

SAGE WELL IIR

**FOR AMERICAN WATER MILITARY SERVICES
JOINT BASE LEWIS-MCCHORD, WASHINGTON**

**PROJECT NUMBER P4-A60MWA2-00003
PUBLIC WATER SYSTEM ID 52200**

CONSULTANT PROJECT NO.: 427-22-03

DECEMBER 2023

OWNER



AMERICAN WATER

ENGINEER



TABLE OF CONTENTS

American Water JBLM SAGE WELL II Replacement

**American Water Specifications and Supplementary Specification
(Additional American Water Specifications may be applicable and govern all
work unless otherwise indicated.)**

DIVISION 03 - CONCRETE

03 30 53 Miscellaneous Cast In Place Concrete
03 48 20 Valve Boxes and Meter Vaults

DIVISION 04 - MASONRY

04 01 20 Masonry Cleaning
04 05 12 Mortar and Grout
04 21 13 Anchored Masonry Veneer
04 22 00 Concrete Unit Masonry
04 26 13 Masonry Veneer

DIVISION 05 - METALS

05 50 00 Metal Fabrications

DIVISION 06 – WOODS, PLASTICS, AND COMPOSITES

06 10 00 Rough Carpentry
06 17 53 Shop-Fabricated Wood Trusses

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

07 14 00 Fluid-Applied Waterproofing
07 19 00 Water Repellents
07 21 00 Thermal Insulation
07 26 00 Vapor Retarders
07 27 15 - Nonbituminous Self-Adhering Sheet Air Barriers
07 41 13.16 Standing-Seam Metal Roof Panels
07 42 93 Soffit Panels
07 62 00 Sheet Metal Flashing and Trim
07 92 00 Joint Sealants

DIVISION 08 - DOORS AND WINDOWS

08 11 13 Hollow Metal Doors and frames
08 71 00 Door Hardware

DIVISION 09 – FINISHES

09 29 00 Gypsum Board
09 90 00 Protective Coatings
09 91 13 Exterior Painting
09 91 23 Interior Painting

DIVISION 10 – SPECIALTIES

10 14 23 Panel Signage
10 44 16 Fire Extinguishers

DIVISION 11 – EQUIPMENT

11 00 00 Equipment General Provisions

DIVISION 22 – PLUMBING

22 11 16 - Domestic Water Piping
22 11 19 - Domestic Water Piping Specialties
22 13 16 - Sanitary Waste and Vent Piping
22 45 00 - Emergency Plumbing Fixtures

DIVISION 23 – HVAC

23 05 00 - Common Work Results for Plumbing and HVAC
23 05 29 - Hangers and Supports for Plumbing Piping and HVAC Equipment
23 05 53 - Identification for Plumbing and HVAC Equipment
23 05 93 - Testing, Adjusting, and Balancing for HVAC
23 07 00 - Plumbing and HVAC Insulation
23 31 13 - Metal Ducts
23 34 23 - HVAC Power Ventilators
23 55 33 - Unit Heaters

DIVISION 26 – ELECTRICAL

26 00 10 General Electrical Requirements
26 00 20 Electrical Materials and Methods
26 29 23 Variable Frequency Drives
26 32 13.13 Emergency Generator
26 36 23 Automatic Transfer Switch

DIVISION 31 – EARTHWORK

31 10 00 Site Preparation

31 23 00 Earthwork

31 23 19 Dewatering

DIVISION 32 – LANDSCAPING

32 90 01 Landscape

DIVISION 33 – UTILITIES

33 01 10.13 Pressure and Leakage Tests

33 01 10.15 Disinfecting Pipeline

33 05 27 Tracer Wire

33 11 00 Piping General Provisions

33 11 00.11 Polyvinyl Chloride Pipe

33 11 00.15 Ductile Iron Pipe Fittings

33 11 00.17 Polyethylene Wrap

33 11 00.19 Abandonment of Water Mains

33 12 16.11 Gate Valves

33 12 16.19 Air Release Valves

33 12 19 Fire Hydrants

33 21 00 Drinking Water Well Requirements

DIVISION 43 – GAS, LIQUID, AND STORAGE

43 20 10 Pumps, General

43 25 10 Submersible Well Pumps and Motors

APPENDIX A - Geotechnical Investigation – JBLM ISDC 21 – Sage Well 2 Replacement,
prepared by GeoEngineers, March 31, 2023

DRAWINGS

END OF TABLE OF CONTENTS

DIVISION 03
CONCRETE

SECTION 03 30 53
MISCELLANEOUS CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes cast-in-place concrete, including forms, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.2 REFERENCES

- A. American Concrete Institute (ACI) standards, most recent editions:

ACI 117	Specifications for Tolerances for Concrete Construction and Materials
---------	---

ACI 301	Specifications for Structural Concrete
---------	--

ACI 305R	Hot Weather Concreting
----------	------------------------

ACI 306R	Cold Weather Concreting
----------	-------------------------

ACI 315	Details of Concrete Reinforcement
---------	-----------------------------------

ACI 318	Building Code Requirements for Reinforced Concrete
---------	--

ACI 347	Formwork For Concrete
---------	-----------------------

- B. American Welding Society (AWS):

D1.4	Structural Welding Code – Reinforcing Steel
------	---

- C. ASTM International (ASTM) standards, most recent editions:

ASTM A82	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
----------	--

ASTM A185	Standard Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
-----------	---

ASTM A497	Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
-----------	--

ASTM A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
-----------	--

ASTM A706	Standard Specification for Low Alloy Steel Deformed Bars for Concrete Reinforcement
-----------	---

ASTM A775	Standard Specification for Epoxy-Coated Reinforcing Steel Bars
ASTM C31	Standard Specification Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specifications for Concrete Aggregates
ASTM C39	Test for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C156	Standard Test Method for Water Loss [from a Mortar Specimen] Through Liquid Membrane-Forming Curing Compounds for Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C920	Standard Specification for Elastomeric Joint Sealants
ASTM C1064	Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

- | | |
|-------------|---|
| ASTM D1751 | Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) |
| ASTM D1752 | Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction |
| ASTM D 4397 | Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications |
| ASTM E1745 | Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs |
- D. Concrete Reinforcing Steel Institute (CRSI) standards, most recent editions:
- Manual of Standard Practice
- E. Federal Specifications, most recent editions:
- | | |
|-----------|---|
| UU-B-790A | Building Paper, Vegetable (Kraft, Waterproofed, Water Repellent and Fire Resistant) |
|-----------|---|
- F. U. S. Army Corps of Engineers standards, most recent editions:
- | | |
|-----------|----------------|
| CRD-C 572 | PVC Waterstops |
|-----------|----------------|

1.3 SYSTEM DESCRIPTION

- A. The Contractor shall be responsible for the design, engineering, construction, maintenance, and safety of all falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, and the requirements specified herein.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 20 – Submittal Procedures.
- B. Submit details of the concrete reinforcement steel and concrete inserts as soon as possible after receipt of the Notice to Proceed.
- C. Include, but not limit to, the following:
1. Complete bar schedule, bar details and erection drawings to conform to ACI 315.
 2. Each type of bar marked with identification corresponding to identification tag on bar.
 3. Length, type, and location of all splices.
 4. Erection drawings shall be clear, easily legible and to a minimum scale of:
 - a. 1/4 inch = 1 foot.
 - b. 1/8 inch = 1 foot if bars in each face are shown in separate views.
 5. Size and location of openings.

