lifts prior to retraction of the temporary casing/auger. A minimum of 150 mm of filter pack shall remain in the temporary casing/auger at all times during filter pack installation. Frequent measurements shall be made inside the annulus during retraction to ensure that the filter pack is properly placed.

3.3.5 Bentonite Seal

After the inner casing and well screen and filter pack have been installed, and after predevelopment of the well, the annular space between the inner and outer casings shall be sealed by use of a bentonite seal. A minimum 1 m thick hydrated bentonite seal shall be placed on top of the filter pack in a manner which prevents bridging of the bentonite in the annulus. The bottom of the bentonite seal shall be a minimum of 2 m above the top of the well screen. The depth to the top of the bentonite seal shall be directly measured and recorded immediately after placement, without allowance for swelling. If the bentonite seal is located above any borehole fluid levels, a 300 mm layer of fine sand shall be placed at the top of the bentonite seal.

3.3.6 Grout Placement

After the inner casing and well screen filter pack have been installed, a non-shrinking cement or high-solids bentonite grout, shall be mechanically mixed in accordance with paragraph CEMENT AND BENTONITE GROUT, and placed by tremie pipe, in one continuous operation into the annulus between the inner and outer casings above the bentonite seal to within 80 mm of the ground surface. Grout injection shall be in accordance with AWWA A100. If the casing interval to be grouted is less than 4.5 m, and without fluids after any drill casing is removed, the grout may be placed either by pouring or pumping. The tremie pipe shall be thoroughly cleaned with high pressure hot water/steam before use in each well. The bottom of the tremie pipe shall be constructed to direct the discharge to the sides rather than downward. The discharge end of the tremie pipe shall be submerged at all times. Additional grout shall be added from the surface to maintain the level of the grout as settlement occurs. Work shall not be conducted in the well within 24 hours after cement grouting. The alignment of the well shall be verified by passing a 1.5 m long section of rigid pipe 6 mm smaller in diameter than the inside diameter of the casing through the entire well. If the pipe does not pass freely, the well will not be accepted. The pipe section shall be thoroughly cleaned with high pressure hot water/steam prior to each test.

3.4 WELL DEVELOPMENT

Within 7 days of completion of each well, but no sooner than 48 hours after cement grouting is completed, the well shall be developed. Predevelopment, or development after the filter pack has been installed, but before the annular seal is installed, may be initiated before this minimum 48 hour period. The well shall be developed in accordance with the Well Installation Plan, by approved methods until the water pumped from the well is substantially free from sand, and until the turbidity is less than 5 on the Jackson Turbidity Scale specified in AWWA 10084. Developing equipment shall be of an approved type and of sufficient capacity to remove all cutting fluids, sand, rock cuttings, and any other foreign material. The well shall be thoroughly cleaned from top to bottom before beginning the well tests. Development shall be performed using only mechanical surging,

over pumping, or jetting, or a combination thereof per ASTM D 5521. Details of the proposed development method shall be included in the Well Installation Plan. At the time of development of any well, the well shall be free of drawdown or surcharge effects due to pump testing, developing or drilling at another location. The Contractor shall be responsible for maintaining at the well site the needed access and work area and clearance, necessary to accomplish development. The Contractor shall furnish, install, or construct the necessary discharge line and troughs to conduct and dispose of the discharge a sufficient distance from the work areas to prevent damage. Development shall be conducted to achieve a stable well of maximum efficiency and shall be continued until a satisfactory sand test, as specified in paragraph Sand Test, is obtained. During predevelopment of the well, filter pack material shall be added to the annular space around the screen to maintain the top elevation of the filter pack to the specified elevation. The Contractor shall provide an open tube or other approved means for accurately determining the water level in the well under all conditions. If, at any time during the development process it becomes apparent in the opinion of the Contracting Officer that the well may be damaged, development operations shall be immediately terminated. The Contracting Officer may require a change in method if the method selected does not accomplish the desired results. The Contracting Officer may order that wells which continue to produce excessive amounts of fines after development for 6 hours be abandoned, plugged, and backfilled, and may require the Contractor to construct new wells nearby. All materials pulled into the well by the development process shall be removed prior to performing the pumping test.

3.4.1 Jetting

Jetting should be performed using either a single or double ring jet. If a double ring jet is used the rings should be 600 mm apart. The jetting tool shall be constructed of high-strength material and conservatively designed and proportioned so that it will withstand high pressures. The jetting tool shall have two 7, 8, or 10 mm diameter hydraulically balanced nozzles spaced 180 degrees or four 7, 8, or 10 mm diameter holes spaced 90 degrees apart and which shall exert the jetting force horizontally through the screen slots. The rings shall be constructed such that the tips of the jets shall be within 13 mm from the inner surface of the well screen. The pump used in conjunction with the jetting tool shall be capable of providing a minimum jetting fluid exit velocity of 45 m/s. Prior to commencing jetting, and following each jetting cycle, all sand and/or other materials shall be removed from inside the screen. The jetting process shall start at the bottom of the screen and consist of rotating the jetting tool slowly while rotating the pipe 180 degrees for two minutes at each location then raising the pipe 150 mm. All wells, more than 100 mm in diameter, shall be pumped during the jetting cycle to remove incoming sand and other material. Such pumping shall be at a rate not less than 115 percent of the rate at which fluid is introduced through the jetting tool. This will allow a flow of material into the well as it is being developed. Water used for development shall be free of sand. The contracting officer may require other means of developing the well such as intermittent pumping method, variation of the intermittent pumping method, or surge block if it appears that the development of the well is not producing the desired results.

3.4.2 Intermittent Pumping

Intermittent pumping shall be performed by pumping the well at a capacity sufficient to produce a rapid drawdown stopping the pump (backflow through pump will not be permitted) to permit the water surface to rise to its former elevation, and repeating this procedure. Cycle time for this procedure will vary as directed but will not be more than 3 cycles per minute. A deep well turbine pump, or electric submersible pump with check valve, shall be used with any attachment necessary to accomplish rapid starting and stopping for intermittent pumping. The intake shall be set at least 3 m below the maximum expected drawdown in the well. Prior to commencing intermittent pumping, and periodically during development by this method, all sand and/or other materials shall be removed from inside the screen. The amount of drawdown may be decreased if, in the opinion of the Contracting Officer, the efficiency of the well might otherwise be impaired.

3.4.3 Surging

Surging of the well shall require use of a circular block, or multiple blocks, which are approximately 25 mm smaller in diameter than the inside diameter of the well and is constructed of a material which will not damage the screen if the block comes in contact with the screen, and a bailer or pump to remove materials drawn into the well. The surging shall be continued for a period of approximately one hour, or until little or no additional material from the foundation or filter pack can be pulled through the screen. The surge block shall be moved by a steady motion up and down the full length of the well screen. Prior to commencing surging, and periodically during development by this method, all sand and/or other materials shall be removed from inside the screen. All materials pulled into the well by the surging process shall be removed by the Contractor.

3.4.4 Well Development Criteria

A well development record shall be maintained in accordance with paragraph Well Development Records. Development is complete when all of the following criteria are met:

a. Well water is clear to the unaided eye ,and turbidity less than or equal to 5 Nephelometric Turbidity Units (NTUs),

b. Sediment thickness in the well is less than 1 percent of the screen length

c. A minimum of three times the standing water volume in the well is removed plus three times the volume of all added water and drilling fluid lost during drilling and installation of the well is removed, and

3.5 TESTS

After the wells have been developed, the Contractor shall notify the Government and shall make the necessary arrangements for conducting the capacity tests. If the capacity test indicates that the required capacity can be obtained, the tests for quality of water shall be made. If the capacity and quality tests indicate that the required capacity and quality can be obtained, the permanent well, as specified, shall be completed at that depth. Prior to making quality tests, drilling equipment, tools and pumps contacting well water shall be cleaned with live steam.

3.5.1 Capacity Test

The Contractor shall furnish and install an approved temporary test pump, with discharge piping of sufficient size and length to conduct the water being pumped to point of discharge, and equipment necessary for measuring the rate of flow and water level in the well. An 8 hour step-drawdown capacity test shall be run with the pumping rate and drawdown at the pump well and observation wells recorded every 1/2 minute during the first 5 minutes after starting the pump; then every 5 minutes for an hour; then every 20 minutes for 2 hours. From this point on, readings taken at hourly intervals, until the water level stabilizes, shall be sufficient. Observation wells (piezometers) shall be read on the same schedule as the pump well. During the step-drawdown test, the pumping rate shall be increased in steps at regular intervals. Specific capacity shall be measured for each step. The test shall begin at the rate of the expected capacity of well and at least that rate maintained throughout the duration of the test. The well shall be "step" tested at rates of approximately 1/2, 3/4, 1 and 1 1/2 times the estimated design capacity of the well. If this capacity cannot be maintained for the test period, the capacity test shall be terminated and the test hole drilled deeper or relocated as directed. When the pump is shut off, water level readings shall be taken during the rebound period for the same intervals of time as the drawdown test. The record of the test, in triplicate, shall be delivered to the Contracting Officer.

3.5.2 Test for Plumbness and Alignment

Upon completion of the permanent well, plumbness and alignment shall be tested by lowering into the well, to the total depth of the well, a plumb 12 m long or a dummy of the same length. The outer diameter of the plumb shall not be more than 13 mm smaller than the diameter of that part of the hole being tested. If a dummy is used, it shall consist of a rigid spindle with three rings, each ring being 300 mm wide. The rings shall be cylindrical and shall be spaced one at each end of the dummy and one in the center. The central member of the dummy shall be rigid so that it will maintain the alignment of the axis of the rings. The dummy shall be decontaminated as specified in paragraph Decontamination, before use. If the plumb or dummy fail to move freely throughout the length of the casing or well screen for the depth of well or should the well vary from the vertical in excess of two-thirds the inside diameter of that part of the well being tested for each 30 m of depth, the plumbness and alignment of the well shall be corrected by the Contractor. If the faulty alignment and plumbness is not correctable, as determined by the Contracting Officer, the well shall be abandoned as specified in paragraph WELL DECOMMISSIONING/ABANDONMENT and a new well drilled at no additional cost to the Government.

3.5.3 Test for Quality of Water

When the capacity test in the test hole has been completed, and again after the yield in the permanent well and drawdown test or capacity test have been completed, the Contractor shall secure samples of the water in suitable containers, and of sufficient quantity, to have bacterial, physical, and chemical analyses made by a recognized testing laboratory. Water Quality Analysis shall address each item specified in the Water Quality Analysis Table at the end of this section. Expenses incident to these analyses shall be borne by the Contractor and the results of the analyses shall be

furnished to the Contracting Officer. All sampling and analyses shall be performed using EPA approved methods, procedures, and holding times.

3.5.4 Sand Test

As part of each capacity test, or at the end of each intermittent pumping, a determination of the amount of sand (filter pack and/or foundation material) a well is producing shall be performed. Prior to starting the sand test all material shall be removed from the bottom of the tailpipe. The Contractor shall test each well by pumping at a rate sufficient to produce an easily measureable amount of drawdown, preferably over 3 meters. After the pump is at the desired pumping rate the flow from the discharge shall be diverted into a container that will collect all the sand being carried by the water. Development of the well is satisfactory if the amount of sand collected is less than 0.5 L per 100,000 L of water pumped at the specified rate. Upon completion of the test the amount of sand in the tailpipe shall be determined to verify that no material is being deposited in the bottom of the well.

3.6 INSTALLATION OF PERMANENT PUMP

The permanent well pump shall be installed in the well at a minimum depth of 8 m below the maximum drawdown groundwater level after the drawdown test has been completed. The pump shall be secured at the required elevation as recommended by the pump manufacturer. After installation of the pumping units and appurtenances is complete, operating tests shall be carried out to assure that the pumping installation operates properly. Tests shall assure that the pumping units and appurtenances have been installed correctly, that there is no objectionable heating, vibration, or noise from any parts, and that all manual and automatic controls function properly.

3.7 DISINFECTING

After completion of tests of well, or installation of permanent pump, or at time of tests for yield and drawdown test, whichever is later, the wells shall be disinfected by adding chlorine, conforming to AWWA B301, or hypochlorite, conforming to AWWA B300, in sufficient quantity so that a concentration of at least 50 ppm of chlorine shall be obtained in all parts of the well. Chlorine solution shall be prepared and introduced into the well in an approved manner and shall remain in the well for period of at least 12 hours but not more than 24 hours. Information on methods for preparing chlorine solution and introducing it into the well may be found in AWWA C654. After the contact period, the well shall be pumped until the residual chlorine content is not greater than 1.0 ppm. The well shall be pumped to waste for an additional 15 minutes with less than 1 ppm chlorine residual after which two samples shall be taken not less than 30 minutes apart and tested for the presence of coliform bacteria. The well shall be disinfected and redisinfected as may be required until two consecutive samples of water are found upon test to be free from Coli Acrogenes group of organisms.

3.8 PUMPHOUSE AND SLAB

Pumphouse and slab shall be constructed preventing the infiltration of surface water or precipitation into the well. The slab shall be constructed of reinforced concrete. The top of the outer casing shall extend above the

top of the slab. The pumphouse shall be constructed on the slab and thermally insulated.

3.9 SITE CLEAN-UP

After completion of the work, tools, appliances, surplus materials, temporary drainage, rubbish, and debris incidental to work shall be removed. Excavation and vehicular ruts shall be backfilled and dressed to conform with the existing landscape. Utilities, structures, roads, fences, or any other pre-existing item which must be repaired or replaced due to the Contractor's negligence shall be the Contractor's responsibility; repair or replacement shall be accomplished prior to completion of this contract.

3.10 SURVEYS

Coordinates and elevations shall be established for each well/test hole. Horizontal coordinates shall be determined to the closest 300 mm and referenced to the Universal Transverse Mercator (UTM). If the UTM is not readily available, an existing local grid system shall be used. A ground elevation to the closest 30 m shall be obtained at each well. The highest point on the top of the riser pipe will serve as a measurement point. The elevation of the well shall reference this point, and shall be surveyed to the nearest 3 mm. If a recognized datum is not readily available, the existing local vertical datum shall be used. The location, identification, coordinates, and elevations of the well and monuments shall be plotted on maps with a scale large enough to show their location with reference to other structures. If no local survey reference is available, an arbitrary survey datum created for the site may be used.

3.11 WELL DECOMMISSIONING/ABANDONMENT

Any well disapproved by the Contracting Officer, or any well decommissioned/abandoned by the Contractor for any reason shall be decommissioned/abandoned according to the requirements of ASTM D 5299, and the requirements of these specifications. Well decommissioning/abandonment includes the removal of all materials left in the borehole/well, excluding the filter pack, and including backfill materials, casing, screen, and any other material placed into the hole before the decision was made to abandon the borehole/well. Test holes decommissioned/abandoned for any reason shall be grouted from the bottom to within 80 mm of the top of the ground surface according to the protocol for grout/bentonite placement established in paragraph Grout Placement, using the grout mix specified in paragraph CEMENT AND BENTONITE GROUT. The top 80 mm shall be backfilled with material appropriate for the intended land use. The Contractor shall maintain a well decommissioning/abandonment record as specified in paragraph Well Decommissioning/Abandonment Records. Groundwater levels, if encountered before the decision is made for decommissioning/abandonment, shall be measured in all borings prior to backfilling. These water levels shall be included in the well decommissioning/abandonment records. No well shall be decommissioned/abandoned without the approval of the Contracting Officer.

3.12 DOCUMENTATION AND QUALITY CONTROL REPORTS

The Contractor shall establish and maintain documentation and quality control reports for well construction and development to record the desired information and to assure compliance with contract requirements, including, but not limited to, the following:

3.12.1 Borehole Logs

A borehole log shall be completed for each boring drilled. Borehole logs shall be prepared by the geologist present onsite during all well drilling and installation activities. The log scale shall be 10 mm equals 300 mm. Copies of complete well logs shall be kept current in the field at each well site and shall be available at all times for inspection by the Contracting Officer. Information provided on the logs shall include, but not be limited to, the following:

a. Name of the project and site.

b. Boring/well identification number.

c. Location of boring (coordinates, if available).

d. Make and manufacturer's model designation of drilling equipment and name of drilling firm.

e. Date boring was drilled.

f. Reference data for all depth measurements.

g. Name of driller and name and signature of geologist preparing log.

h. Nominal hole diameter and depth at which hole diameter changes.

i. Total depth of boring.

j. Method of drilling, including sampling methods and sample depths, including those attempted with no recovery. Indication of penetration resistance such as drive hammer blows given in blows per 150 mm of driven sample tubes. Information shall include hammer weight and drop distance. Information such as rod size, bit type, pump type, etc., shall be recorded. A description of any temporary casing used, drill fluids and fluid additives used, if any, including brand name and amount used, along with the reason for and start (by depth) of its use shall be included. If measured, mud viscosities and weight shall be recorded.

k. Depth of each change of stratum. If location of strata change is approximate, it shall be so stated.

l. Description of the material of which each stratum is composed, in accordance with ASTM D 2488, and/or standard rock nomenclature in accordance with CED TR GL-85-3, as necessary. Soil parameters for logging shall include, but shall not be limited to, classification, depositional environment and formation, if known, Unified Soil Classification Symbol, secondary components and estimated percentages, color, plasticity, consistency (cohesive soil), density (non-cohesive soil), moisture content, structure and orientation, and grain angularity. Rock core parameters for logging shall include, but shall not be limited to, rock type, formation, modifier denoting variety (shaly, calcareous, siliceous, etc.), color, hardness, degree of cementation, texture, crystalline structure and orientation, degree of weathering, solution or void

conditions, primary and secondary permeability, and lost core. The results of any chemical field screening shall also be included on the boring log. Classification shall be prepared in the field at the time of sampling. The results of visual observation of the material encountered, and any unusual odor detected shall also be duly noted and recorded.

m. Depth of any observed fractures, weathered zones, or any abnormalities encountered.

n. Depth and estimated percent of drill fluid loss or lost circulation. Measures taken to regain drill water circulation. Significant color changes in the drilling fluid return.

o. Depth to water and date measured before, during, and after each drilling shift, and prior to well installation. The Contractor shall provide and maintain at each well under construction a portable water level measuring device of sufficient length to measure the water /NAPL level. The device shall be available onsite at all times and measuring wire shall be graduated in cm. The method of measuring the liquid level shall be noted on the boring log. Water level measurements shall be taken to the nearest mm. It shall be noted on the boring log if the boring was purged and allowed to recover at intervals during the installation, or that water used in drilling was allowed to dissipate into the formation prior to measuring the water level.

p. Box or sample number. Depths and the number of the core boxes and/or samples shall be recorded at the proper interval.

q. Percent Rock Core Recovery. The percent core recovery for the individual drill runs, if rock is cored, shall be shown.

3.12.2 Installation Diagrams

The well will not be accepted before the geologic logs and installation diagrams are received. The diagram shall illustrate the as-built condition of the well and include, but not be limited to, the following items:

a. Name of the project and site.

b. Well identification number.

c. Name of driller and name and signature of the geologist preparing diagram.

d. Date of well installation.

e. Description of material from which the well is constructed, including well casing/riser pipe and screen material, centralizer composition, if used, diameter and schedule of casing and screen, gradation of filter pack, lithologic description, brand name (if any), source, and processing method, and method of placement of the filter pack, bentonite seal type (pellets, granules, chips, or slurry), grout type (cement or high-solids bentonite) and type of protective cover (protective casing or flush-to-ground),if used.

f. Total depth of well.

g. Nominal hole diameter.

h. Depth to top and bottom of screen, and filter pack.

i. Depth to top and bottom of any seals installed in the well boring (grout or bentonite).

j. Type of cement and/or bentonite used, mix ratios of grout, method of placement and quantities used.

k. Elevations/depths/heights of key features of the well, such as top of well casing/riser pipe, top and bottom of protective casing (if used), ground surface, the depth of maximum frost penetration (frost line), bottom of well screen, top and bottom of filter pack, and top and bottom of seal.

l. Other pertinent construction details, such as slot size and percent open area of screen, type of screen, and manufacturer of screen.

m. Well location by coordinates. A plan sheet shall also be included showing the coordinate system used and the location of each well. A plan sheet is not required for each well installation diagram; multiple wells may be shown on the same sheet.

n. Static water level upon completion of the well.

o. Special problems and their resolutions; e.g., grout in wells, lost casing, or screens, bridging, etc.

p. Description of surface completion.

3.12.3 Well Development Records

A well development record shall be prepared for each well installed under the supervision of the geologist present during well installation operations. Information provided on the well development record shall include, but not be limited to, the following:

a. Date, time, and elevation of water level in the well, before development.

b. Depth to bottom of well, name of project and site, well identification number, and date of development.

c. Method used for development, to include size, type and make of equipment, bailer, and/or pump used during development.

d. Time spent developing the well by each method, to include typical pumping rate, if pump is used in development.

e. Volume and physical character of water removed, to include changes during development in clarity, color, particulates, and odor.

f. Volume of water added to the well, if any.

g. Volume and physical character of sediment removed, to include changes during development in color, and odor.

h. Source of any water added to the well.

i. Clarity of water before, during, and after development. Nephelometric turbidity unit (NTU) measurements.

j. Total depth of well and the static water level as per ASTM D 4750from top of the casing, immediately after pumping/development, and 24 hours after development.

k. Name and job title of individual developing well.

l. Name and/or description of the disposal facility/area, for the waters removed during development.

3.12.4 Geophysical Logs

Geophysical logs shall be prepared and completed for each well/test hole installed. Information provided on the logs shall include, as a minimum, the following:

a. Project name.

b. Test hole/well identification number.

c. Location of test hole (coordinates, and state, and county name).

d. Date test hole was drilled.

e. Fluid level in test hole before logging.

f. Fluid type and temperature.

g. Fluid resistance in ohm-m.

h. Casing type, diameter, and elevation (top and bottom).

i. Cement type and elevation (top and bottom).

j. Screen type, diameter, and elevation (top and bottom).

k. Date and time test hole was logged.

l. Reference elevation for all depth measurements.

m. Operator's name.

n. Equipment name and address.

o. Logger type and number.

p. Tool type.

q. Detector type (Nuclear Log only).

r. Source type (Nuclear Log only).

s. Source size (Nuclear Log only).

t. Source spacing (Nuclear Log only).

u. Tool length, cable head to detector.

v. Calibration.

w. Logging speed cm/min.

x. Log vert. scale m/cm.

y. Module settings.

z. Recorder settings.

aa. Document all field problems, including equipment malfunctions. This should include the steps taken to solve the problem and how the log might have been affected.

3.12.5 Well Decommissioning/Abandonment Records

Decommissioning/abandonment records shall include, as a minimum, the following:

a. Project name.

b. Well or test hole number.

c. Well/boring location, depth and diameter.

d. Date of decommissioning/abandonment.

e. Method of decommissioning/abandonment.

f. All materials used in the decommissioning/abandonment procedure and the interval in which test materials were placed.

g. Casing, and or other items left in hole by depth, description, and composition.

h. Description and total quantity of grout used initially.

i. Description and daily quantities of grout used to compensate for settlement.

j. Water or mud level (specify) prior to grouting and date measured.

k. The reason for decommissioning/abandonment of the well/test hole.

3.12.6 Project Photographs

Before, during, and after completion of work, the Contractor shall take a minimum of one view of each well installation. If rock is cored at the site, after the core has been logged, the core shall be dampened, if it has

dried, neatly arranged in the core box, and photographed. Photographs shall be 80 x 120 mm color prints. The photographs shall be mounted and enclosed back-to-back in a double face clear plastic sleeve punched to fit standard three ring binders. Each color print shall show an information box, 20 x 50 mm. The box shall be typewritten and arranged as follows:

Project No. Contract No.

Contractor/Photographer:

Photograph No. Date/Time:

Description:

Direction of View:

3.12.7 Survey Maps and Notes

A tabulated list of all wells and monuments, copies of all field books, maps showing the locations, and elevations of all wells, datum used (e.g. state plane NAD27, NAD83, UTM, etc.), elevation datum, units of measurement, and all computation sheets shall be prepared as a submittal. The tabulation shall consist of the designated number of the well or monument, the X and Y coordinates, and all the required elevations. Also, a diagram showing where on the top of the well the elevation was determined by the surveyor shall be prepared.

WATER QUALITY ANALYSIS TABLE

Physical Characteristics

Color	Resistivity in ohms per cubic centimeter and 25 degrees C.
Taste	pH value
Threshold odor number	Temperature
Turbidity	

Chemical Characteristics (Expressed as mg/L)

Arsenic	Total Hardness as CaCO(3)
Barium	Endrin
Cadmium	Lindane
Chromium	Methoxychlor
Copper	Toxaphene
Lead	2-4-D
Mercury	2, 4, 5 TP Silvex
Selenium	Total Organic Halogens
Silver	TOC
Zinc	Sulphates as SO(4)
Fluoride as F	Chlorides as C1
Manganese as Mn (dissolved and total)	Bicarbonates as HCO(3)
Iron as Fe (dissolved and total)	Carbonates as CO(3)
Suspended Solids	Nitrates as NO(3)
Total Dissolved Solids	Alkalinity (methyl-orange)

Calcium as Ca (Phenolphthalein) as CaCO(3)
Magnesium as Mg Silica as SiO(2)
Sodium and Potassium as Na

-- End of Section --

SECTION 33 30 00

SANITARY SEWERS
07/06

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 WATER WORKS ASSOCIATION (AWWA)

AWWA C605	(2005) Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
AWWA C900	(1997) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Distribution
AWWA M23	(2002) Manual: PVC Pipe - Design and Installation
AWWA M9	(1995) Manual: Pressure Pipe

ASTM INTERNATIONAL (ASTM)

ASTM C 14	(2005a) Standard Specifications for Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 14M	(2005a) Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)
ASTM C 150	(2005) Standard Specification for Portland Cement
ASTM C 260	(2006) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 33	(2003) Standard Specification for Concrete Aggregates
ASTM C 443	(2005a) Standard Specifications for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C 443M	(2005a) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)

ASTM C 478	(2006b) Standard Specifications for Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(2006b) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C 76	(2006) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 76M	(2005b) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 923	(2002) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C 923M	(2002) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals (Metric)
ASTM C 94/C 94M	(2006) Standard Specification for Ready-Mixed Concrete
ASTM C 969	(2002) Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
ASTM C 969M	(2002) Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines (Metric)
ASTM C 990	(2006) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C 990M	(2006) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants (Metric)
ASTM D 1784	(2006a) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(2005) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

ASTM D 2412	(2002) Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D 2464	(2006) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 3034	(2006) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1996a; R 2003e1) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F 402	(1993; R 1999) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F 758	(1995; R 2000) Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F 794	(2003) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 949	(2003) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS A-A-60005	(Basic) Frames.Covers, Gratings, Steps, Sump and Catch Basin, Manhole

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

29 CFR 1910.27	Fixed Ladders

1.2 SYSTEM DESCRIPTION

1.2.1 Sanitary Sewer Gravity Pipeline

Provide mains and laterals of polyvinyl chloride (PVC) plastic pipe. Provide building connections of polyvinyl chloride (PVC) plastic pipe.

Provide each system complete and ready for operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 1.5 m outside of building walls.

1.2.2 Sanitary Sewer Pressure Lines

Provide pressure lines of polyvinyl chloride (PVC) plastic pressure pipe.

1.3 GENERAL REQUIREMENTS

The construction required herein shall include appurtenant structures and building sewers to points of connection with the building drains 1.5 m outside the building to which the sewer system is to be connected. The Contractor shall replace damaged material and redo unacceptable work at no additional cost to the Government. Backfilling shall be accomplished after inspection by the Contracting Officer. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe shall be stored in accordance with the manufacturer's recommendation and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings;

Drawings and calculations by a professional engineer showing the design and layout of the sanitary collection and treatment systems.

Installation and As-Built drawings, as specified.

Metal items

Frames, covers, and gratings

Details, as specified.

SD-03 Product Data

Pipeline materials

Submit manufacturer's standard drawings or catalog cuts.

SD-07 Certificates

Portland Cement

Certificates of compliance stating the type of cement used in manufacture of concrete pipe, fittings and precast manholes.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage

1.5.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.5.1.3 Cement, Aggregate, and Reinforcement

As specified in Section 03 30 00.00 40 CAST-IN-PLACE CONCRETE.

1.5.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Carry, do not drag, pipe to trench.

1.6 DRAWINGS

a. Submit Installation Drawings showing complete detail, both plan and side view details with proper layout and elevations.

b. Submit As-Built Drawings for the complete sanitary sewer system showing complete detail with all dimensions, both above and below grade, including invert elevation.

c. Sign and seal As-Built Drawings by a Professional Surveyor and Mapper. Include the following statement: "All potable water lines crossed by sanitary hazard mains are in accordance with the permitted utility separation requirements."

PART 2 PRODUCTS

2.1 PIPELINE MATERIALS

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 PVC Plastic Gravity Sewer Piping

2.1.1.1 PVC Plastic Gravity Pipe and Fittings

ASTM D 3034, SDR 35, Type PSM with ends suitable for elastomeric gasket joints.

2.1.1.2 PVC Plastic Gravity Joints and Jointing Material

Joints shall conform to ASTM D 3212. Gaskets shall conform to ASTM F 477.

2.1.2 PVC Plastic Pressure Pipe and Associated Fittings

2.1.2.1 PVC Plastic Pressure Pipe and Fittings

a. Pipe and Fittings Less Than 100 mm Diameter: Pipe, couplings and fittings shall be manufactured of materials conforming to ASTM D 1784, Class 12454B.

(1) Push-On Joint: ASTM D 3139, with ASTM F 477 gaskets. Fittings for push-on joints shall be iron conforming to AWWA C110/A21.10 or AWWA C111/A21.11. Iron fittings and specials shall shall be cement-mortar lined (standard thickness) in accordance with AWWA C104/A21.4.

(2) Solvent Cement Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 1.03 Mpa working pressure and 1.38 Mpa hydrostatic test pressure. Fittings for solvent cement jointing shall conform to ASTM D 2466 or ASTM D 2467.

b. Pipe and Fittings 100 mm Diameter to 300 mm: Pipe shall conform to AWWA C900 and shall be plain end or gasket bell end, Pressure Class 150 (DR 18), with cast-iron-pipe-equivalent OD. Fittings shall be gray-iron or ductile-iron conforming to AWWA C110/A21.10 or AWWA C153/A21.53 and shall have cement-mortar lining conforming to AWWA C104/A21.4, standard thickness. Fittings with push-on joint ends shall conform to the same requirements as fittings with mechanical-joint ends, except that bell design shall be modified, as approved, for push-on joint suitable for use with the PVC plastic pressure pipe specified in this paragraph.