- D. Do not use Contract Documents as erection drawings.

1.5 QUALITY ASSURANCE

- A. Ready mix concrete manufacturer qualifications: Concrete producer shall be a firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94 requirements for production facilities and equipment.
- B. Perform work in accordance with ACI 301 and the applicable referenced documents.
- C. Welders' Certificates: When welding of reinforcing steel is proposed, submit welders' certificates certifying welders employed on the Work and verifying AWS qualification within the previous 12 months. All welding to be performed in accordance with AWS D1.4.
- D. Conform to ACI 305R and/or ACI 306R when concreting during hot or cold weather as appropriate.

PART 2 - PRODUCTS

2.1 FORMWORK

- A. Conform to ACI 301, ACI 318, and ACI 347, using plywood or metal forms.
- B. Plywood forms: Douglas Fir or Southern Yellow Pine species; solid one side or high density overlaid one side; sound, undamaged sheets designed to support weight of concrete with minimum deflection.
- C. Steel forms: Stiffened to support weight of concrete with minimum deflection.
- D. Glass fiber reinforced resin type: Preformed shape, stiffened to support weight of concrete with minimum deflection.
- E. Tubular column type: Round, spirally wound, laminated fiber material, surface treated with release agent; non-reusable, of sizes indicated.
- F. Form ties: Removable or snap-off metal of fixed length, leaving no metal within 1 inch of finished surface.
- G. Form release agent: Colorless mineral oil that will not stain concrete or absorb moisture.

2.2 STEEL REINFORCEMENT

- A. Reinforcing steel: ASTM A615, Grade 60, deformed billet steel bars, uncoated finish.
 - 1. When shown on Drawings, supply epoxy coated bars in accordance with ASTM A775.
 - 2. Plain-steel wire: ASTM A82 as drawn.
 - 3. Plain steel welded wire reinforcement: ASTM A185, fabricated from as-drawn steel wire into flat sheets.
 - 4. Deformed-steel welded wire reinforcement: ASTM A497, flat sheet.
 - 5. Tie wire: Minimum 16 gage annealed type.

- 6. Chairs, bolsters, bar supports and spacers: Sized and shaped for strength and support of reinforcement during concrete placement.
- B. Welding reinforcing steel: When welded reinforcing steel is called for on the Drawings or in these Specifications, provide per ASTM A706.

2.3 CONCRETE MATERIALS

- A. Blended Hydraulic Cement: Comply with ASTM C595, Type IL (10) (MS), grey color.
 - 1. Cement shall not contain more than 0.60 percent equivalent alkalis.
 - 2. Limestone content is limited to 10 percent.
 - 3. Single brand of cement used throughout Work; brand approved by Engineer.
- B. Fly ash: ASTM C618, Class F including supplementary optional requirements relating to reactive aggregates and alkalis, and loss on ignition (LOI) not to exceed 5 percent.
 - 1. Maximum of 25 percent replacement at 1.0 pounds of fly ash per pound of cement replaced.
- C. Coarse aggregate: ASTM C33,
 - 1. Graded Size No. 67.
 - 2. Obtain coarse aggregates from sources approved by Engineer.
- D. Fine aggregate: ASTM C33
 - 1. Fineness Modulus: Not over 3.00.
 - 2. Obtain fine aggregates from sources approved by Engineer.
- E. Lightweight aggregates: Not permitted unless specifically allowed by Engineer.
- F. Water
 - 1. Clean and not detrimental to concrete; potable.
 - 2. Conform to ASTM C94.

2.4 ADMIXTURES

- A. Air entrainment: ASTM C260.
- B. Water reducing: ASTM C494, Type A.
- C. Water reducing and retarding: ASTM C494, Type D.
- D. Water reducing and accelerating: ASTM C494, Type E.
- E. Water reducing, high range plasticizer: ASTM C494, Type F.
- F. Do not use calcium chloride.
- G. Pigments for underground conduit banks: Pigment shall be added to concrete encasing electrical duct banks as required by Rocky Mountain Power Company.

2.5 RELATED MATERIALS

- A. Waterstops, plastic serrated type.
 - 1. Extruded elastomeric polyvinyl chloride compound: containing plasticizers, resins, stabilizers, and other materials necessary to meet requirements of Specifications.
 - a. Provide manufacturer's factory fabrications for intersections, transitions, and changes of direction.
 - a. In accordance with Specification CRD-C572.
 - b. Style:
 - 1) Centerbulb, 7/8-inch OD, 6 inches long.
 - 2) Flat Strip, 6 inches long unless noted otherwise.
 - 3) Split Rib, as shown on Drawings, used only when specifically approved for application.
- B. Waterstops, plastic adhesive type.
 - 1. Non expansive plastic adhesive strip type manufactured solely for the purpose of preventing water from passing through construction joints.
 - a. Synko Flex, as manufactured by Henry Co. or Engineer approved equal.
- C. Bonding agent: Polymer resin emulsion acceptable to Engineer.
- D. Bond breaker: VOC compliant, water or solvent based membrane forming, reactive bond breaker.
- E. Vapor barrier: Multi-ply reinforced polyethylene sheet, ASTM E1745, Class C, not less than 7.8 mils thick or polyethylene sheet, ASTM D4397, not less than 15 mils thick.
- F. Grout: Premixed compound with non-metallic aggregate, cement, water reducing and plasticizing agents, capable of minimum compressive strength of 2500 psi in 3 days and 6000 psi in 28 days.
- G. Construction joints: Locate and install construction joints that are not shown on Drawings so as not to impair strength of concrete, and as acceptable to the Engineer.
- H. Premolded joint filler:
 - 1. Provide expansion joints in concrete construction in locations shown on Contract Drawings.
 - 2. Expansion Joint Filler: Preformed, non-extruding, resilient type, constructed of cellular neoprene sponge rubber, extending full thickness of slab, in accordance with ASTM D1751 or ASTM D1752, Type I.
- I. Expansion joints: Locate and install where shown on the Drawings.
- J. Joint sealant: 2-component polyurethane conforming to ASTM C920.

2.6 CURING MATERIALS

- A. Water: Clean and potable.