2.1.2.2 PVC Plastic Pressure Joints and Jointing Material

Joints for pipe, 100 mm to 300 mm diameter, shall be push-on joints as specified in ASTM D 3139. Joints between pipe and fittings shall be push-on joints as specified in ASTM D 3139 or shall be compression-type joints/mechanical-joints as respectively specified in ASTM D 3139 and AWWA C111/A21.11. Each joint connection shall be provided with an elastomeric gasket suitable for the bell or coupling with which it is to be used. Gaskets for push-on joints for pipe shall conform to ASTM F 477. Gaskets for push-on joints and compression-type joints/mechanical-joints for joint connections between pipe and fittings shall be as specified in AWWA C111/A21.11, respectively, for push-on joints and mechanical-joints.

2.2 CONCRETE MATERIALS

2.2.1 Cement Mortar

Cement mortar shall conform to ASTM C 270, Type M with Type II cement.

2.2.2 Portland Cement

Portland cement shall conform to ASTM C 150, Type II or V as applicable for concrete used in concrete pipe, concrete pipe fittings, and manholes and type optional with the Contractor for cement used in concrete cradle,

concrete encasement, and thrust blocking. Air-entraining admixture conforming to ASTM C 260 shall be used with Type V cement. Where aggregates are alkali reactive, as determined by Appendix XI of ASTM C 33, a cement containing less than 0.60 percent alkalies shall be used.

2.2.3 Portland Cement Concrete

Portland cement concrete shall conform to ASTM C 94/C 94M, compressive strength of 28 MPa at 28 days, except for concrete cradle and encasement or concrete blocks for manholes. Concrete used for cradle and encasement shall have a compressive strength of 17 MPa minimum at 28 days. Concrete in place shall be protected from freezing and moisture loss for 7 days.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Gaskets and Connectors

Gaskets for joints between manhole sections shall conform to ASTM C 443M. Resilient connectors for making joints between manhole and pipes entering manhole shall conform to ASTM C 923M or ASTM C 990M.

2.3.2 External Preformed Rubber Joint Seals

An external preformed rubber joint seal shall be an accepted method of sealing cast iron covers to precast concrete sections to prevent ground water infiltration into sewer systems. All finished and sealed manholes constructed in accordance with paragraph entitled "Manhole Construction" shall be tested for leakage in the same manner as pipelines as described in paragraph entitled "Leakage Tests." The seal shall be multi-section with a neoprene rubber top section and all lower sections made of Ethylene Propylene Di Monomer (EPDM) rubber with a minimum thickness of 1.5 mm. Each unit shall consist of a top and bottom section and shall have mastic on the bottom of the bottom section and mastic on the top and bottom of the top section. The mastic shall be a non-hardening butyl rubber sealant and shall seal to the cone/top slab of the manhole/catch basin and over the lip of the casting. Extension sections shall cover up to two more adjusting rings. Properties and values are listed in the following tables:

Properties, Test Methods and Minimum Values for
Rubber used in Preformed Joint Seals

Physical Properties	Test Methods	EPDM	Neoprene	Butyl mastic
Tensile, kPa	ASTM D 412	12,684	15,132	-
Elogation percent	ASTM D 412	553	295	350
Tear Resistance, N/mm	ASTM D 624 (Die B)	49	28	-
Rebound, percent, 5 minutes	ASTM C 972 (mod.)	-	-	11
Rebound, percent, 2 hours	ASTM C 972	-	-	12

2.3.3 Metal Items

2.3.3.1 Frames, Covers, and Gratings for Manholes

Frames and covers shall be cast iron, ductile iron or reinforced concrete with H2O load rating. Cast iron frames and covers shall be as indicated or shall be of type suitable for the application, circular, without vent holes. The frames and covers shall have a combined weight of not less than 181.4 kg. Reinforced concrete frames and covers shall be as indicated or shall conform to ASTM C 478M. Frame shall be 750 mm inside diameter.

2.3.3.2 Manhole Ladders

A steel ladder shall be provided where the depth of manhole exceeds 3.6m. The ladder shall not be less than 406 mm in width, with 19 mm diameter rungs spaced 305 mm apart. The two stringers shall be a minimum 10 mm thick and 51 mm wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123/A 123M.

2.3.5 Sewage Absorption Field Materials

Pipe shall be perforated bell-and-spigot PVC plastic pipe conforming to ASTM F 758. Covering for open joints in drain tile lines shall be asphalt-treated paper or asphalt-covered fibrous glass cloth. Wire for fastening covering to tile shall be 1.2 mm, nonferrous metal composition.

2.3.6 Grease Interceptor

Grease interceptor shall be minimum 900 liter capacity double basin grease interceptor to prevent large amounts of pipe-clogging fats, oil, and grease and solid waste materials from entering the sanitary sewer system. The Double Basin Grease Interceptor shall be constructed as shown in the drawings to intercept and collect liquid greasy waste and/or garbage from the discharge piping originating from dining facilities. Flow to the interceptor shall be by gravity. Interceptor shall remove the floating and settle-able wastes and prevent their interference with the proper drainage and treatment of wastewater. Interceptor shall be installed underground with top access at or above grade level and be constructed of 28 MPa concrete.

2.4 REPORTS

Submit Test Reports. Compaction and density test shall be in accordance with Section 31 00 00 EARTHWORK. Submit Inspection Reports for daily activities during the installation of the sanitary system. Information in the report shall be detailed enough to describe location of work and amount of pipe laid in place, measured in linear meters.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION

3.1.1 General Requirements for Installation of Pipelines

These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

3.1.1.1 Location

The work covered by this section shall terminate at a point approximately 1.5 m from the building, unless otherwise indicated. Where the location of the sewer is not clearly defined by dimensions on the drawings, do not lay sewer line closer horizontally than 3 m to a water main or service line. Install pressure sewer lines (if any) beneath water lines only, with the top of the sewer line being at least 0.60 m below bottom of water line. Where sanitary sewer lines pass above water lines or below paved or unpaved roadways, encase sewer in concrete for a distance of 3 m on each side of the crossing, or substitute rubber-gasketed pressure pipe for the pipe being used for the same distance. Where sanitary sewer lines pass below water lines, lay pipe so that no joint in the sewer line will be closer than 0.9 m, horizontal distance, to the water line.

a. Sanitary piping installation parallel with water line:

(1) Normal conditions: Sanitary piping or manholes shall be laid at least 3 m horizontally from a water line whenever possible. The distance shall be measured edge-to-edge.

(2) Unusual conditions: When local conditions prevent a horizontal separation of 3 m, the sanitary piping or manhole may be laid closer to a water line provided that:

(a) The top (crown) of the sanitary piping shall be at least 450 mm below the bottom (invert) of the water main.

(b) Where this vertical separation cannot be obtained, the sanitary piping shall be constructed of AWWA-approved ductile iron water pipe pressure tested in place without leakage prior to backfilling.

(c) The sewer manhole shall be of watertight construction and tested in place.

b. Installation of sanitary piping crossing a water line:

(1) Normal conditions: Lay sanitary sewer piping by crossing under water lines to provide a separation of at least 450 mm between the top of the sanitary piping and the bottom of the water line whenever possible.

(2) Unusual conditions: When local conditions prevent a vertical separation described above, use the following construction:

(a) Sanitary piping passing over or under water lines shall be constructed of AWWA-approved ductile iron water pipe, pressure tested in place without leakage prior to backfilling.

(b) Sanitary piping passing over water lines shall, in addition, be protected by providing:

1. A vertical separation of at least 450 mm between the bottom of the sanitary piping and the top of the water line.

2. Adequate structural support for the sanitary piping to prevent excessive deflection of the joints and the settling on and breaking of the water line.

3. That the length, minimum 6.1 m, of the sanitary piping be centered at the point of the crossing so that joints shall be equidistant and as far as possible from the water line.

c. Sanitary sewer manholes: No water piping shall pass through or come in contact with any part of a sanitary sewer manhole.

3.1.1.2 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.1.1.3 Pipe Laying and Jointing

Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Lay nonpressure pipe with the bell ends in the upgrade direction where practical. Adjust spigots in bells to give a uniform space all around. Blocking or wedging between bells and spigots or tongues and grooves will not be permitted. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more than 7.50 m apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batterboards for the same purpose. Branch connections shall be made by use of regular fittings or solvent cemented saddles as approved. Saddles for PVC pipe shall conform to Table 4 of ASTM D 3034.

3.1.2 Special Requirements

3.1.2.1 Installation of PVC Plastic Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM D 2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D 2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.1.2.2 Installation of PVC Plastic Pressure Pipe and Fittings

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section; with the requirements of AWWA C605 for laying of pipe, joining PVC pipe to fittings and accessories, and setting of valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."

a. Pipe Less Than 100 mm Diameter:

(1) Threaded joints shall be made by wrapping the male threads with joint tape or by applying an approved thread lubricant, then threading the joining members together. The joints shall be tightened with strap wrenches which will not damage the pipe and fittings. The joint shall be tightened no more than 2 threads past hand-tight.

(2) Push-On Joints: The ends of pipe for push-on joints shall be beveled to facilitate assembly. Pipe shall be marked to indicate when the pipe is fully seated. The gasket shall be lubricated to prevent displacement. Care shall be exercised to ensure that the gasket remains in proper position in the bell or coupling while making the joint.

(3) Solvent-weld joints shall comply with the manufacturer's instructions.

b. Pipe 100 mm Joints: Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to fittings, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use an approved lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of AWWA C605 for laying the pipe and the recommendations in AWWA M23, Chapter 7, "Installation," for pipe joint assembly. Assemble push-on joints for connection to fittings in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories and with the applicable requirements of AWWA C600 for joint assembly. Make compression-type joints/mechanical-joints with the gaskets, glands, bolts, nuts, and internal stiffeners specified for this type joint and assemble in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories, with the applicable requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel.

c. Pipe anchorage: Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to ASTM C 94/C 94M having a minimum compressive strength of 13.80 MPa at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

3.1.3 Concrete Work

Cast-in-place concrete is included in Section 03 30 00.00 40 CAST-IN-PLACE CONCRETE. The pipe shall be supported on a concrete cradle, or encased in concrete where indicated or directed.

3.1.4 Manhole Construction

Construct base slab of cast-in-place concrete or use precast concrete base sections. Make inverts in cast-in-place concrete and precast concrete bases with a smooth-surfaced semi-circular bottom conforming to the inside contour of the adjacent sewer sections. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert of as large a radius as manhole size will permit. For cast-in-place concrete construction, either pour bottom slabs and walls integrally or key and bond walls to bottom slab. No parging will be permitted on interior manhole walls. For precast concrete construction, make joints between manhole sections with the gaskets specified for this purpose; install in the manner specified for installing joints in concrete piping. Parging will not be required for precast concrete manholes. Cast-in-place concrete work shall be in accordance with the requirements specified under paragraph entitled "Concrete Work" of this section. Make joints between concrete manholes and pipes entering manholes with the resilient connectors specified for this purpose; install in accordance with the recommendations of the connector manufacturer. Where a new manhole is constructed on an existing line, remove existing pipe as necessary to construct the manhole. Cut existing pipe so that pipe ends are approximately flush with the interior face of manhole wall, but not protruding into the manhole. Use resilient connectors as previously specified for pipe connectors to concrete manholes.

3.1.5 Miscellaneous Construction and Installation

3.1.5.1 Connecting to Existing Manholes

Pipe connections to existing manholes shall be made so that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. The connection shall be centered on the manhole. Holes for the new pipe shall be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cutting the manhole shall be done in a manner that will cause the least damage to the walls.

3.1.5.2 Metal Work

a. Workmanship and finish: Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form iron to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surfaces are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined lines and arises. Provide necessary rabbets, lugs, and brackets wherever necessary for fitting and support.

b. Field painting: After installation, clean cast-iron frames, covers, gratings, and steps not buried in concrete to bare metal of mortar, rust, grease, dirt, and other deleterious materials and apply a coat of bituminous paint. Do not paint surfaces subject to abrasion.

3.1.6 Sewage Absorption Field Design and Construction

Perform soil percolation or "perc" tests and size the required leach field per "AED Design Requirements: Sanitary Sewers and Septic System" dated

September 2009. Grade pipe lines uniformly downward to the outlet. Lay perforated pipe with the perforations downward.

3.1.7 Installations of Wye Branches

Cutting into piping for connections shall not be done except in special approved cases. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, the pipe shall be encased in concrete backfill or supported on a concrete cradle as directed. Concrete required because of conditions resulting from faulty construction methods or negligence by the Contractor shall be installed at no additional cost to the Government. The installation of wye branches in an existing sewer shall be made by a method which does not damage the integrity of the existing sewer. One acceptable method consists of removing one pipe section, breaking off the upper half of the bell of the next lower section and half of the running bell of wye section. After placing the new section, it shall be rotated so that the broken half of the bell will be at the bottom. The two joints shall then be made with joint packing and cement mortar.

3.2 FIELD QUALITY CONTROL

3.2.1 Field Tests and Inspections

The Contracting Officer will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests and provide labor, equipment, and incidentals required for testing. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

3.2.2 Tests for Nonpressure Lines

Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; it shall show a practically full circle of light through the pipeline when viewed from the adjoining end of line. When pressure piping is used in a nonpressure line for nonpressure use, test this piping as specified for nonpressure pipe.

3.2.2.1 Leakage Tests

Test lines for leakage by either infiltration tests or exfiltration tests, or by low-pressure air tests. Prior to testing for leakage, backfill trench up to at least lower half of pipe. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

a. Infiltration tests and exfiltration tests: Perform these tests for sewer lines made of the specified materials, not only concrete, in accordance with ASTM C 969M. Make calculations in accordance with the Appendix to ASTM C 969M.

b. Low-pressure air tests: Perform tests as follows:

PVC plastic pipelines: Test in accordance with UBPPA UNI-B-6. Allowable pressure drop shall be as given in UBPPA UNI-B-6. Make calculations in accordance with the Appendix to UBPPA UNI-B-6.

3.2.2.2 Deflection Testing

Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads determined in accordance with ASTM D 2412. Deflection of pipe in the installed pipeline under external loads shall not exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.

a. Pull-through device: This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided the device meets the applicable requirements specified in this paragraph, including those for diameter of the device, and that the mandrel has a minimum of 9 arms. Ball, cylinder, or circular sections shall conform to the following:

(1) A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.

(2) Homogeneous material throughout, shall have a density greater than 1.0 as related to water at 4 degrees C, and shall have a surface Brinell hardness of not less than 150.

(3) Center bored and through-bolted with a 6 mm minimum diameter steel shaft having a yield strength of not less than 483 MPa, with eyes or loops at each end for attaching pulling cables.

(4) Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

b. Deflection measuring device: Sensitive to 1.0 percent of the diameter of the pipe being tested and shall be accurate to 1.0 percent of the indicated dimension. Deflection measuring device shall be approved prior to use.

c. Pull-through device procedure: Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions.

d. Deflection measuring device procedure: Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest

pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, replace pipe which has excessive deflection and completely retest in same manner and under same conditions.