- B. Polyethylene sheet for use as concrete curing blanket shall be white and shall have a nominal thickness of 6 mils. The loss of moisture when determined in accordance with the requirements of ASTM C156 shall not exceed 0.055 grams per square centimeter of surface.
- C. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, having a nominal thickness of 2 mils and permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A (1) (2). The loss of moisture, when determined in accordance with the requirements of ASTM C156, shall not exceed 0.055 gram per square centimeter of surface.
- D. Polyethylene-coated burlap for use as concrete curing blanket shall be 4 mils thick, white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when determined in accordance with the requirements of ASTM C156, shall not exceed 0.055 gram per square centimeter of surface.
- E. Evaporation retardant to provide thin continuous film over freshly placed flatwork concrete to prevent rapid moisture loss before finishing.
 - 1. Membrane Curing Compound (with fugitive dye added): ASTM C309, Type 1-D, Class B. Sodium silicate compounds shall not be allowed.

2.7 CONCRETE MIXTURES

- A. Normal-weight concrete: Select proportions for normal-weight concrete in accordance with ACI 301 using either the “statistical method” or the “trial batch method”.
 - 1. “Statistical method” is preferred with a minimum of 30 tests acceptable to the Engineer.
 - 2. If “trial batches” are used to verify the mix design strength, the proposed mix design shall achieve an average compressive strength of 1200 psi in excess of strengths given in table below.
- B. Concrete strength, cement content and slump per the following table:

Type of Construction	Compressive Strength (psi)	Aggregate Gradation (ASTM C33)	Slump in Inches (Max.)	Max W/C Ratio (by Weight)
Structure walls and top slabs.	4,000	#57 (1")	4	0.42
Structure footings; foundations and bottom slabs.	4,000	#467 (1-1/2")	4	0.42
Reinforced concrete encasements; thrust blocks	4,000	#467 (1-1/2")	4	0.50
Site Slabs; Curb and gutter	4,000	#57 (1")	4	0.50
Lean Concrete	3,000	#467 (1-1/2")	5	0.60
Site underground conduit banks: Min. 3 lbs. red pigment/sack cement	3,000	#8 (3/8")	5	0.60

1. Slump as shown above shall be plus or minus 1 inch.
2. Minimum cement content:
 - a. Reinforced Concrete: Six sacks of Portland Cement per cubic yard.
 - b. Unreinforced Concrete: Five sacks of Portland Cement per cubic yard.
3. Air content: Provide air entrainment resulting in a total air content of 5 to 7 percent for all types of construction.
 - a. Air content to be measured in accordance with ASTM C231, ASTM C173, or ASTM C138.
 - b. Air may be omitted from interior slabs to be trowel finished.

2.8 CONCRETE MIXING

- A. Measure, batch, mix, and deliver concrete according to ASTM C94 and furnish batch ticket for each truck delivered.
 1. Deliver and place concrete within 90 minutes from the time the water is added to the mix.
 2. When ambient air temperature is above 90 degrees F, reduce delivery and placement time to 60 minutes.

PART 3 - EXECUTION

3.1 GENERAL

- A. Earth surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. Surface shall be free from standing water, mud and debris at the time of placing concrete.
- B. Provide slabs and beams of minimum indicated depth when sloping foundation base slabs or elevated floor slabs to drains.
 1. For slabs on grade, slope top of subgrade to provide floor slabs of minimum uniform indicated depth.
 2. Do not place floor drains through beams.
- C. Unless otherwise indicated, provide exterior corners in concrete members with 3/4-inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

3.2 FORMWORK

- A. Verify lines, levels, and measurement before proceeding with formwork.
- B. Hand trim sides and bottom of earth forms. Remove all loose soil.
- C. Align form joints.
- D. Do not apply form release agent where concrete surfaces will receive special finishes or applied coatings that may be affected by the agent.

- E. Coordinate work of other trades in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

3.3 WATERSTOPS

A. Preparation

1. Uncoil waterstop minimum of 24 hours prior to installation for ease of handling and fabrication.
2. Position waterstop to ensure proper distance from steel reinforcing bars and to prevent rock pockets and honeycomb.
3. Clean concrete joint and waterstop after first pour to remove debris and dirt.

B. Installation

1. Position waterstop across joints as specified herein and as indicated on Drawings.
2. Center waterstops on joint unless shown otherwise.
3. When centerbulb is present at moving joints, ensure that it is not embedded.
4. All waterstops fully continuous for the extent of the joint.
5. Secure plastic serrated waterstop in correct position before concrete placement with hog rings and wire to adjacent reinforcing steel at 12-inch maximum spacing. Center-to-center spacing may be increased upon written request and approval of Engineer.
6. Take suitable precautions and means to support and protect waterstops during the progress of the work.
7. Carefully place concrete without displacing waterstop from proper position.

3.4 VAPOR BARRIER

- A. Except where membrane waterproofing is required, place interior concrete slabs on a continuous vapor barrier
- B. Place 2" of fine granular fill over the vapor barrier to act as a blotter for the concrete slab.
- C. Lap joints minimum of 6 inches and seal with a compatible pressure-sensitive tape
- D. Patch punctures and tears before placing sand blotter or concrete.

3.5 STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
 1. Do not cut or puncture vapor barrier if used.

3.6 CONCRETE PLACEMENT

- A. Notify Engineer a minimum of 24 hours prior to commencement of concreting operations.
- B. Before placing new concrete on or against concrete which has set, existing surfaces shall be roughened and cleaned free from all laitance, foreign matter, and loose particles.
- C. Place concrete in accordance with ACI 301.

- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301. In no case shall water be added to exceed the specified water-cement ratio of the mix.
- E. Conform to ACI 305R when concreting during hot weather.
- F. Conform to ACI 306R when concreting during cold weather.

3.7 FLOOR SLABS

- A. Install control joints in slab by forming or cutting within 4 hours of placement using an early entry saw.
- B. Separate slabs-on-grade from vertical surfaces using full-depth joint filler. Apply joint sealant when shown on Drawings.

3.8 FINISHING FORMED SURFACES

- A. Rough-formed finish: As-cast concrete texture imparted by form facing material with tie holes and defective areas repaired and patched.
 - 1. Remove fins and other projections exceeding 1/2 inch.
 - 2. Apply to concrete surfaces not exposed to view after final grading.
- B. Smooth-formed finish: As-cast concrete texture imparted by form facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
 - 1. Repair and patch tie holes and defective areas.
 - 2. Remove fins and other projections exceeding 1/8 inch.
 - 3. Apply to concrete surfaces exposed to view or to be covered with a coating or covering material applied directly to concrete.

3.9 FINISHING UNFORMED SURFACES

- A. Steel trowel surfaces at interior floor slabs which are to be exposed.
- B. Steel trowel surfaces that are to receive carpeting, resilient flooring, seamless flooring, thin-set marble, quarry, or ceramic tile.
- C. Wood float surfaces that are scheduled to receive quarry, ceramic tile, or terrazzo tile, with full bed setting system.
- D. Broom finish at exterior concrete slabs, paving, and steps.
- E. Broom or wood float finish at exposed concrete filled pan stair treads.
- F. Floor densifier/sealer:
 - 1. Apply to all exposed concrete floor surfaces.
 - 2. Apply after concrete has cured minimum 7 days.
 - 3. Apply in accordance with manufacturer's recommendations.
 - 4. Keep floors covered and free of traffic and loads for a minimum of 10 days after completion.