3.2.3 Tests for Pressure Lines

Test pressure lines in accordance with the applicable standard specified in this paragraph, except for test pressures. For hydrostatic pressure test, use a hydrostatic pressure 345 kPa in excess of the maximum working pressure of the system, but not less than 690 kPa, holding the pressure for a period of not less than one hour. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test. Test ductile-iron pressure lines in accordance with the requirements of AWWA C600 for hydrostatic testing. Leakage on ductile-iron pipelines with mechanical-joints or push-on joints shall not exceed the amounts given in AWWA C600; allow no leakage at joints made by other methods. Test concrete pressure lines in accordance with the recommendations in AWWA M9, Chapter 10, "Hydrostatic Testing and Disinfection of Mains." Leakage on concrete pipelines shall not exceed 1.88 L/24 hours per mm of pipe diameter per kilometer of pipeline. Test PVC plastic pressure lines in accordance with the requirements of AWWA C605 for pressure and leakage tests, using the allowable leakage given therein.

-- End of Section --

SECTION 33 40 01

STORM DRAINAGE
07/06

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.

ACI INTERNATIONAL (ACI)

ACI 346	(2001) Specification for Cast-in-Place Concrete Pipe

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005) Standard Specifications for Highway Bridges
AASHTO M 198	(2005) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM C 14	(2005a) Standard Specifications for Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 1433	(2006) Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
ASTM C 1433M	(2006) Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers (Metric)
ASTM C 14M	(2005a) Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)
ASTM C 231	(2004) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

ASTM C 443	(2005a) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C 478M	(2006b) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C 564	(2003a) Standard Specifications for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 655	(2004e1) Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
ASTM C 76M	(2005b) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 877	(2002; E 2005) External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
ASTM C 877M	(2002; E 2005) External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections (Metric)
ASTM D 1557	(2002e1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 1751	(2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1784	(2006a) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2729	(2003) Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 2922	(2005) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(2005) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3034	(2006) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1996a; R 2003e1) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

ASTM D 3350	(2006) Polyethylene Plastics Pipe and Fittings Materials
ASTM F 1417	(1992; R 2005) Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air
ASTM F 477	(2002e1) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 679	(2003) Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F 714	(2006a) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 794	(2003) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 894	(1998a) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F 949	(2003) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail drawings, prepared and signed by an professional engineer for all stormwater structures and pipe, as specified.

SD-03 Product Data

Placing Pipe

Printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

SD-04 Samples

Pipe for Culverts and Storm Drains

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

1.3.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall conform to the requirements specified.

2.1.1 Corrugated Steel Pipe

ASTM A 760/A 760M, zinc or aluminum (Type 2) coated pipe of either:

a. Type I or II pipe with annular 68 by 13 mm corrugations.

b. Type IR or IIR pipe with helical 19 by 19 by 190 mm corrugations.

2.2 DRAINAGE STRUCTURES

2.2.1 Flared End Sections

Sections shall be of a standard design fabricated from material compatible with the piping to which it attaches

2.3 MISCELLANEOUS MATERIALS

2.3.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 28 MPa concrete under Section 03 30 00.00 40 CAST-IN-PLACE CONCRETE.

2.3.2 Mortar

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C 270, Type M, except that the

maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

2.3.3 Frame and Cover for Gratings

Frame and cover for gratings shall be cast gray iron, ASTM A 48/A 48M, Class 35B; cast ductile iron, ASTM A 536, Grade 65-45-12; or cast aluminum, ASTM B 26/B 26M, Alloy 356.OT6.

2.3.4 Joints

2.3.4.1 Flexible Watertight Joints

a. Materials: Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe and with factory-fabricated resilient materials for clay pipe. The design of joints and the physical requirements for plastic gaskets shall conform to AASHTO M 198, and rubber-type gaskets shall conform to ASTM C 443M. Factory-fabricated resilient joint materials shall conform to ASTM C 425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 1.35 m.

b. Test Requirements: Watertight joints shall be tested and shall meet test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C 443M. Certified copies of test results shall be delivered to the Contracting Officer before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished, if specifically approved.

2.3.4.2 External Sealing Bands

Requirements for external sealing bands shall conform to ASTM C 877M.

2.3.4.3 Flexible Watertight, Gasketed Joints

a. Gaskets: When infiltration or exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately 178 mm wide and approximately 10 mm thick, meeting the requirements of ASTM D 1056, Type 2 A1, and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D 1171. Rubber O-ring gaskets shall be 21 mm in diameter for pipe diameters of 914 mm or smaller and 22 mm in diameter for larger pipe having 13 mm deep end corrugation. Rubber O-ring gaskets shall be 35 mm in diameter for pipe having 25 mm deep end corrugations. O-rings shall meet the requirements of AASHTO M 198 or ASTM C 443. Flexible plastic gaskets shall conform to requirements of AASHTO M 198, Type B.

b. Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded. Watertight joints shall be tested and shall meet the test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS.

2.4 RESILIENT CONNECTORS

Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to ASTM C 923M.

PART 3 EXECUTION

3.1 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches for appurtenances and backfilling for culverts and storm drains shall be in accordance with the applicable portions of Section 31 00 00 EARTHWORK.

3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
Corrugated Steel and Aluminum Alloy	5

Not less than 30 days after the completion of backfilling, the Government may perform a deflection test on the entire length of installed flexible pipe using a mandrel or other suitable device. Installed flexible pipe showing deflections greater than those indicated above shall be retested by

a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced.

3.3.1 Multiple Culverts

Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 1 meter apart, whichever is less.

3.4 DRAINAGE STRUCTURES

3.4.1 Manholes and Inlets

Construction shall be of reinforced concrete, plain concrete, brick, precast reinforced concrete, precast concrete segmental blocks, prefabricated corrugated metal, or bituminous coated corrugated metal; complete with frames and covers or gratings; and with fixed galvanized steel ladders where indicated. Pipe studs and junction chambers of prefabricated corrugated metal manholes shall be fully bituminous-coated and paved when the connecting branch lines are so treated. Pipe connections to concrete manholes and inlets shall be made with flexible, watertight connectors.

3.5 BACKFILLING

3.5.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 150 mm in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 300 mm above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 150 mm. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

3.5.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 150 mm in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 300 mm above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 4 m, whichever is less. After the backfill has reached at least 300 mm above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 150 mm.

3.5.3 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

3.5.4 Compaction

3.5.4.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

3.5.4.2 Minimum Density

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

a. Under paved roads, sidewalks, unpaved and paved parking areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.

b. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.

c. Under nontraffic areas, density shall be not less than that of the surrounding material.

3.6 Determination of Density

Testing shall be the responsibility of the Contractor and performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D 1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D 2167 or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as

described in ASTM D 3017 or ASTM D 2922. Test results shall be furnished the Contracting Officer. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

-- End of Section --

SECTION 33 56 10

FUEL OIL TANK AND PIPING

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 PETROLEUM INSTITUTE (API)

API RP 1110	(1997) Pressure Testing of Liquid Petroleum Pipelines
API Std 599	(2002) Metal Plug Valves - Flanged, Threaded and Welding Ends
API Std 600	(2001; R 2006) Bolted Bonnet Steel Gate Valves for Petroleum and Natural Gas Industries

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2004; Errata 2004) Specification for Filler Metals for Brazing and Braze Welding
AWS Z49.1	(2005) Safety in Welding, Cutting and Allied Processes

ASME INTERNATIONAL (ASME)

ASME A13.1	(1996; R 2002) Scheme for the Identification of Piping Systems
ASME B1.1	(2003) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B16.11	(2005) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2005) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.3	(1998) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.39	(1998) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.5	(2003) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24

ASME B16.9	(2003) Standard for Factory-Made Wrought Steel Butt welding Fittings
ASME B18.2.2	(1987; R 2005) Square and Hex Nuts (Inch Series)
ASME B18.52.1	(1996; R 2005) Square and Hex Bolts and Screws Inch Series
ASME B31.1	(2004; Addenda 2005) Power Piping
ASME B31.3	(2004) Process Piping
ASME B31.4	(2006) Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquid
ASME B40.100	(2006) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2004; 2005 Addenda; 2006 Addenda) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2004; 2005 Addenda; 2006 Addenda) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

ASTM INTERNATIONAL (ASTM)

ASTM A 194/A 194M	(2006a Standard Specification for) Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service or Both
ASTM A 307	(2004e1) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 36/A 36M	(2005) Standard Specification for Carbon Structural Steel
ASTM A 53/A 53M	(2006a) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM B 88	(2003) Standard Specification for Seamless Copper Water Tube
ASTM B 88M	(2005) Standard Specification for Seamless Copper Water Tube (Metric)

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

MSS SP-110	(1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
MSS SP-58	(2002) Standard for Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-69	(2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application
MSS SP-72	(1999) Standard for Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(2003) Bronze Gate, Globe, Angle and Check Valves

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2003; Errata 2004; Errata 2006) Flammable and Combustible Liquids Code
NFPA 31	(2006; Errata 2006) Installation of Oil Burning Equipment
NFPA 70	(2005; TIA 2005) National Electrical Code

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA Seismic Restraint Mnl	(1998; Addendum 2000, 2nd Ed) Seismic Restraint Manual: Guidelines for Mechanical Systems

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 20	(2002; E 2004) Paint Specification No. 20 Zinc-Rich Coating Type I Inorganic and Type II Organic
SSPC SP 10	(2000; E 2004) Near-White Blast Cleaning

1.2 DEFINITIONS

1.2.1 Carrier Piping

Piping which contains diesel fuel or MOGAS, exclusively.

1.2.2 Secondary Containment System

System which contains carrier piping and prevents fuel leakage from carrier piping into surrounding soil and/or water. System to be double-walled piping.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings; G

Diesel Fuel Storage Tanks

Fuel Pumps

SD-03 Product and Catalog Data; G

Pipe and fittings

Fuel Pumps

Valves

Flexible hose

Dielectric unions

Strainers

Instruments

Secondary containment system for piping

SD-06 Testing of Fuel Oil Tanks and Fuel Oil Pumps Including Instrumentation and Fuel Oil Piping Including Prefabricated Joints; G

The contractor shall provide the following: Six copies of each test containing the information described below (items 1-7) in bound letter-size booklets; individual reports shall be provided for the storage tank tests, the piping tests, the system performance tests, the high level alarm test, and the system leak tests. Drawings shall be folded blue lines, with the title block visible. 1) The date the tests were performed. 2) A list of equipment used, with calibration certifications. 3) A copy of measurements taken. 4) The parameters to be verified. 5) The condition specified for the parameter. 6) The inspection results, signed, dated, and certified by the installer. The certification shall state that required procedures were accomplished, that the procedures were conducted in compliance the plans and specifications. 7) A description of adjustments performed.

SD-07 Certificates; G

Welding procedure

Qualification of welders

List of welder's names and symbols

Flexible hose

Dielectric unions

Tank surface preparation

Coating materials

Coating application procedure

SD-08 Manufacturer's Instructions

Secondary containment system for piping

Flexible pipe

SD-10 Installation, Operation and Maintenance Manuals

Diesel Fuel Tank

Fuel Pumps

Submit Data Package 3 in accordance with Section 01780 OPERATION AND MAINTENANCE DATA.

1.4 QUALITY ASSURANCE

1.4.1 Welding Procedure

Before performing welding, submit three copies of welding procedure specification for metals included in the work, together with proof of its qualifications as outlined in ASME B31.1.

1.4.2 Qualification of Welders

Before welder or operator performs welding, submit to the Contracting Officer three copies of the Welder's Performance Qualification Record in conformance with ASME B31.1 showing that the welder was tested under the approved procedure specification submitted by the Contractor.

1.4.3 List of Welder's Names and Symbols

Submit each welder's assigned number, letter, or symbol which shall be used to identify the work of the welder and shall be affixed immediately upon completion of the weld.

1.4.4 Defective Welds

Welders making defective welds after passing a qualification test shall be required to take a re-qualification test. Welders failing the re-qualification tests will not be permitted to work under this contract.

1.4.5 Previous Welder Qualifications

Welding procedures, welders, and welding operators previously qualified by test may be accepted for this contract without re-qualification, subject to approval by the Contracting Officer provided that all the conditions specified in ASME B31.1 are met before a procedure can be used.

1.5 WELDING SAFETY

AWS Z49.1.

1.6 REGISTRATION

Contractor shall obtain required tank registration or permit/approval application forms from governing regulatory agencies. Furnish completed forms to the Contracting Officer and the installation environmental office within 10 days after contract award for their submission to the regulatory agency.

PART 2 PRODUCTS

Fuel oil system including equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with ASME B31.1, NFPA 70 and SMACNA Seismic Restraint Mnl, as modified and supplemented by the contract specifications and drawings.

2.1 MATERIALS AND EQUIPMENT

2.1.1 Steel Pipe and Fittings

2.1.1.1 Secondary Containment System for Piping

Provide double-walled steel secondary containment piping for diesel fuel and MOGAS piping systems. Secondary containment piping systems shall be an engineered and prefabricated double pipe type containment system. Carrier pipe shall be standard weight carbon steel, ASTM A-53, Grade B, ERW or seamless. Joints shall be socket or butt weld. Secondary containment pipe shall be carbon steel ASTM A-139, Grade B, ASTM A-135, Grade B or ASTM A-53, Grade B. Thickness for pipe diameters under 125 mm shall be schedule 40. Provide a fiberglass reinforced polyester external cladding to outer pipe for corrosion resistance. Secondary containment shall allow for complete inspection of carrier pipe connections, during carrier pipe hydrostatic testing, before the secondary containment system is sealed. The secondary containment system shall be:

a. Compatible with diesel fuel and MOGAS fuel.

b. Non-corrosive, di-electric, non-degradable and resistant to attack from microbial growth.

2.1.1.2 Socket-Welding Fittings

ASME B16.11, forged steel, Class 2000.

2.1.1.3 Butt-Welding Fittings

ASME B16.9, Class 150. Backing rings shall conform to ASME B31.3 and be compatible with materials being welded.

2.1.1.4 Flanges and Flange Fittings

ASME B16.5, steel flanges or convoluted steel flanges which meet the criteria of ASME BPVC SEC VIII D1. Flange faces shall have integral grooves of rectangular cross section which afford containment for self-energizing gasket material.

2.1.3 Vent Piping

ASTM A 53/A 53M standard weight, zinc-coated steel with zinc-coated malleable iron fittings ASME B16.3.

2.1.4 Valves

2.1.4.1 Bronze Gate Valves

MSS SP-80 Class 125, 50 mm and smaller, wedge disk, non-rising stem.

2.1.4.2 Steel Gate Valves

API Std 600, oil service, Class 150.

2.1.4.3 Ball Valves

MSS SP-72 for flanged or butt-welding ends and MSS SP-110 for socket-welding.

2.1.4.4 Relief Valves

Steel or bronze bodies, corrosion-resistant valve seats, and positive closing to prevent leakage.

2.1.4.5 Check Valves

Metal body, Class 200, suited for use in diesel fuel and gasoline applications.

2.1.5 Piping Accessories

2.1.5.1 Flexible Hose

Flexible metal hose, corrugated type with braided wire sheath covering, close-pitch annular corrugations, rated for a working pressure of at least 862 kPa (gage), 200 mm minimum live length, screwed end connections, listed for flammable liquid service. Metal for hose and braided wire sheath shall be stainless steel, any type of ASTM 300-series.

2.1.5.2 Unions

ASME B16.39, Class 150 pound.

a. Dielectric Unions: Union comprised of steel female pipe thread end and copper solder-joint end conforming to dimensional, strength, and pressure requirements of ASME B16.39, Class 1. Steel parts shall be galvanized or plated. Union shall have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, it shall be able to withstand a 600-volt breakdown test.

2.1.5.3 Welding Filler Metal

ASME B31.4 and compatible with the materials to be welded.

2.1.5.4 Brazing Filler Metal

AWS A5.8/A5.8M, silver base alloy, with melting point not less than 593 degrees C.

2.1.5.5 Hangers, Supports, and Shields

Design, selection, fabrication, installation, and spacing shall conform to MSS SP-58 and MSS SP-69. Hangers, supports, rods, anchors, nuts, bolts, and washers shall be hot-dip galvanized. Hangers and supports shall be of the adjustable type.

2.1.5.6 Strainers

Single basket type, with inlet and outlet on the same center line. Cast steel or fabricated steel body, 40 by 40 mesh ASTM 300-series stainless steel baskets. Open area of one basket shall be 2 1/2-times inlet or outlet piping area. Furnish one spare basket.

2.1.5.7 Gaskets

Provide one piece, factory cut, 1.60 mm thick, gaskets resistant to the effects of fuel oil and manufactured of fire-resistant materials. Provide full-face gaskets for flat-face flanged joints, and ring gaskets for raised-face flanged joints. Dimensions for gaskets shall be in accordance with ASME B16.21.

2.1.5.8 Bolting

Material for bolts and studs ASTM A 307, Grade-B and for nuts ASTM A 194/A 194M, Grade-2. Dimensions of bolts, studs and nuts ASME B18.52.1 and ASME B18.2.2 with threads conforming to ASME B1.1 coarse type, with Class 2A fit for bolts and studs, and Class 2B for nuts.

2.1.5.9 Sleeves in Stone, Masonry and Concrete Walls, Floors,

Provide ASTM A 53/A 53M, Schedule 40 or Standard Weight, zinc-coated steel pipe sleeves.

2.1.5.10 Sleeves in Other Wall, and Floor Materials

Provide minimum 26 gage zinc-coated steel sheet sleeves in partitions and other than masonry and concrete walls, floors, and roof.

2.1.5.11 Floor, Walls, and Ceiling Plates

Plates shall be painted cast-iron, malleable iron, or steel.

2.1.5.12 Identification for Piping Aboveground

Labels for pipes 20 mm diameter and larger shall bear printed legends to identify contents of pipes and arrows to show direction of flow. Labels shall have color coded background to signify levels of hazard in accordance with ASME A13.1. Legends and type and size of characters shall also conform to ASME A13.1. Make labels of plastic sheet with pressure sensitivity suitable for intended applications, or they may be pre-molded of plastic to fit over pipe. For pipes smaller than 20 mm diameter, provide brass identification tags 40 mm in diameter with legends in depressed black filled characters.

2.1.5.13 Miscellaneous Metal

ASTM A 36/A 36M, standard mill finished structural shapes, hot-dip galvanized after fabrication.

2.1.6 Instruments

2.1.6.1 Tank Gages

Buoyant force type with direct reading dial.

2.1.6.2 Thermometers

Thermometers shall be bi-metal dial type with stainless steel case, stem, and fixed thread connection; 125 mm diameter dial with glass face gasketed within the case; accuracy within one percent of scale range. Provide scale range suitable for the intended service.

2.1.6.3 Pressure Gages

ASME B40.100, single style with 115 mm diameter dial for fuel, brass or aluminum case, bronze tube; accuracy within 2 percent of scale range. Provide scale range suitable for the intended service.

2.1.7 Protective Coating Materials for Aboveground Pipe and Tanks

Coatings shall be the products of one manufacturer and coating application procedure shall be in accordance with manufacturer's instruction. Tank surface preparation shall be abrasive blast clean steel surfaces in accordance with SSPC SP 10 to a surface profile of 0.013 to 0.051 mm.

2.1.7.1 External Coatings

Protect aboveground piping and steel tanks against atmospheric corrosion with a coat of organic, lead and chromate free, zinc-rich primer conforming to SSPC Paint 20, Type II applied to a minimum dry film thickness of 0.102 mm and finish with two coats of epoxy-polyamide topcoat. Apply a gray first topcoat, Formula 151 applied to a minimum dry film thickness of 0.076 mm and finish with a white second topcoat, Formula 152 applied to a minimum dry film thickness of 0.076 mm resulting in a total system minimum dry film thickness of 0.28 mm.

2.2 Fuel Pumps

Provide pumps designed for use with diesel fuels and working pressure of 1896 kPa (gage) at 38 degrees C.
Design shall provide for nonoverloading characteristics throughout entire head capacity curve under operating conditions. Pump motors shall conform to NEMA MG 1, Design B; NFPA 70, Class I, Division 1, Group D, explosion and weather-proof, squirrel cage induction type, rated for continuous duty based on 55 degrees C temperature rise and Class B insulation. Motors shall have built-in, nonsparking, nonreverse ratchet type mechanism to prevent reversal of pump shaft. Centrifugal pumps shall be base mounted. Turbine pumps shall have antivortex device which permits pump removal without entering the tank.

2.2.1 ELECTRICAL COMPONENTS
Provide explosion proof motors, controllers, contactors, and disconnects conforming to NFPA 70, Class I, Division 1, Group D, except where NFPA 70, Class I, Division 2, Group D is indicated. Furnish motors, controllers, contactors, and disconnects with respective pieces of equipment. Motors, controllers, contactors, and disconnects shall conform to and shall have electrical connections provided under Division 16, "Electrical." Controllers and contactors shall have a maximum of 220-volt control circuits, and shall have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of providing additional electrical service and related work shall be included under this section.

PART 3 EXECUTION

3.1 INSTALLATION

Contractor shall provide installation of fuel oil piping system in accordance with applicable Federal, State, regional or local regulations.

3.1.1 Fuel Oil Piping System

Install piping in out-of-the-way locations, in a manner that will minimize cutting of beams, girders, columns, or load-bearing members. Installation of oil piping and equipment in buildings shall conform to NFPA 30 and NFPA 31, except as indicated or specified herein.

3.1.2 Pipe Sleeves and Plates

Provide sleeves where piping passes through walls, floors, and partitions. Secure sleeves in proper position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, floors, and partitions. Extend sleeves in floor slabs 80 mm above the finished floor. Provide not less than 6 mm space between exterior of piping or pipe insulation and interior of sleeve. Firmly pack space with insulation and calk at both ends of the sleeve with plastic waterproof cement which will dry to a firm but pliable mass, or provide a segmented elastomeric seal. Secure plates to pipes at sleeves.

3.1.3 Steel Piping

Steel piping 50 mm and smaller shall be threaded or socket-welded. Steel piping 65 mm and larger shall be butt welded. Flanges may be used for valves and equipment installation. Piping joints shall conform to ASME B31.3.

3.1.4 Threaded Joints in Piping

Provide lubricant or polytetrafluoroethylene tape on male threads of screwed joints. Red or white lead and zinc may be used. Lubricate threaded pipe joints, as well as bolts and studs used on high temperature pipe joints up to 566 degrees C, with anti-seize compound. Piping shall be free from fins and burrs. Ream or file out pipe ends to size of bore and remove chips. Attach screwed flanges by screwing the pipe through the flange, and reface pipe and flange accurately.

3.1.5 Welding

3.1.5.1 Welding of Piping

Welding of joints in piping, butt welds, fillet welds, bends, loops, offsets, and cleaning of pipe shall be in accordance with ASME B31.1. Welds shall be visually examined and meet acceptance standards specified in Chapter VI of ASME B31.1.

3.1.5.2 Quality of Welds

Quality of welds, correction of defects, stress relieving, and preheating shall be in accordance with ASME B31.1.

3.1.5.3 Arc Welding and Gas Welding

In accordance with ASME BPVC SEC IX.

3.1.6 Unions and Flanges

Place unions and flanges where necessary to permit easy disconnection of piping and apparatus. Each connection having a threaded end valve shall have a union.

3.1.7 Valves

Install valves in positions accessible for operation and repair.

3.1.8 Thermometers

Provide thermometers and thermal sensing elements of control valves with separable sockets. Install separable sockets in pipe lines in such a manner to sense the temperature of flowing fluid and minimize obstruction to flow.

3.1.9 Diesel Fuel Storage Tanks

Install storage tanks, vents and other connections in accordance with NFPA 30, NFPA 31, recommendations and published instructions of the manufacturer, and as indicated. Provide grounding of tanks directly through ground rods or through bonding to grounded network in accordance with NFPA 780. Fasten aboveground fuel oil tanks on a firm reinforced concrete foundation. Provide fireproofed steel supports between tank and foundation. Concrete shall have a compressive strength of 2.8 kPa, 20 mm (3/4) inch maximum aggregate size and 80 to 100 mm slump. Materials for sand, gravel, and concrete shall meet requirements specified in Section 03 30 00.00 40 CAST-IN-PLACE CONCRETE.

3.2 FIELD QUALITY CONTROL

Prior to application of test pressure, remove or valve off piping components which may be damaged by test and install a calibrated test gage in the system. Maintain test pressure for at least one hour. In the event of leakage, locate and repair leak by rewelding and repeat test. Materials and equipment shall be subject to inspection at the installation site by the Contracting Officer.

3.2.1 Piping Test

Before final acceptance of the work, test each system as in service to demonstrate compliance with contract requirements. Furnish electricity, instruments, connecting devices, and personnel for the tests. Correct defects in work provided by the Contractor and repeat tests until work is in compliance with contract requirements. Government will furnish fuel for piping testing and flushing provided by the Contractor. Contractor shall be responsible for test fuel losses greater than 10 percent.

3.2.1.1 Pneumatic Test

Pneumatically test each piping system to 172 kPa (gage), examine joints with soap solution. Gradually increase to 345 kPa (gage) and hold for 1 hour. The pneumatic test is more hazardous than a hydrostatic test, therefore, special safety measures, including the wearing of face masks, shall be taken during testing under pressure. Only authorized personnel shall be permitted in the area during pneumatic and hydrostatic testing.

3.2.1.2 Hydrostatic Tests

Upon completion of pneumatic testing, hydrostatically test each piping system at 1.5 times maximum system operating pressure but in no case more than 1896 kPa (gage) in accordance with ASME B31.3 and API RP 1110, with no leakage or reduction in gage pressure for 4 hours.

3.2.1.3 Flushing

Thoroughly flush piping before placing in operation. Flush piping, including branch piping, at a minimum velocity of 2.40 meters per second.

3.2.2 Secondary Containment Piping Test

The secondary containment piping system shall undergo a 34 kPa minimum air-pressure/soap test upon completion of installation to confirm the secondary containment integrity. This testing shall be in compliance with the manufacturer's published installation instructions.

3.2.3 Protective Coating Systems

Inspect protective coating systems, with a holiday tester just prior to placement. Holidays revealed shall be promptly repaired. Steel piping coating system shall be given a holiday test with a voltage of 100 to 200 times the mm thickness of the coating.

3.2.4 Steel Fuel Oil Storage Tanks

Test tanks for leaks by applying internal air pressure and using soapsuds, linseed oil or equivalent material on external welds. For horizontal tanks, test pressure shall be not less than 34 nor more than 48 kPa (gage). For vertical tanks, test pressure shall be not less than 10 kPa (gage) nor more than that pressure which first causes visible deformation of the tank. During testing, tank shall be provided with a suitable pressure relief device.

-- End of Section --

SECTION 33 70 02.00 10

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND
04/06

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 C42.100	(2000) Standard Dictionary of Electrical and Electronics Terms

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC C8	(2000) Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV
AEIC CS8	(2000) Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B 3	(2001) Standard Specification for Soft or Annealed Copper Wire

FM GLOBAL (FM)

FM P7825a	(2005) Approval Guide Fire Protection

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2005) National Electrical Safety Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA C80.1	(2005) Standard for Electrical Rigid Steel Conduit (ERSC)

NEMA FB 1	(2003) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
NEMA PB 1	(2006) Standard for Panelboards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005; TIA 2005) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 198D	(1995) Class K Fuses
UL 198E	(1988; Rev Jul 1988) Class R Fuses
UL 467	(2004) Standard for Grounding and Bonding Equipment
UL 486A-486B	(2003; Rev thru Aug 2006) Standard for Wire Connectors
UL 489	(2004; Rev thru Jun 2006) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 510	(2005; Rev thru Aug 2005) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 514A	(2005) Standard for Metallic Outlet Boxes
UL 6	(2004e13) Standard for Electrical Rigid Metal Conduit-Steel
UL 651	(2005e7) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings

1.1.1 EQUIVALENT REFERENCES

Equipment and material meeting standards that are deemed equivalent (by the Authority Having Jurisdiction) to the above referenced standards may be submitted for approval.

1.2 GENERAL REQUIREMENTS

1.2.1 Terminology

Terminology used in this specification is as defined in ANSI C42.100.

1.2.2 Service Conditions

Items provided under this section shall be specifically suitable for the following service conditions.

a. Altitude 19,686 m.

b. Ambient Temperature +50 degrees and -40 degrees C.

c. Frequency 50 hz

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings
As-Built Drawings

Drawings, as specified.

SD-03 Product Data

Nameplates;

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material and Equipment;

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each such item.

Installation Requirements;

SD-06 Test Reports

Factory Tests; G

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests. The manufacturer's pass-fail criteria for tests specified in paragraph FIELD TESTING shall be included.

Field Testing; G

A proposed field test plan, 30 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Operating Tests;G

Six copies of the tests report in 215.9 by 279.4 mm (8-1/2 by 11 inch) binders having a minimum of three rings, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

1.4 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers and switches shall be stored in accordance with the manufacturer's requirements. Wood poles held in storage for more than 2 weeks shall be stored in accordance with ATIS O5.1. Handling of wood poles shall be in accordance with ATIS O5.1, except that pointed tools capable of producing indentations more than 25 mm in depth shall not be used. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

1.5 EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the contracting officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

1.6 DRAWINGS

1.6.1 Detail Drawings

The Contractor shall submit detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams manufacturers standard installation drawings and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings.

a. If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be included with the detail drawings. Approved departures shall be made at no additional cost to the Government.

b. Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

1). Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for

installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. All optional items shall be clearly identified as included or excluded.

2). Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

1.6.2 As-Built Drawings; G

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall provide three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within 10 calendar days from the time the drawings are returned to the Contractor.

PART 2 PRODUCTS

2.1 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.2 NAMEPLATES

2.2.1 General

Each major component of this specification shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Nameplates shall be made of noncorrosive metal. Equipment containing liquid dielectrics shall have the type of dielectric on the nameplate. Sectionalizer switch nameplates shall have a schematic with all switch positions shown and labeled. As a minimum, nameplates shall be provided for transformers, circuit breakers, meters, switches, and switchgear.

2.3 CORROSION PROTECTION

2.3.1 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

2.4 CABLES

Cables shall be single conductor type unless otherwise indicated.