3.10 CONCRETE CURING AND PROTECTION

- A. Evaporation retarder.
 - 1. Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. per hour before and during finishing operations.
 - 2. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- B. Cure concrete for not less than 14 days after placing.
- C. Leave forms in place at least 14 days, or until concrete has attained specified 28-day strength, unless otherwise approved by Engineer. If forms are allowed to be removed within 14 days of placing concrete, continue curing in accordance with other methods specified herein or as directed by Engineer.
- D. Strictly follow careful procedures for the removal of forms and perform with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted.
- E. Keep encasement concrete, concrete cradles and anchor blocks moist until covered. The surface shall be covered with moist earth not less than 4 hours, or more than 24 hours, after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 days after placement of concrete.
- F. Concrete slabs may be cured by either of the following two methods:
 - 1. Method 1:
 - a. After finishing slab, wet surface with a fine spray of water and cover with polyethylene-bonded waterproof paper sheeting.
 - b. Lap sheets 4 inches at sides and ends and seal with adhesive tape to form a continuous watertight joint.
 - c. Weigh sheeting down with wood planks to keep sheeting in contact with concrete.
 - d. Repair or replace sheets immediately if damage occurs.
 - 2. Method 2:
 - a. Cover concrete with water-saturated polyethylene-coated burlap curing mats and keep continuously wet for curing period.
 - b. Lap sheets 4 inches at sides and ends and seal with adhesive tape to form a continuous watertight joint.
 - c. Weigh sheeting down with wood planks to keep sheeting in contact with concrete.
 - d. Repair or replace sheets immediately if damage occurs.
- G. As an alternate to above referenced curing methods for formed and slab concrete, spray surface with liquid curing compound that does not affect bond of paint to concrete surface.
 - 1. Apply curing compound in accordance with manufacturer's instructions as soon as the concrete has hardened enough to prevent marring on unformed surfaces, and within 2 hours after completion of finish or stripping of forms, if stripped in less than 14 days.
 - a. Maximum coverage rate of 200 square feet per gallon, applied in such a manner as to cover surface with a uniform film to seal thoroughly.

2. Curing vertical surfaces with a curing compound:
 - a. Cover vertical surfaces with a minimum of two coats of the curing compound.
 - b. Apply the first coat of curing compound immediately after form removal. Vertical surface at the time of receiving the first coat shall be damp with no free water on the surface.
 - c. Allow the preceding coat to completely dry prior to applying the next coat.
 - d. Vertical surface is defined as any surface steeper than 1 vertical to 4 horizontal.
3. Curing Compound: As specified herein.
4. Take care to avoid damage to seal during curing period.
5. Repair broken or damaged seals occurring before expiration of curing period by application of additional curing compound over damaged portion.
6. Do not use curing film method where construction joints are to be made.
7. In hot weather, follow curing procedures outlined in ACI 305R.
8. In Cold Weather, following curing procedures outlined in ACI 306R.

3.11 TOLERANCES

- A. Construction Tolerances: Set and maintain concrete forms and perform finishing operations so as to ensure that the completed Work is within the tolerances specified in ACI 117. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades, or dimensions shown.

3.12 FIELD QUALITY CONTROL

- A. General
 1. Tests on component materials and for slump, temperature, air content, and compressive strength will be performed as specified herein.
 2. The cost of all laboratory tests for qualification of mix designs on cement, aggregates, and concrete, including strength testing will be borne by the Contractor. The cost of all field-testing during construction, including slump, temperature, air, and strength will also be borne by the Contractor. Contractor's testing laboratory shall meet or exceed the requirements of ASTM C1077.
 3. Concrete for testing shall be supplied by the Contractor at no additional cost to the Owner, and the Contractor shall assist Engineer in obtaining samples, and disposal and cleanup of excess material.
 4. Composite samples of concrete placed in the Work shall be taken in accordance with ASTM C172 from the first placement of each class of concrete and at the following minimum frequency for each class:
 - a. Not less than one sample per day on which concrete is placed.
 - b. Not less than one sample for each 50 cubic yards of concrete placed.
 - c. Not less than one sample for each 5,000 square feet of surface area for slabs or walls.
 - d. Not less than 5 samples from randomly selected batches for the Work.
- B. Slump Tests
 1. Perform in accordance with requirements of ASTM C143 at frequency indicated for sampling above.
- C. Temperature Tests

1. Test concrete temperature per ASTM C1064 at frequency indicated for sampling above.
- D. Air Content Tests
1. Test air content per ASTM C231 at frequency indicated for sampling above.
- E. Field Compression Tests
1. Field compression test specimens will be made at the frequency indicated for sampling above.
 2. Each set of test specimens will be a minimum of five cylinders.
 3. Compression test specimens for concrete shall be made in accordance with ASTM C31. Specimens shall be 6-inch diameter by 12-inch high cylinders.
 4. Compression tests shall be performed in accordance with ASTM C 39. One test cylinder will be tested at 7 days and two at 28 days. The remaining cylinders will be held to verify test results, if needed.
- F. Evaluation and Acceptance of Concrete
1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 318 and as specified herein.
 2. All concrete which fails to meet the ACI requirements and these Specifications, is subject to removal and replacement at no increase in cost to the Owner.

3.13 APPLICATION OF LOADS

- A. Do not allow traffic, construction equipment, or materials of any kind to be placed on elevated concrete slabs until the concrete has attained a minimum age of 7 days and 80% of the minimum specified 28-day strength as proven by concrete strength tests.
- B. Do not place backfill against cantilevered walls until the concrete has attained a minimum age of 7 days and 100% of the minimum specified 28-day concrete strength as proven by concrete strength tests.
- C. Do not place backfill against walls that are tied to elevated slabs or decks until the both the slabs and walls have attained a minimum age of 7 days and 80% of the minimum specified 28-day strength as proven by concrete strength tests.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

SECTION 03 48 20**VALVE BOXES AND METER VAULTS****PART 1: GENERAL****1.01 SECTION INCLUDES**

- A. Valve boxes for water and cleanout boxes for wastewater service.
- B. Meter boxes for water service.
- C. Meter vaults for water and wastewater service.

1.02 SUBMITTALS

- A. Conform to requirements of Section 01 33 00 - Submittals.
- B. Submit manufacturers' product data for following items for approval:
 - 1. Each type of valve box and lid.
 - 2. Each type of meter box and cover.
 - 3. Each type of meter vault frame and cover.
- C. Submit design calculations and shop drawings for precast vault elements, sealed by a Professional Engineer licensed to practice in the State in which the Work is performed..
- D. Submit shop drawings for cast-in-place meter vaults for approval if proposed construction varies from Project Drawings.