2.4.1 Low-Voltage Cables

Cables shall be rated 600 volts and shall conform to the requirements of NFPA 70, and must be UL listed for the application or meet the applicable section of either ICEA or NEMA standards.

2.4.1.1 Conductor Material

Underground cables shall be annealed copper complying with ASTM B 3 and ASTM B 8.

2.4.1.2 Insulation

Insulation must be in accordance with NFPA 70, and must be UL listed for the application or meet the applicable sections of either ICEA, or NEMA standards.

2.4.1.3 Jackets

Multiconductor cables shall have an overall PVC outer jacket.

2.4.1.4 Direct Buried

Single and multi-conductor cables shall of a type identified for direct burial. Service entrance cables shall conform to UL 854 for Type USE service entrance cable.

2.4.1.5 In Duct

Cables shall be single-conductor cable, in accordance with NFPA 70.

2.5 CABLE JOINTS, TERMINATIONS, AND CONNECTORS

2.5.1 Low-Voltage Cable Splices

Low-voltage cable splices and terminations shall be rated at not less than 600 Volts. Splices in conductors No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A-486B. Splices in conductors No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A-486B. Splices shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. Splices below grade or in wet locations shall be sealed type conforming to NEMA C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

2.5.2 Terminations

Terminations shall be in accordance with IEEE Std 48, Class 1 or Class 2; of the molded elastomer, wet-process porcelain, prestretched elastomer, heat-shrinkable elastomer, or taped type. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Terminations shall be of the outdoor type, except that where installed inside outdoor equipment housings which are sealed against normal infiltration of moisture and outside air, indoor, Class 2 terminations are acceptable. Class 3 terminations are not acceptable. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, and armor.

2.5.2.1 Factory Preformed Type

Molded elastomer, wet-process porcelain, prestretched, and heat-shrinkable terminations shall utilize factory preformed components to the maximum extent practicable rather than tape build-up. Terminations shall have basic impulse levels as required for the system voltage level.

2.5.2.2 Taped Terminations

Taped terminations shall use standard termination kits providing terminal connectors, field-fabricated stress cones, and rain hoods. Terminations shall be at least 635mm long from the end of the tapered cable jacket to the start of the terminal connector, or not less than the kit manufacturer's recommendations, whichever is greater.

2.6 CONDUIT AND DUCTS

Ducts shall be single, round-bore type, with wall thickness and fittings suitable for the application. Duct lines shall be nonencased direct-burial, thick-wall type. Low-voltage lines run elsewhere may be direct-burial, thick-wall type.

2.6.1 Metallic Conduit

Intermediate metal conduit shall comply with UL 1242. Rigid galvanized steel conduit shall comply with UL 6 and NEMA C80.1. Metallic conduit fittings and outlets shall comply with UL 514A and NEMA FB 1.

2.6.2 Nonmetallic Ducts

2.6.2.2 Concrete Encased Ducts

UL 651 Schedule 40.

2.6.2.1 Direct Burial

UL 651 Schedule 80.

2.6.3 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 2 degrees C, shall neither slump at a temperature of 150 degrees C, nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

2.7 MANHOLES, HANDHOLES, AND PULLBOXES

Manholes, handholes, and pullboxes shall be as indicated. Strength of manholes, handholes, and pullboxes and their frames and covers shall conform to the requirements of IEEE C2. Precast-concrete manholes shall have the required strength established by ASTM C 478, ASTM C 478M. Frames and covers shall be made of gray cast iron and a machine-finished seat shall be provided to ensure a matching joint between frame and cover. Cast iron shall comply with ASTM A 48/A 48M, Class 30B, minimum. Handholes for low voltage cables installed in parking lots, sidewalks, and turfed areas shall be fabricated from an aggregate consisting of sand and with continuous woven glass strands having an overall compressive strength of at least 69MPa and a flexural strength of at least 34.5MPa. Pullbox and handhole covers in sidewalks, and turfed areas shall be of the same material as the box. Concrete pullboxes shall consist of precast reinforced concrete boxes, extensions, bases, and covers.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Steel conduits installed underground shall be installed and protected from corrosion in conformance with the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of Section 31 00 00 EARTHWORK. Concrete work shall have minimum 20 MPa compressive strength and conform to the requirements of Section 03 30 00.00 40 CAST-IN-PLACE CONCRETE.

3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable.

3.1.2 Verification of Dimensions

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

3.2 CABLE AND BUSWAY INSTALLATION

3.2.1 Cable Inspection

The cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture

shall be removed from cable in accordance with the cable manufacturer's recommendations.

3.2.1.1 Duct Cleaning

Duct shall be cleaned with an assembly that consists of a flexible mandrel (manufacturers standard product in lengths recommended for the specific size and type of duct) that is 6.4 mm less than inside diameter of duct, 2 wire brushes, and a rag. The cleaning assembly shall be pulled through conduit a minimum of 2 times or until less than a volume of 131 cubic centimeters of debris is expelled from the duct.

3.2.1.2 Duct Lubrication

The cable lubricant shall be compatible with the cable jacket for cable that is being installed. Application of lubricant shall be in accordance with lubricant manufacturer's recommendations.

3.2.1.3 Cable Installation

The Contractor shall provide a cable feeding truck and a cable pulling winch as required. The Contractor shall provide a pulling grip or pulling eye in accordance with cable manufacturer's recommendations. The pulling grip or pulling eye apparatus shall be attached to polypropylene or manilla rope followed by lubricant front end packs and then by power cables. A dynamometer shall be used to monitor pulling tension. Pulling tension shall not exceed cable manufacturer's recommendations. The Contractor shall not allow cables to cross over while cables are being fed into duct. For cable installation in cold weather, cables shall be kept at 10 degrees temperature for at least 24 hours before installation.

3.2.2 Duct Line

Low-voltage cables shall be installed in duct lines where indicated. Neutral and grounding conductors shall be installed in the same duct with their associated phase conductors.

3.2.3 Direct-Burial

3.2.3.1 Trenching

Trenches for direct-burial cables shall be excavated to depths required to provide the minimum necessary cable cover. Bottoms of trenches shall be smooth and free of stones and sharp objects. Where bottoms of trenches comprise materials other than sand, a 75 mm layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil.

3.2.3.2 Cable Burial

Cables shall be unreeled along the sides of or in trenches and carefully placed on sand or earth bottoms. Pulling cables into direct-burial trenches from a fixed reel position will not be permitted, except as required to pull cables through conduits under paving or railroad tracks. Where cables cross, a separation of at least 75 mm shall be provided, unless each cable circuit is protected by a nonmetallic conduit sleeve at the crossing. Where single-conductor cable is installed, all 3 phases and the neutral shall be

installed in the same sleeve. Bend radius of any cable shall be not less than 8 times the diameter of the cable. In no case shall cables be left under longitudinal tension. The first 150 mm layer of backfill shall be of sand. Machine compaction shall not be used within 150 mm of the cable.

3.2.3.3 Other Requirements

Where direct-burial cables cross under roads or other paving exceeding 1.5 m in width, such cables shall be installed in concrete-encased ducts. Where direct-burial cables cross under railroad tracks, such cables shall be installed in reinforced concrete-encased ducts. Ducts shall extend at least 300 mm beyond each edge of any paving and at least 1.5 m beyond each side of any railroad tracks. Cables may be pulled into duct from a fixed reel where suitable rollers are provided in the trench. Where direct burial cable transitions to duct-enclosed cable, direct-burial cables shall be centered in duct entrances, and a waterproof nonhardening mastic compound shall be used to facilitate such centering. If paving or railroad tracks are in place where cables are to be installed, coated rigid steel conduits driven under the paving or railroad tracks may be used in lieu of concrete-encased ducts. Damage to conduit coatings shall be prevented by providing ferrous pipe jackets or by predrilling. Where cuts are made in any paving, the paving and subbase shall be restored to their original condition.

3.2.3.4 Low-Voltage Cable Splices

Cable joints or splices in direct-burial cables are not permitted in runs of 305 m or less, nor at intervals of less than 305 m in longer runs, except as required for taps. Locations of cable joints or splices in shorter intervals, where required to avoid obstructions or damage to cables, shall be approved. Cable joints or splices in direct burial installations shall be installed in above-ground junction boxes or in cast metal splice boxes suitable for direct burial use.

3.3 DUCT LINES

3.3.1 Requirements

Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 100 mm per 30 m. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 450 mm for ducts of less than 80 mm diameter, and 900 mm for ducts 80 mm or greater in diameter. Otherwise, long sweep bends having a minimum radius of 7.6 m shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in manholes or handholes.

3.3.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration

with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

3.3.3 Concrete Encasement

Ducts requiring concrete encasements shall comply with NFPA 70, except that electrical duct bank configurations for ducts 150 mm 6 inches in diameter shall be determined by calculation and as shown on the drawings. The separation between adjacent electric power and communication ducts shall conform to IEEE C2. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. Submit proposed bonding method for approval in accordance with the detail drawing portion of paragraph SUBMITTALS. At any point, except railroad and airfield crossings, tops of concrete encasements shall be not less than the cover requirements listed in NFPA 70. At railroad and airfield crossings, duct lines shall be encased with concrete and reinforced as indicated to withstand specified surface loadings. Tops of concrete encasements shall be not less than 1.5 m below tops of rails or airfield paving unless otherwise indicated. Where ducts are jacked under existing pavement, rigid steel conduit will be installed because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For crossings of existing railroads and airfield pavements greater than 15 m in length, the predrilling method or the jack-and-sleeve method will be used. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 1.2 m on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 150 mm vertically.

3.3.4 Nonencased Direct-Burial

Top of duct lines shall be below the frost line but not less than 915 mm below finished grade and shall be installed with a minimum of 75 mm of earth around each duct, except that between adjacent electric power and communication ducts, 300 mm of earth is required. Bottoms of trenches shall be smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches comprise materials other than sand, a 75 mm layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts. Joints in adjacent tiers of duct shall be vertically staggered at least 150 mm. The first 150 mm layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in 75 to 150 mm layers. Duct banks may be held in alignment with earth. However, high-tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling.

3.3.5 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved.

3.3.5.1 Plastic Duct

Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4-turn twist to set the joint tightly.

3.4 MANHOLES, HANDHOLES, AND PULLBOXES

3.4.1 General

Manholes shall be constructed approximately where shown. The exact location of each manhole shall be determined after careful consideration has been given to the location of other utilities, grading, and paving. The location of each manhole shall be approved by the Contracting Officer before construction of the manhole is started. Manholes shall be the type noted on the drawings and shall be constructed in accordance with the applicable details as indicated. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction. The Contractor may, as an option, utilize monolithically constructed precast-concrete manholes having the required strength and inside dimensions as required by the drawings or specifications. In paved areas, frames and covers for manhole and handhole entrances in vehicular traffic areas shall be flush with the finished surface of the paving. In unpaved areas, the top of manhole covers shall be approximately 15 mm above the finished grade. Where existing grades that are higher than finished grades are encountered, concrete assemblies designed for the purpose shall be installed to elevate temporarily the manhole cover to existing grade level. All duct lines entering manholes must be installed on compact soil or otherwise supported when entering a manhole to prevent shear stress on the duct at the point of entrance to the manhole. Duct lines entering cast-in-place concrete manholes shall be cast in-place with the manhole. Duct lines entering precast concrete manholes through a precast knockout penetration shall be grouted tight with a portland cement mortar. PVC duct lines entering precast manholes through a PVC endbell shall be solvent welded to the endbell. A cast metal grille-type sump frame and cover shall be installed over the manhole sump. A cable-pulling iron shall be installed in the wall opposite each duct line entrance.

3.4.2 Electric Manholes

Cables shall be securely supported from walls by hot-dip galvanized cable racks with a plastic coating over the galvanizing and equipped with adjustable hooks and insulators. The number of cable racks indicated shall be installed in each manhole and not less than 2 spare hooks shall be installed on each cable rack. Insulators shall be made of high-glazed porcelain. Insulators will not be required on spare hooks.

3.4.3 Communications Manholes

The number of hot-dip galvanized cable racks with a plastic coating over the galvanizing indicated shall be installed in each telephone manhole. Each cable rack shall be provided with 2 cable hooks. Cables for the telephone and communication systems will be installed by others.

3.7.4 Handholes

Handholes shall be located approximately as shown. Handholes shall be of the type noted on the drawings and shall be constructed in accordance with the details shown.

3.4.5 Pullboxes

Pullbox tops shall be flush with sidewalks or curbs or placed 15 mm 1/2 inch above surrounding grades when remote from curbed roadways or sidewalks. Covers shall be marked "Low-Voltage" and provided with 2 lifting eyes and 2 hold-down bolts. Each box shall have a suitable opening for a ground rod. Conduit, cable, ground rod entrances, and unused openings shall be sealed with mortar.

3.4.6 Ground Rods

A ground rod shall be installed at the manholes, handholes and pullboxes. Ground rods shall be driven into the earth before the manhole floor is poured so that approximately 100 mm of the ground rod will extend above the manhole floor. When precast concrete manholes are used, the top of the ground rod may be below the manhole floor and a No. 1/0 AWG ground conductor brought into the manhole through a watertight sleeve in the manhole wall.

3.5 CONNECTIONS TO BUILDINGS

Cables shall be extended into the various buildings as indicated, and shall be connected to the first applicable termination point in each building. Interfacing with building interior conduit systems shall be at conduit stubouts terminating 1.5 m outside of a building and 600 mm below finished grade as specified and provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. After installation of cables, conduits shall be sealed with caulking compound to prevent entrance of moisture or gases into buildings.

3.6 GROUNDING

A ground ring consisting of the indicated configuration of bare copper conductors and driven ground rods shall be installed around pad-mounted equipment as shown. Equipment frames of metal-enclosed equipment, and other noncurrent-carrying metal parts, such as cable shields, cable sheaths and armor, and metallic conduit shall be grounded.

3.6.1 Grounding Electrodes

Grounding electrodes shall be installed as shown on the drawings and as follows:

a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be driven into the earth until the tops of the rods are approximately 300 mm below finished grade.

3.6.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors, in compliance with UL 467, and those below grade shall be made by a fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

3.6.3 Grounding and Bonding Conductors

Grounding and bonding conductors include conductors used to bond transformer enclosures and equipment frames to the grounding electrode system. Grounding and bonding conductors shall be sized as shown, and located to provide maximum physical protection. Bends greater than 45 degrees in ground conductors are not permitted. Routing of ground conductors through concrete shall be avoided. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground conductor, and the opening shall be sealed with a suitable compound after installation.

3.6.4 Manhole, Handhole, or Concrete Pullbox Grounding

Ground rods installed in manholes, handholes, or concrete pullboxes shall be connected to cable racks, cable-pulling irons, the cable shielding, metallic sheath, and armor at each cable joint or splice by means of a 25mm2 braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 50 mm above and 150 mm below concrete penetrations. Grounding electrode conductors shall be neatly and firmly attached to manhole or handhole walls and the amount of exposed bare wire shall be held to a minimum.

3.7 FIELD TESTING

3.7.1 Ground-Resistance Tests

The resistance of each grounding electrode shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

a. Single rod electrode - 25 ohms.

3.7.2 Low-Voltage Cable Test

Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energizing. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

Each cable failing this test shall be repaired or replaced. The repaired cable shall be retested until failures have been eliminated.

3.7.3 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers. Pass-fail criteria shall be in accordance with the circuit breaker manufacturer's specifications.

a. Insulation resistance test phase-to-phase.

b. Insulation resistance test phase-to-ground.

c. Closed breaker contact resistance test.

d. Power factor test.

e. High-potential test.

f. Manual operation of the breaker.

3.7.4 Operating Tests

After the installation is completed, and at such times as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the requirements herein. An operating test report shall be submitted including the following:

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The condition specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

3.78 MANUFACTURER'S FIELD SERVICE

3.8.1 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the onsite tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment.

3.9 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

SECTION 34 71 13.19

VEHICLE BARRIERS
04/06

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 HB-17	(2002; Errata 2003; Errata 2005) Standard Specifications for Highway Bridges

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2006; Errata 2006) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 106/A 106M	(2006) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM D 3034	(2006) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J517	(2003) Hydraulic Hose

U.S. DEPARTMENT OF STATE (SD)

SD Std-01.01	(1993 Rev G Amended; Inx Certified Prod/Mfg) Certification Standard Forced Entry and Ballistic Resistance of Structural Systems
SD Std-02.01,rev.a,March 2003	Certified Anti-Ram Vehicle Barriers
SD Std-02.01, April 1985	Certified Anti-Ram Vehicle Barriers

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD	(2003) Manual of Uniform Traffic Control Devices for Streets and Highways

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

29 CFR 1910	Occupational Safety and Health Standards

UNDERWRITERS LABORATORIES (UL)

UL 486A-486B	(2003; Rev thru Aug 2006) Standard for Wire Connectors
UL 752	(2005; Rev thru Dec 2006) Bullet-Resisting Equipment

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation;
Equipment;

Detail drawings containing details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including foundation and clearances for maintenance and operation. Detail drawings shall include a copy of the Department of State certificate of barrier performance.

SD-03 Product Data

Vehicle Barriers

A complete list of equipment, materials, including industrial standards used and how they apply to the applicable component and manufacturer's descriptive data and technical literature, catalog cuts, and installation instructions. Information necessary to document a minimum 1-year successful field operation performance history for each type of vehicle barrier installed.

1.3 GENERAL REQUIREMENTS

Vehicle Barriers furnished shall in all respects be identical to the unit tested and certified except for the width of the vehicle barrier, which is as indicated.

1.4 NAMEPLATES

Nameplate data shall be permanently attached to each vehicle barrier. The data shall be legibly marked on corrosion-resistant metal plates and shall consist of at least the following:

a. Manufacturer's name.

b. Model number.

c. Serial number.

d. Date of manufacture.

1.5 BARRIER SYSTEM

The Barrier system shall be crated or mounted on skids as necessary to prevent damage from handling. The shipping container(s) shall be of sufficient structural integrity to enable the assembly to be lifted and transported by overhead crane or forklift without failure.

1.6 DELIVERY AND STORAGE

Components placed in storage shall be protected from the weather, humidity, and temperature variation, dirt and dust, or other contaminants. Structural materials shall be stored on sleepers or pallets and shall be protected from rust and objectionable materials such as dirt, grease, or oil.

1.7 SPARE PARTS

A manufacturer's standard recommended spare parts package, with current unit prices and source of supply complete with detailed manuals on parts replacement, shall be provided with each barrier to facilitate 1 year of normal operation. Particular consideration shall be given to system components which are not readily available from local or commercial sources and which are critical to the operation of the system.

1.8 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment supplied shall be available. The representative shall supervise the installation, adjustment, and testing of the equipment.

PART 2 PRODUCTS

2.1 DROP ARM GATE CRASH BEAM

The crash beam shall be an above-grade assembly that, in the "DOWN" position, shall present a visible obstacle to approaching vehicles. The height of the barrier shall be a minimum of 750 mm as measured from the roadway surface to the centerline of the crash beam. The crash beam shall be capable of blocking a minimum road width of 4 m. The crash beam end shall contain a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position. Crash beam shall withstand a 6804 kg vehicle traveling at 80 km/hour, with maximum vehicle penetration of 6 m.

2.1.1 Drop Arm Gate - Manual Crash Beam

The crash beam shall be manually raised and lowered with the aid of a counterbalanced end requiring approximately 134 N of force.

2.1.1.1 System Configuration

a. Barrier Construction. Barrier shall be an above grade assembly containing a crash beam hinged at one end, which can be raised and lowered manually. When in the down locked position the beam shall present a formidable obstacle to approaching vehicles. Upon vehicle impact, the force shall first be absorbed by the beam assembly and then transmitted to the foundation bollards of the unit.

b. Foundation Finish. The foundation base of the barrier shall be asphalt emulsion coated for corrosion protection. Exposed barrier surfaces shall have galvanized finish. The drop arm beam shall be furnished with red reflective tape sufficient to provide alternate 20 inch (0,5 M) bands on the Barrier tube and Barrier Yoke.

c. Foundation shall be as per Section 03 30 00.00 40 "CAST IN PLACE CONCRETE" and as shown on drawings including anchor bolts.

2.1.1.2 Performance

a. Experience. Barrier and auxiliary equipment shall be of a proven design. Manufacturer shall have 15 years documented experience with similar vehicle Barriers.

b. Qualification Tests. The barrier system shall have been tested in full scale configuration in accordance with the Department of State Certification Standard Test Method for Vehicle Crash Testing of Perimeter Barriers and Gates, SD-STD-02.01, Revision A, March 2003, K12 rating.

2.1.1.3 Operation

The Drop Arm Barricade shall be counterbalanced by a manual counter balance system that shall permit raising and lowering the Drop Arm by a single person of normal size and strength.

2.2 PASSIVE SURFACE BARRIER

The passive surface barrier shall be a surface mounted assembly that shall present a visible obstacle to approaching vehicles. The height of the barrier shall be a minimum of 750 mm as measured from the surface to the top of the passive surface barrier. The passive surface barrier shall be capable of blocking any specified width. The passive surface barrier shall withstand a 6804 kg vehicle traveling at 80 km/hour, with maximum vehicle penetration of 6 m.

2.2.1 Experience

Barrier and auxiliary construction shall be of a proven design. Manufacturer shall have 5 years documented experience with similar vehicle barriers.

2.2.2 System Configuration

Barrier Construction. Barrier shall be a surface assembly consisting of a prefabricated, joinable, extensible, fillable, multicellular system, comprising high strength construction such as galvanized steel mesh with non-woven polypropylene geotextile lining and appropriate fill material e.g. concrete, sand, etc. The system shall present a formidable obstacle to approaching vehicles. Upon vehicle impact, the force shall be absorbed by the passive surface barrier.

2.2.3 Qualification Tests

The barrier system shall have been tested in full scale configuration in accordance with the Department of State Certification Standard Test Method for Vehicle Crash Testing of Perimeter Barriers and Gates, SD-STD-02.01, Revision A, March 2003, rating K12.

2.3 FINISH

Surfaces shall be painted in accordance with requirements of Section 09 90 00 PAINTS AND COATINGS. The crash beam shall be painted white with 75 mm wide reflective red diagonal stripes.

2.4 CONCRETE

The concrete reinforcements, and accessories shall conform to Section 03 30 00.00 40 CAST-IN-PLACE CONCRETE.

2.5 WELDING

Welding shall be in accordance with AWS D1.1/D1.1M.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be in accordance with manufacturer’s instructions and in the presence of a representative of the manufacturer. Manufacturer's representative shall be experienced in the installation, adjustment, and operation of the equipment provided. The representative shall also be present during adjustment and testing of the equipment.

3.2 FIELD TESTING

Upon completion of construction, a field test shall be performed for each vehicle barrier. The test shall include raising and lowering drop-arm gate barrier or moving the sliding gate barrier manually, through its complete range of operation. Each vehicle barrier shall then be continuously cycled for not less than 30 minutes to test for heat build-up in the hydraulic system. The Contracting Officer shall be notified at least 7 days prior to the beginning of the field test. The Contractor shall furnish all equipment and make all necessary corrections and adjustments prior to tests witnessed by the Contracting Officer. Any conditions that interfere with the proper operation of the barrier disclosed by the test shall be corrected at no additional cost to the Government. Adjustments and repairs shall be done by the Contractor under the direction of the Contracting Officer. After

adjustments are made to assure correct functioning of components, applicable tests shall be completed.

3.3 FIELD TRAINING

A field training course shall be provided for designated operating staff members. Training shall be provided for a total period of not less than 1 hour of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance instructions.

-- End of Section --

SECTION 43 21 39

PUMPS: WATER, SUBMERSIBLE VERTICAL TURBINE AND HAND OPERATED

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 WATER WORKS ASSOCIATION (AWWA)

AWWA E101	(1988) Vertical Turbine Pumps - Line Shaft and Submersible Types

ASME INTERNATIONAL (ASME)

ASME B1.1	(2003) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B16.1	(2005) Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125 and 250
ASME B16.5	(2003) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24
ASME B40.100	(2006) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 307	(2004e1) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2006) Standard for Motors and Generators

1.2 GENERAL REQUIREMENTS

1.2.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Pumps of the same type shall be the product of one manufacturer.

1.2.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model, serial number, and catalog number on a plate secured to the item of equipment. Submersible pumps and motors shall also have identical nameplates affixed in a conspicuous place to the pump house wall or discharge piping. In addition, the nameplate for each pump shall show the capacity in L/second at rated head in meters and speed in revolutions per minute.

1.2.3 Verification of Dimensions

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

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G

Detail drawings consisting of a complete list of equipment and materials. Detail drawings and calculations by a Professional Engineer containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-03 Product Data

Submersible Pumping Units; G
Hand Pump Units; G
Controls and Instrumentation, Valves, and Piping; G

The contractor shall provide manufacturer's standard catalog, installation manuals, operation and maintenance manuals, descriptive data and technical literature, performance charts and curves, and catalog cuts.

Spare Parts

Spare parts data for each different item of material and equipment specified.

Posted Instructions

Proposed diagrams, instructions, and other sheets, prior to posting.

SD-06 Test Reports; G

Testing; G

The contractor shall provide the following: Six copies of each test containing the information described below (items 1-7) in bound letter-sized booklets, individual reports shall be provided for the storage tank tests, the piping tests, the system performance tests, alarm test, and the system leak tests. Drawings shall be folded blue lines, with the title block visible. 1) The date the tests were performed. 2) A list of equipment used, with calibration certifications. 3) A copy of measurements taken. 4) The parameters to be verified. 5) The condition specified for the parameter. 6) the inspection results, signed, dated, and certified by the installer. The certification shall state that required procedures were accomplished, that the procedures were conducted in compliance with the plans and specifications. 7) A description of adjustments performed.

Testing, Adjusting, and Balancing; G

For all pumps, pump system controls and instrumentation, valves, and piping, the contractor shall provide the following: 1)Two copies of the TAB schematic drawings and report forms, no later than 7 days prior to the start of TAB field measurements 2) A list of related submittals no later than 7 days prior to the start of TAB field measurements 3) Proposed procedures for TAB, submitted with the TAB schematic drawings and report forms 4) Proposed date and time to begin system readiness check 5) Proposed date and time to begin field measurement, making adjustments, etc. for the TAB report, submitted with the system readiness check report 6) Proposed date and time to begin the TAB verification, submitted with the TAB report 7) A copy of completed checklists for each contract in the project scope, each signed by the contractor's representative 8) Two copies of completed TAB reports no later than 7 days after the execution of TAB signed by the contractor's representative.

SD-10 Operation and Maintenance Data

Submersible and Hand Pumping Units, Pump Controls, Valves; G

Six complete copies of operating manual outlining the step-by-step procedures required for system startup, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six complete copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals

shall include simplified wiring, layout, and control diagrams of the system as installed. Submit Data Package 3 in accordance with Section 01780 OPERATION AND MAINTENANCE DATA.

1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.5 SPARE PARTS

The Contractor shall submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 2 months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 year(s) of service.

PART 2 PRODUCTS

2.1 PUMP AND DRIVER REQUIREMENTS

2.1.1 Type of Installation

The work shall include furnishing, installing, and testing submersible and hand pumping units and their appurtenances as indicated. Pumps shall be utilized for a elevated water storage tank and both pumps shall be installed in a common well, unless otherwise approved

2.1.2 Pump Drivers

Pumps shall have motor controllers with non reversible magnetic starter and overload protection with level switches for the well pump.

2.1.3 Well Data

Pumps shall be suitable for installation in the well casings and under the conditions indicated.

2.2 PUMP PERFORMANCE

Pumps shall be capable of discharging quantities of water at maximum pump speed and total pump head with the minimum efficiency indicated. Total pump head in meters shall consist of the pumping level below datum and the static and friction head above datum at design capacity.

2.3 HAND PUMPS

Hand pumps shall be provided as a backup pumping system. The hand pump shall be capable of discharging directly into the system piping at a sufficient pressure. The hand pump shall be capable of providing 18 liters per minute. The pump shall be protected from freezing conditions by a drain and shall include a spigot or similar outlet for optional direct discharge of water. The pump cylinder, riser pipe, and connection rod shall be installed within a well casing pipe which may also contain the submersible electric pump. The electric submersible pump discharge and the manual hand

pump suction shall be separate pipes. The casing and cap shall be sized to provide room for both pumps and piping, unless separate well casings are provided. A check valve shall be provided as indicated on the plans.

2.4 SUBMERSIBLE VERTICAL TURBINE PUMPS

Unless otherwise specified, submersible vertical turbine pumps shall be constructed in accordance with AWWA E101, driven by an electric motor. Pumps shall be designed for connection to piping as indicated. A strainer shall be provided at the pump suction. Pumps shall be operable at heads above or below the normal design head as required to maintain water levels in the elevated water tank.

2.4.1 Pump Head Assembly

Pump head assembly shall consist of the surface plate from which the vertical discharge pipe is suspended and an elbow or fitting as required for connecting to the piping system. Head assembly shall be provided with eyebolts, lugs, or other means for securing slings to facilitate setting and lifting.

2.4.2 Pump Bowl Assembly

Pump bowl assembly shall include the pump bowls, impellers, shaft, and bearings and may be of single stage or multistage configuration.

2.4.2.1 Pump Bowls

Pump bowls shall have integrally-cast vanes with smooth, streamlined water passageways, and shall be constructed of close-grained cast-iron.

2.4.2.2 Impellers

Impellers shall be carefully finished with smooth water passageways and shall not load the prime mover beyond the nameplate rating over the entire performance range of the pump.

2.4.2.3 Pump Shafts

Pump shafts shall be stainless steel and the pump-motor coupling shall be stainless steel capable of transmitting the required thrust in either direction.

2.4.2.4 Bearings

Intermediate bowl bearings shall be water-lubricated bronze or fluted rubber. Top bowl bearings and suction interconnecting bearings shall be grease packed bronze or water-lubricated bronze or fluted rubber. Grease in grease-packed bearings shall be non water-soluble hydraulic type permanently sealed against loss. Grease-packed bearings shall be provided with sand caps to prevent intrusion of abrasive particles. Thrust bearings shall be located in the pump motor.

2.4.2.5 Strainer

A bronze or stainless steel strainer shall be furnished at the pump suction.