PART 2: PRODUCTS**2.01 VALVE BOXES AND CLEANOUT BOXES**

- A. Provide approved Type A, cast-iron/ductile-iron, slide-type or screw-type, valve boxes. Design of valve box shall minimize stresses on valve imposed by loads on box lid.
- B. Cast letter 'S' into lid for cleanouts serving wastewater force main lines, 1/2-inch in height and raised 3/32-inch. Cast letter 'W' into lid for valves serving potable water lines, 1/2-inch in height and raised 3/32-inch.
- C. Unless otherwise specified, uncoated cast iron.
- D. Riser Pipe.
 - 1. Provide 6-inch PVC, Class 150, DR 18, riser pipes in accordance with Section 33 11 00.11 - Polyvinyl Chloride Pipe or;

2. 6-inch ductile-iron, thickness Class 51 riser pipes in accordance with Section 33 11 00.15 - Ductile Iron Pipe and Fittings.
 3. Provide single section of pipe.
- E. Concrete for valve box placement:
1. For locations in new concrete pavement, provide concrete in accordance with Cast-In-Place Concrete Section.

2.02 METER BOXES

- A. Provide meter boxes for 5/8-inch through 1-inch meters of the following materials:
1. Non-traffic bearing locations: Cast iron, polyethylene, or concrete. Meter boxes of polyethylene construction shall not be installed in roadways.
 2. Traffic bearing locations: Cast iron.
- B. Provide cast iron, concrete or polyethylene meter boxes for 1 1/2-inch and 2-inch meters.
- C. Provide meter box with reading lid. Provide lids with spring-type latching devices. Lids shall contain sufficient metal that meter box can be easily located with metal detector. Cast words "WATER METER" into lid with letters of 1/2-inch height and raised 3/32-inch.
- D. All meter box lids shall be cast iron rated for H20 loading.
- E. Extensions: Meter box extensions 3-inches and 6-inches in height shall be available from manufacturer as standard item.
- F. Cast-Iron Boxes: Clean and free from sand blow-holes or other defects conforming to requirements of ASTM A48, Class 30B. Bearing surfaces shall be machined so that covers seat evenly in frames.
1. Boxes and lids shall have dipped, coal-tar-pitch, varnish finish.
 2. Provide lock-type meter boxes when required by Project Drawings. Lock mechanisms shall work with ease.
- G. Concrete Meter Boxes: Made of Class A concrete, with minimum 4000 psi compressive strength. Construct to dimensions shown on Project Drawings.
1. Castings: Free from fractures, large or deep cracks, blisters or surface roughness or any other defects that may affect serviceability.
 2. Concrete meter lids are not permitted.
- H. Meter Boxes shall be as per AW Standard Details.

2.03 METER VAULTS

- A. Meter vaults may be constructed of precast concrete or cast-in-place concrete unless a specific type of construction is required by Drawings.
- B. Concrete for meter vaults: Conform to requirements of Section - Cast-In-Place Concrete.

- C. Reinforcing steel for meter vaults: Conform to requirements of Section – Cast In Place Concrete.
- D. Meter vaults shall be designed to include anti-floatation provisions.
- E. Grates and Covers: Use castings for frames, grates, rings and covers conforming to ASTM A48, Class 35B. Provide locking covers if indicated on Project Drawings.
 - 1. Use clean castings capable of withstanding application of AASHTO M306 - 40,000 pound proof loading without detrimental permanent deformation.
 - 2. Fabricate castings to conform to shapes, dimensions, and with wording or logos shown on Project Drawings. Standard dimension for manhole cover opening is 32-inches in diameter.
 - 3. Use clean castings, free from blowholes and other surface imperfections. Use clean and symmetrical cast holes in covers, free of plugs.
- F. Provide safety grate option and keyed locks for all access hatches. Provide master access keys in accordance with Owner's requirements. Two of each key shall be provided and keys shall be tagged for lock location.

PART 3: EXECUTION

3.01 EXAMINATION

- A. Obtain approval from AW Project Manager for location of meter vault and meter boxes.
- B. Verify lines and grades are correct.
- C. Verify compacted subgrade will support loads imposed by vaults.
 - i. Require 12" compacted soil
or
 - ii. 6" compacted soil and 6" of <1" clean stone

3.02 VALVE BOXES

- A. Install riser pipe with suitable length for depth of cover indicated on Project Drawings or to accommodate actual finish grade.
 - 1. Install with bell on top of valve
 - 2. Install valve box and riser piping plumbed in a vertical position
- B. Provide 6-inches telescoping freeboard space between riser pipe top butt end, and interior contact flange of valve box, for vertical movement damping. End of pipe resting on valve shall be notched out sufficiently to provide a snug fit around the valve bonnet and to center valve inside of pipe.
- C. Set, align, and adjust valve box so that lid is level with final grade.

3.03 METER BOXES

- A. Install cast iron meter boxes in accordance with manufacturer's instructions.
- B. Construct concrete meter boxes to dimensions shown on Project Drawings.
- C. Adjust top of meter boxes to conform to cover elevations specified in Paragraph 3.05, Frame and Cover for Meter Vaults, below.
- D. Do not locate under paved areas unless approved by AW Project Manager. Use approved traffic type box with cast iron lid when meter must be located in paved areas.

3.04 METER VAULTS

- A. Construct concrete meter vaults to dimensions shown on Project Drawings. Do not cast in presence of water. Make bottom uniform. Verify lines and grades are correct and compacted subgrade will support loads imposed by vaults.
- B. Precast Meter Vaults:
 - 1. Install precast vaults in accordance with manufacturer's recommendations. Set level on a minimum 3-inch-thick bed of sand conforming to requirements of Utility Backfill Materials Section.
 - 2. Seal lifting holes with cement-sand mortar or non-shrink grout.
- C. Meter Vault Floor Slab:
 - 1. Construct floor slabs of 6-inch-thick reinforced concrete. Slope floor 1/4-inch per foot toward sump. Make sump 12-inches in diameter, or 12-inches square, and 4-inches deep, unless other dimensions are required by Project Drawings. Install dowels at maximum of 18-inches, center-to-center for keying walls to floor slab.
 - 2. Precast floor slab elements may be used for precast vault construction.
- D. Cast-in-Place Meter Vault Walls:
 - 1. Key walls to floor slab and form to dimensions shown on Project Drawings. Minimum wall thickness shall be 6-inches.
 - 2. Cast walls monolithically. One construction joint will be allowed when vault depth exceeds 12-feet.
 - 3. Set frame for cover in concrete.

3.05 FRAME AND COVER FOR METER VAULTS

- A. Set cast iron frame in a mortar bed and adjust elevation of cover as follows:
 - 1. In unpaved areas, set top of meter box or meter vault cover 4 to 6-inches above natural grade.
 - 2. In paved areas, set top of meter box or meter vault cover flush with adjacent concrete.