2.4.3 Discharge Pipe

Discharge pipe shall be sized as required to provide the required flow and pressure. Discharge column retainers or spiders shall be utilized to maintain the discharge pipe centered in the well casing. A minimum of one retainer shall be provided for each 15 m of discharge pipe except if this is in conflict with the hand pump riser pipe. Provisions shall be made for fastening the retainer spiders to prevent them from sliding on the pipe and damaging the power cable when the pump is installed in the well.

2.4.4 Check Valves

Check valves shall be provided in the column pipe located at a pipe joint as recommended by the pump manufacturer. Check valves shall be vertical type, of the same size as the column pipe in which they are installed. Check valves shall be designed to hold the column full of water, or provide bleed-back through the valve, as recommended by the pump manufacturer. Pumps with bleed-back check valves shall be provided with a positive time-delay relay that will not permit the pump to start until bleed-back is complete.

2.5 PUMP ACCESSORIES

2.5.1 Pressure Gauge

A pressure gauge of the direct-reading type, equipped with a shut-off cock and snubber, shall be provided on the discharge from each pump. Pressure gauge shall conform to ASME B40.100 and shall be calibrated in kPa and mm of water in not more than 13.8 kPa and 1.5 m increments from zero to a minimum of 34.5 kPa and 3 m above the shut-off head of the pump. Rating point shall be at approximately the mid-point of the scale.

2.5.2 Air Release/ Vacuum Valve

Provide Air Release and/or Vacuum valve with the necessary pipe connections shall be provided to permit the automatic escape of air from the discharge column when the pump is started. Valve shall b compatible with the selected pump and anticipated discharge rates and shall prevent water hammer, accumulation of air, or formation of damaging vacuum in pump column an discharge lines. Size of the valve and piping shall suit the actual requirements of the individual installation and the recommendations of the pump manufacturer.

2.6 ELECTRICAL EQUIPMENT

2.6.1 General

Electrical motor-driven equipment shall be provided complete with motors, non reversible magnetic motor starters, overload protection, high and low level float switches, and controls. The control system will operate the water pump.

2.6.2 Submersible Vertical Turbine Pumps

2.6.2.1 Electric Motors

Submersible motors shall be designed and manufactured expressly for the intended use. Motor rating shall be stamped on the nameplate. Submersible

motors may be the wet-stator type, dry-stator type, or oil-filled stator type. Wet-stator motors shall be filled at the factory with water treated to minimize corrosion, and shall be provided with a seal to keep interchange of cooling water and water being pumped to a minimum. Windings shall be insulated with a waterproof material. Dry-stator motors shall have rotor bearings immersed in a coolant lubricant of water-oil or water-glycol mixture, or a water-grease emulsion. When the coolant is water, it may be sealed in the motor or allowed to flow through the motor, depending upon design. Stator case shall be hermetically sealed and may be filled with a solid plastic material to help dissipate heat. Oil-filled stator motors shall be completely filled with high-dielectric constant oil. A mechanical seal shall be provided between the shaft and the motor housing and shall be designed to minimize the loss of oil. An oil reservoir shall be provided to replenish the oil loss for the life of the motor. Wet-stator motors and oil-filled stator motors shall employ a system to automatically balance the liquid pressure in the motor at any depth of submergence up to the maximum allowable. Motor bearings shall provide smooth operations under the conditions encountered for the life of the motor. Adequate thrust bearings shall be provided in the motor to carry the weight of all rotating parts plus the hydraulic thrust, and shall be capable of withstanding the upthrust imposed during pump starting.

2.6.2.2 Control Equipment

Automatically controlled pump shall have three-position MANUAL-OFF-AUTOMATIC selector switch in cover. A pump low-water cutoff shall be installed in the well and shall shut the pump off when the water level in the well reaches the level shown.
The sequence of operation shall be as follows: High and Low Level Switches and level transmitters shall be installed in the Water Storage Tank at predetermined levels. The level switches shall be standard float switches. The low level switch in the water tank shall turn the well pump on. The high level switch will shut off the well pump. The Well Pump Controller will be located near the Well Pump and shall consist of a Non Reversible Magnetic Starter with Fused Disconnect Switch sized for the pump motor and a Hand Off Automatic Switch (HOA). The HOA switch will be placed in the Hand or Off position only when maintenance is being performed on the Well Pump or the Water Tank. Otherwise the HOA switch is normally in the automatic position.

2.6.2.3 Power Cables

Submersible power cables shall be specifically designed for use with submersible pumps, and shall be as recommended by the manufacturer of the motors with which the cables are used. Each cable shall be not less than No. 12 AWG stranded copper and shall have an ampacity of not less than 125 percent of the motor full load current. Each conductor shall be insulated with a heat resistant, moisture resistant synthetic rubber or thermosetting plastic jacket. A separate stranded, green insulated, grounding conductor shall be provided for each circuit. Single- and multiple-conductor cables shall be jacketed with a watertight synthetic rubber, plastic, or metal jacket impervious to oil or water. Metal jackets shall have a polychloroprene covering. Submersible cables shall be suitable for continuous immersion in water at the maximum depth encountered. Multiple-conductor cables may be used for ampacities up to and including 200 amperes; for greater ampacities single-conductor cables or two multiple-conductor cables shall be used. Cables shall be securely supported from the pump column at intervals not to exceed 4.5 m by corrosion-resistant bands or

clamps designed to prevent damage to the cable jacket. Single-conductor cables shall be laced, cabled together, or clamped at intervals to prevent spreading apart. Except where cables are connected to the motor terminal wiring, cables shall contain no splices in the length from the junction box or motor starter to the motor. Cables shall be terminated at the junction box or motor starter with a watertight cable connector. Splices in cables will be allowed only at the connection to the motor, and may be made at that point only if there is sufficient room in the well casing without interfering with proper pump setting and operation. A waterproof plug and connector or other type of fitting may be provided for connection of the cable at the motor. Such connection shall be suitable for continuous immersion at the maximum water depth encountered. Splices shall use pressure connectors and shall be cast in an epoxy resin, providing a homogeneous waterproof bond to the outer jacket of the cables. Splices shall be factory fabricated and tested and shall be waterproof and suitable for continuous immersion at the maximum depth encountered. For each 15 m of setting depth, 300 mm of extra cable length shall be provided to compensate for possible twist or sag of the cable during installation. Where cables pass the pump bowl assembly, cables shall be flat or protected against damage by a corrosion-resistant shield forming a smooth rounded surface. Sharp bends in the cables at the shield or at the connection to the motor will not be allowed.

2.7 EQUIPMENT APPURTENANCES

2.7.1 Attachments

All necessary bolts, nuts, washers, bolt sleeves, and other types of attachments for the installation of the equipment shall be furnished with the equipment. Bolts shall conform to the requirements of ASTM A 307and nuts shall be hexagonal of the same quality as the bolts used. Threads shall be clean-cut and shall conform to ASME B1.1. Bolts, nuts, and washers specified to be galvanized or not otherwise indicated or specified, shall be zinc coated after being threaded, by the hot-dip process conforming to ASTM A 123/A 123M or ASTM A 153/A 153M as appropriate. Bolts, nuts, and washers specified or indicated to be stainless steel shall be Type 316.

2.7.2 Equipment Guards

Equipment driven by open shafts, belts, chains, or gears shall be provided with all-metal guards enclosing the drive mechanism. Guards shall be constructed of galvanized sheet steel or galvanized woven wire or expanded metal set in a frame of galvanized steel members. Guards shall be secured in position by steel braces or straps which will permit easy removal for servicing the equipment. The guards shall conform in all respects to all applicable safety codes and regulations.

2.7.3 Special Tools

A complete set of all special tools which may be necessary for the adjustment, operation, maintenance, and disassembly of all equipment shall be furnished. Special tools are considered to be those tools which because of their limited use are not normally available, but which are necessary for the particular equipment. Tools shall be high-grade, smooth, forged, alloy, tool steel. Special tools shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and

safeguard such special tools until completion of the work, at which time they shall be delivered to the Contracting Officer.

2.7.4 Shop Painting

All motors, pump casings, and similar parts of equipment customarily finished in the shop shall be given coats of paint filler and enamel, or other acceptable treatment customary with the manufacturer and suitable for the intended service. Ferrous surfaces obviously not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General

Each pump shall be installed in accordance with the written instruction of the manufacturer. Engine fuel supply system shall be installed as indicated and in conformance with NFPA 30 and NFPA 37.

3.1.2 Foundations

Anchor bolts and expansion bolts shall be set accurately. Where indicated, specified, or required, anchor bolts shall be provided with square plates at least 101.6 by 101.6 by 9.5 mm or shall have square heads and washers and be set in the concrete forms with suitable pipe sleeves, or both. Any templates necessary and all dimensions for setting the anchor bolts shall be furnished at the proper time. Top of the foundation shall be carefully leveled to permit the pump to hang free.

3.2 PAINTING AND FINISHING

Unless otherwise specified all exposed ferrous metal not factory finished shall be painted as specified in Section 09 90 00 PAINTS AND COATINGS. No factory finished equipment or appurtenances shall be painted except that damaged factory finishes shall be retouched in an acceptable manner with paint obtained from the manufacturer. Nameplates shall not be covered with paint but shall be cleaned and legible at completion of the work.

3.3 TESTING

3.3.1 Factory Submersible Pump Test

Factory pump performance test shall be made in conformance with AWWA E101 for the following:

a. Running test.

b. Witnessed running test.

c. Sample calculation from test readings.

d. Shop inspection.

e. Hydrostatic test of bowl assembly.

f. Hydrostatic test of discharge head.

3.3.2 Field Equipment Test

After installation of the pumping units and appurtenances is complete, operating tests shall be carried out to assure that the pumping installation operates properly. Each pumping unit shall be given a running field test in the presence of the Contracting Officer for a minimum of 2 hours. Each pumping unit shall be operated at its rated capacity or such other point on its head-capacity curve selected by the Contracting Officer. The Contractor shall provide an accurate and acceptable method of measuring the discharge flow. For submersible pumping units, an insulation resistance test of the cable and the motor shall be conducted prior to installation of the pump, during installation of the pump, and after installation is complete. The resistance readings shall be not less than 10 megohms.

3.3.2.1 Correct Installation of Appurtenances

Tests shall assure that the units and appurtenances have been installed correctly, that there is no objectionable heating, vibration, or noise from any parts, and that all manual and automatic controls function properly.

3.3.2.2 Deficiencies

If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted.

3.4 MANUFACTURER'S FIELD SERVICES

The Contractor shall obtain the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installing, adjusting, and testing of the equipment.

-- End of Section --

SECTION 43 32 76

CHLORINE-FEEDING MACHINES (AUTOMATIC, SEMIAUTOMATIC AND MANUAL)

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.

ASME INTERNATIONAL (ASME)

ASME B16.1	(2005) Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125 and 250
ASME B16.11	(2005) Forged Fittings, Socket-Welding and Threaded
ASME B16.3	(1998) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2003) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24
ASME BPVC SEC VIII D1	(2004; 2005 Addenda; 2006 Addenda) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

ASTM INTERNATIONAL (ASTM)

ASTM A 106/A 106M	(2006) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 53/A 53M	(2006a) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 587	(1996; R 2005) Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry
ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120

ASTM F 441/F 441M	(2002) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

CHLORINE INSTITUTE (CI)

CI Pamphlet 1	(1997) Chlorine Manual
CI Pamphlet 6	(2005) Piping Systems for Dry Chlorine

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are For Information only and for Contractor Quality Control approval. Submit the following in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation;

Detail drawings and calculations by a Professional Engineer containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-03 Product Data

Material and Equipment; G

A complete list of equipment and material, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions.

Diagrams, instructions, and other sheets, proposed for posting.

SD-06 Test Reports

Testing

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

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions

Six complete copies of operating manuals outlining the step-by-step procedures required for system startup, operation and shutdown.

The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six complete copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The instructions shall include gas pipe layout, liquid chlorine pipe layout, dilution liquid pipe layout, equipment layout, and simplified wiring and control diagrams of the system as installed.

Submit Data Package 3 in accordance with Section 01780 OPERATION AND MAINTENANCE DATA.

1.3 GENERAL REQUIREMENTS

1.3.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

1.3.2 Nameplates

Major equipment items shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 CHLORINE-FEEDING MACHINE

The machine shall be designed to use hypochlorite compounds for disinfection. A manufacturer assembled, self-contained, skid-mounted, hypo-chlorinator consisting of mixer, mixing tank, diaphragm pump, feed injector mechanism and control panel. System shall be used to feed a sodium hypochlorite solution of 5-15% available chlorine into a pressurized piping system. Hypochlorite compound may be a liquid or solid form. The pump shall feed a hypochlorite solution in proportion to the water demand. The hypo-chlorinator shall have a pumping rate, liters per day (lpd) (gallons per day (gpd)) adequate to deliver 5 percent (%) available hypochlorite solution adjustable to the quantity of water being produced from the source. The chlorine-feeding system shall consist of controls and devices necessary for a complete operating system.

2.1.1 Capacity

Each chlorine-feeding machine shall be compatible with the anticipated raw water flow rate and shall be capable of continuous operation at rated capacity.

2.2 PIPING

2.2.1 Water Piping

Water piping shall be as recommended by the system manufacturer based on the anticipated pressure.

2.2.2 Chlorine Piping

Chlorine solution piping shall be as recommended by the system manufacturer based on the anticipated pressure.

2.3 ELECTRICAL WORK

Electric motor-driven equipment, and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Ratings shall be as indicated. Motor starters shall be provided complete with thermal-overload protection and other appurtenances necessary for motor controls specified. Manual or automatic control and protective or signal devices required for controls and devices shall be provided. All electrical connections at junction terminal boxes and at contactor-starter unit enclosures shall be prewired.

2.4 EQUIPMENT APPURTENANCES

Bolts, nuts, anchors, washers, and all other types of supports necessary for the installation of the equipment shall be galvanized steel, cadmium plated steel, or Type 316 stainless steel.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Chlorine-Feeding Equipment

The chlorine feeding machines, and all equipment appurtenances shall be installed so as to provide a complete and integrated system in accordance with the instructions of the manufacturer.

3.1.2 Pipe, Tubing, Hangers, and Supports

The installation of pipes and tubes shall be in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.2 TESTING

After installation of the chlorine-feeding machine is complete, operating tests shall be carried out to assure that the chlorine-feeding installation operates properly. All piping shall be tested hydrostatically and for leaks. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted.

3.3 PAINTING

3.3.1 Factory Painting

Factory painting shall conform to manufacturer's standard factory finish.

3.3.2 Field Painting

Equipment which did not receive a factory finish shall be painted as specified in Section 09 90 00 PAINTS AND COATINGS. Factory painted items requiring touching up in the field, shall be thoroughly cleaned of all foreign material and shall be primed and topcoated with the manufacturer's standard factory finish provided it does not discolor in the presence of hydrogen sulfide fumes, high water vapor atmosphere, alkaline water vapor, and concentrated chlorine (oxidizing) conditions. Coating shall be not less than 0.05 mm thick.

3.4 FRAMED INSTRUCTIONS

Operating instructions including wiring and control diagrams showing the complete layout of the entire system shall be provided. 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.

3.5 MANUFACTURER'S FIELD SERVICE

3.5.1 Manufacturer's Supervision

Services of a representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

-- End of Section --