3.06 BACKFILL

- A. Provide backfill in accordance with Utility Backfill Materials Section and backfill and compact in accordance with Excavation and Backfill for Utilities Section.
- B. Compacted soil and stone shall extend minimum of 6" beyond meter vaults and 3" beyond valve boxes.
- C. Valve boxes shall be supported by bricks all around, where needed.

END OF SECTION 03 48 20

DIVISION 4
MASONRY

**SECTION 04 01 20
MASONRY CLEANING**

PART 1 - GENERAL

1.1 SUMMARY

- A. Work includes cleaning exposed masonry surfaces.

1.2 SUBMITTALS

- A. Submit in accordance with Section 01 33 20 – Submittal Procedures.
- B. Provide a letter stating that Contractor has a minimum of 5 years' experience in this type of masonry cleaning.
- C. Product Data:
1. Manufacturer's instructions, including application rates.
 2. Manufacturer's recommendations for neutralizing rinse after cleaning.
- D. Samples for Verification:
1. Prior to erecting mock-up, procure and clean two samples of each type of masonry used in Work. Cleaned samples shall be submitted to Engineer for review of aesthetics and effectiveness.

1.3 QUALITY ASSURANCE

- A. Qualifications:
1. Manufacturer: Engaged in producing masonry cleaners that have been used for similar applications with successful results for a minimum of five years, and with factory-trained representatives who are available for consultation and site inspection and assistance at no additional cost to the Owner.
 2. Applicator: Trained, approved, and accepted by the cleaning compound manufacturer. Application personnel shall have at least two years of experience with the particular materials being applied.
- B. Mock-ups:
1. Clean an area approximately 10 to 20 square feet or larger as required to demonstrate effectiveness of cleaner on each type of masonry unit used. Upon approval of Engineer, cleaner may be applied to mock-up panels constructed in Section 04800 Reinforced Masonry Assemblies.
 - a. Prepare mock-ups on existing walls under same weather conditions to be expected during remainder of Work.
 - b. Test cleaners and methods on samples of adjacent non-masonry materials for possible adverse reactions. Samples of tested materials shall be available for Engineer's review upon request.

- c. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.
- B. Deliver materials in manufacturer's original, unopened containers, labeled with manufacturer's name, batch number, and type of materials
- C. Store materials in original, unopened containers in compliance with manufacturer's printed instructions.
- D. Do not store in areas where temperature will fall below 20 degrees F or rise above 100 degrees F.

1.5 PROJECT CONDITIONS

- A. Schedule application of products such that temperature and humidity levels conform to manufacturer's requirements during and after application.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. Cleaning solution: Detergent type.
 - a. Diedrich Technologies, Inc.; "202 New Masonry Detergent."
 - b. Elgene; "Florok 700 Masonry Detergent."
 - c. PROSOCO, Inc.; "Sure Klean #600 Detergent."
 - d. Engineer approved equal.
 - 2. Cleaning solution for manganese and vanadium stained masonry:
 - a. Diedrich Technologies, Inc.; "202V Vana-Stop Mew Masonry."
 - b. Elgene "960 Masonry Cleaner."
 - c. PROSOCO "Ferrous Stain Remover."
 - d. Engineer approved equal.

2.2 MATERIALS

- A. Water for Cleaning: Potable
- B. Detergent Type Cleaning Solution:
 - 1. Manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use products expressly approved for intended use by cleaning solution manufacturer and manufacturer of masonry units being cleaned.
 - 2. Cleaner shall be a solution of blended liquid acids, heavily inhibited and emulsified and in combination with special wetting systems.

3. Specific product selection shall be dependent upon substrate as recommended by the cleaning solution manufacturer.
 4. Muratic acid will not be acceptable as a cleaning solution for new masonry.
- C. Cleaning Solution for Manganese or Vanadium Stained Masonry:
1. Manufacturer's standard-strength cleaner designed for removing vanadium, manganese, and other metallic stains without discoloring or damaging masonry surfaces. Use products expressly approved for intended use by cleaning solution manufacturer and manufacturer of masonry units being cleaned.
 2. Cleaner shall be a solution of blended liquid acids, heavily inhibited and emulsified and in combination with special wetting systems.
 3. Specific product selection shall be dependent upon substrate as recommended by the cleaning solution manufacturer.
 4. Muratic acid will not be acceptable as a cleaning solution for new masonry.
- D. Neutralizing rinse: Rinse to be as required by the manufacturer of the cleaners used.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Allow 7 to 28 days after completion of masonry work before start of cleaning.
- B. Protection:
1. Protect surrounding surfaces and installed Work from run-off, overspray, and splashing. Erect temporary protective covers and walkways at points of pedestrian and vehicular entrance and exit that must remain in service during course of cleaning.
 2. Comply with cleaning solution manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent cleaning solutions from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.
 - a. Cover adjacent surfaces with materials that are proven to resist the cleaning solutions used. Use materials that contain only waterproof, UV-resistant adhesives. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. Promptly remove masking after cleaner application to prevent adhesive staining.
 - b. Keep wall wet below area being cleaned to prevent streaking from runoff.
 - c. Do not clean masonry during winds of sufficient force to spread cleaning solutions to unprotected surfaces.
 - d. Dispose of runoff from cleaning operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.
- C. Surface Preparation:
1. Prepare surfaces in strict accordance with manufacturer's printed instructions.
 2. Remove excess mortar using wooden paddles and scrapers. Do not scratch or chip masonry surface.
 3. Point up cracks, other than hairline cracks
 4. Defective mortar joints shall be routed out, pointed with mortar, and tooled.

5. Before beginning general cleaning, remove extraneous substances that are resistant to cleaning methods being used. Extraneous substances include paint, calking, asphalt, and tar.
6. Remove paint and calking with approved alkaline or solvent paint remover.
 - a. Comply with requirements for paint removal
 - b. Repeat application up to two times if needed.
7. Remove asphalt and tar with approved asphalt and tar remover solution.
 - a. Apply only to asphalt and tar by brush without prewetting.
 - b. Allow asphalt and tar remover to remain on surface for 10 to 30 minutes.
 - c. Rinse off with water using low pressure spray.
 - d. Repeat application if needed.

3.2 CLEANER APPLICATION

- A. Apply cleaner in strict accordance with manufacturer's printed instructions.
 1. Do not use wire brushes or brushes that are not resistant to cleaning solution being used.
 2. Use spray equipment that provides controlled application at volume and pressure recommended by manufacturer, measured at spray tip. Adjust pressure and volume to ensure that cleaning methods do not damage masonry.
 3. Cleaning solution application:
 - a. In accordance with manufacturer's instructions, apply cleaning solution to masonry surfaces using brush or spray application methods, at Contractor's option.
 - b. Use low-pressure tank or chemical pump suitable for cleaner indicated, equipped with cone-shaped spray tip.
 - c. Do not spray apply at pressures exceeding 50 psi.
 - d. Do not allow solution to remain on surface for periods longer than those indicated or recommended by manufacturer.
 - e. Reapply cleaner as recommended by manufacturer prior to removing excess mortar.
 4. Water application:
 - a. Water soak application:
 - 1) Soak masonry surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles.
 - 2) Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.
 - b. Spray Applications:
 - 1) Use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.
 - 2) Unless otherwise indicated, hold spray nozzle at least six inches from surface of masonry and apply water in horizontal back and forth weeping motion, overlapping previous strokes to produce uniform coverage.
 5. High-pressure water spray application:
 - a. Use fan-shaped spray tip that disperses water at an angle of at least 40 degrees.

- B. Perform cleaning method indicated in a manner that results in uniform coverage for all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces.
- C. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that cleaning solution is completely removed. Apply neutralizing agent and repeat rinse, if necessary, to produce tested pH of between 6.7 and 7.5.
- D. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

3.3 FINAL CLEANING

- A. Wash adjacent woodwork and other nonmasonry surfaces. Use detergent and soft brushes or cloths.
- B. Clean mortar and debris from roof. Remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.
- C. Sweep and rake adjacent pavement and grounds to remove mortar and debris. Where necessary, pressure wash surfaces to remove mortar, dust, dirt, and stains.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

**SECTION 04 05 12
MORTAR AND GROUT**

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish and install mortar and grout for masonry construction in accordance with Contract Documents.

1.2 RELATED SECTIONS

- A. Section 04 22 00 – Concrete Unit Masonry

1.3 REFERENCES

- A. ASTM International (ASTM) standards, most recent editions:

ASTM C5	Standard Specification for Quicklime for Structural Purposes
ASTM C109	Compressive Strength of Hydraulic Cement Mortars
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C207	Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C270	Standard Specification for Mortar for Unit Masonry
ASTM C404	Standard Specification for Aggregates for Masonry Grout
ASTM C476	Standard Specification for Grout for Masonry
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C1019	Standard Test Method for Sampling and Testing Grout
ASTM E514	Standard Test Method for Water Penetration and Leakage through Masonry

1.4 DEFINITIONS

- A. Coarse grout and fine grout are defined by the aggregate size used in accordance with ASTM C476.
- B. Coarse aggregate and fine aggregate are defined in ASTM C404, Table 1.

1.5 SUBMITTALS

- A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

- B. Submit proposed grout mix design including aggregate data to show conformance to these specifications, including cement data to show conformance to these specifications and ASTM C150. Submit the proposed method of placing grout.
- C. Submit proposed mortar mix design including aggregate data to show conformance to these specifications, including cement data to show conformance to these specifications and ASTM C150.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.
- B. Maintain all materials clean, dry and protected against dampness, freezing and foreign matter.
- C. Store sand only on smooth, well-drained ground free from dust, mud and debris.
- D. Do not use bottom 6 inches of pile in mortar.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. Integral mortar water repellent:
 - a. ACM Chemistries, Inc.: RainBloc.
 - b. BASF/Master Builders; MasterPel 240MA.
 - c. Grace Construction Products; Dry Block.
 - d. Krete Industries, Inc.; Gard Mortar Mix.
 - e. Engineer approved equal.
 - 2. Admixtures for grout
 - a. BASF/Master Builders; Pozzolith.
 - b. Sika Corporation; SikaGrout Aid Type II.
 - c. Engineer approved equal.

2.2 MATERIALS

- A. Blended Hydraulic Cement: Comply with ASTM C595, Type IL (10] (MS)
 - 1. Color
 - a. For CMU: grey color.
 - b. For brick veneer: natural color or white cement as required to produce mortar color indicated.
 - 2. Limestone content is limited to 10 percent.
 - 3. Single brand of cement used throughout Work; brand approved by Engineer.
- B. Mortar Aggregate: ASTM C144, standard masonry type.
- C. Hydrated Lime: ASTM C207, Type S.
- D. Quicklime: ASTM C5, non-hydraulic type.

- E. Grout Aggregate: ASTM C404.
- F. Mixing Water: Potable.
- G. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units that also contain integral water repellent by same manufacturer.
- H. Admixtures for Mortar:
 - 1. Admixtures may be used to obtain the desired or required workability and may be used instead of lime.
 - 2. The admixture shall not be detrimental to bonding characteristics nor increase the efflorescence.
- I. Admixtures for Grout:
 - 1. Admixtures for grout may be used only when approved by Engineer. If used, they shall be used in accordance with the manufacturer's published recommendations and included in the proposed grout mix submittal.
- J. Color: When colored masonry is specified, mortar for use with colored masonry units shall have integral color as approved by Engineer. Color shall match block color.
 - 1. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Davis Colors.
 - b. Lanxess Corporation.
 - c. Solomon Colors, Inc.
- K. Colored Cement Products: Packaged blend made from and mortar pigments, all complying with specified requirements, and containing no other ingredients.
 - 1. Colored Portland Cement-Lime Mix:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Argos USA LLC.
 - 2) Holcim (US) Inc.
 - 3) Lehigh Hanson; HeidelbergCement Group.
 - 2. Colored Masonry Cement:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Argos USA LLC.
 - 2) Cemex S.A.B. de C.V.
 - 3) Holcim (US) Inc.
 - 4) Lafarge North America Inc.
 - 5) Lehigh Hanson; HeidelbergCement Group.
 - 3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
 - 4. Pigments do not exceed 10 percent of portland cement by weight.

5. Pigments do not exceed 5 percent of masonry cement or mortar cement by weight.

2.3 MORTAR MIXES

- A. ASTM C270, Type M or S mortar mix shall be used. Use the Property Method.
- B. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
 1. Do not use calcium chloride in mortar or grout.
 2. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- C. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- D. Whenever a fire-resistance classification or rating is shown for unit masonry construction, provide mortar of type which has been tested and listed by UL for construction indicated.
- E. Thoroughly mix mortar ingredients in quantities needed for immediate use in accordance with ASTM C270.
- F. Mix materials a minimum of 3 minutes.
- G. Do not use masonry cement.
- H. Do not use anti-freeze compounds to lower the freezing point of mortar.
- I. Provide water repellant treated mortar per water repellant manufacturer's recommended rate. When tested as a wall assembly made with CMU containing integral water repellent manufacturer's block additive according to ASTM E514, with test period extended to 24 hours, show no visible water or leaks on the back of the test specimen.
- J. Aggregate for Mortar: ASTM C144.
 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
 4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- K. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with , and recommended by manufacturer for use in masonry mortar of composition indicated.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Euclid Chemical Company (The); an RPM company.
 - b. GCP Applied Technologies Inc.

- L. Water: Potable.
- M. Pigmented Mortar: Use colored cement product.
 - 1. Pigments do not exceed 10 percent of portland cement by weight.
 - 2. Pigments do not exceed 5 percent of masonry cement or mortar cement by weight.
 - 3. Mix to match Architect's sample.
 - 4. Application: Use pigmented mortar for exposed mortar joints with the following units:
 - a. Face brick.
- N. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
 - 1. Mix to match Architect's sample.
 - 2. Application: Use colored-aggregate mortar for exposed mortar joints with the following units:
 - a. Face brick.

2.4 GROUT MIXES

- A. Thoroughly mix mortar ingredients in quantities needed for immediate use in accordance with ASTM C476.
- B. Grout strength: All masonry, 2000 psi strength at 28 days when tested in accordance with ASTM C1019, 8-10 inches slump.
- C. Do not use anti-freeze compounds to lower the freezing point of grout.
- D. Mix materials a minimum of 5 minutes.

2.5 SOURCE QUALITY CONTROL

- A. Perform laboratory test on mortar and grout in accordance with ASTM C109 using the same mix design as proposed for the Work.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Plug cleanout holes with block masonry units to prevent leakage of grout materials. Brace masonry for wet grout pressure.

3.2 INSTALLATION

- A. Install mortar and grout per requirements of Section 04 22 00 – Concrete Unit Masonry.
- B. Use coarse grout in spaces with least dimension over 2 inches.
- C. Use fine grout for grouting door and window frames in masonry.
- D. Remove excess mortar from grout spaces.

E. Work grout into masonry cores and cavities to eliminate voids.

F. Do not displace reinforcement while placing grout.

3.3 FIELD QUALITY CONTROL

A. Field quality control for masonry mortar and grout will be performed in conjunction with masonry prism testing specified in Section 04 22 00 – Concrete Unit Masonry. Separate tests for grout and mortar will not be required.

B. If Mortar begins to stiffen within 2½ hours, it may be retempered by adding water and remixing

C. Do not use mortar after it has begun to set. No mortar shall be used beyond 2½ hours after initial mixing.

D. Use grout within 2 hours after initial mixing. Use no grout after it has begun to set.

END OF SECTION

SECTION 04 21 13
ANCHORED VENEER MASONRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish and install brick, mortar, flashing, and accessories for an anchored veneer system in accordance with the Contract Documents.

1.2 RELATED SECTIONS

- A. Section 04 01 20 Masonry Cleaning
- B. Section 04 05 12 Mortar and Grout
- C. Section 04 22 00 Concrete Unit Masonry
- D. Section 05 50 00 Metal Fabrications
- E. Section 07 92 00 Joint Sealants

1.3 REFERENCES

- A. ASTM International (ASTM) standards, most recent editions:

ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM B370	Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C216	Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)
ASTM D1752	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

1.4 SUBMITTALS

- A. Product Data
1. Submit manufacturer's data sheets for brick and anchors.
- B. Samples for Initial Selection
1. Face brick, in the form of straps of five or more bricks.
 2. Colored mortar.
 3. Weep/cavity vents.

- C. Samples for Verification: For each type and color of the following:
1. Face brick, in the form of straps of five or more bricks
 2. Special brick shapes
 3. Pigmented colored-aggregate mortar. Make amples using same sand and mortar ingredients to be used on Project.
 4. Weep/cavity vents.
 5. Cavity drainage material.
 6. Accessories embedded in masonry.
- D. Certificates
1. Submit manufacturer's certification that the brick units provided meet or exceed the requirements of this Specification.
 2. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 3. For exposed brick, include test report for efflorescence in accordance with ASTM C67/C67M.
 4. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing in accordance with ASTM C67/C67M or a list of addresses of buildings in Project's area where proposed brick has been used successfully and with a history of durability.
 5. Cementitious materials. Include name of manufacturer, brand name, and type.
 6. Grout mixes.
 7. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 8. Anchors, ties, and metal accessories.
- E. Shop Drawings: For the following:
1. Masonry Units: Indicate sizes, profiles, coursing, and locations of special shapes.
 2. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- F. Informational Submittals
1. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.5 QUALITY ASSURANCE

- A. Mock-ups:
1. Erect a 4-foot minimum high by 4-foot minimum long mock-up panel separate from the Work for approval by the Engineer before starting veneer Work. This mock-up may be constructed in conjunction with the mock-up required under Section 04 22 00 Concrete Unit Masonry. Upon its approval, it shall remain at the Site as a standard for reference until all brick Work is completed.
 2. Each sample panel shall include proportionate quantities of required textures and colors of brick materials as specified herein. Construct panel using the selected brick and colored mortar when applicable.
 3. If mock-up panel is not acceptable to Engineer, construct additional panels as required.
 4. All masonry shall conform to the standard of quality established by the Engineer's acceptance of the mock-up panel.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.
- A. Maintain all materials clean, dry and protected against dampness, freezing and foreign matter.
- B. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- E. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- F. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.
- G. Remove and replace all damaged material without additional cost to Owner.

1.7 PROJECT ENVIRONMENTAL REQUIREMENTS

- A. General:
 - 1. Protect masonry from excessive loading during construction. Provide shoring as necessary.
 - 2. At the end of each day, or at shutdown, cover tops of all walls not enclosed or otherwise sheltered to protect masonry from weather.
 - a. Extend cover a minimum of 24 inches down face of veneer, and hold cover securely in place.
- B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry. Immediately remove grout, mortar, and soil that come in contact with masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- C. Temporary Facilities:
 - 1. Construct and maintain temporary protection required to permit continuous and orderly progress of the Work.
 - 2. In cold weather, provide and maintain heat sufficient to assure temperature above 32 degrees F within the protected areas.

3. In hot weather, provide and maintain shade to protect materials and mixing equipment from direct sunlight.
 4. Remove all temporary facilities after completion of the Work.
- D. Cold Weather Construction:
1. Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.
 - a. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
 2. Procedures prior to and during installation:
 - a. Air temperature: 30 to 40 degrees F.
 - 1) Heat mixing water and aggregate to produce mortar temperatures between 40 and 120 degrees F at the time of mixing.
 - b. Air temperature: 25 to 30 degrees F.
 - 1) Heat mixing water and aggregate to produce mortar temperatures between 40 and 120 degrees F at time of mixing.
 - 2) Maintain mortar temperatures above freezing until used.
 - 3) Heat grout water and aggregate to produce grout temperatures between 70 and 120 degrees F at the time of mixing.
 - 4) Maintain grout temperatures above 70 degrees F until placed.
 - c. Air temperature: Below 25 degrees F.
 - 1) Do not place masonry.
 3. Procedures after installation:
 - a. Air temperature: 32 to 40 degrees F.
 - 1) Protect from rain or snow for not less than 24 hours by covering with weather-resistant membrane.
 - b. Air temperature: 25 to 32 degrees F.
 - 1) Completely cover with weather-resistant covering for not less than 48 hours.
 - c. Air temperature: 20 to 25 degrees F.
 - 1) Completely cover with weather-resistant insulating blankets for not less than 48 hours or provide other protection approved by Engineer.
 - d. Air temperature: Below 20 degrees F.
 - 1) Provide enclosed shelters and heating to maintain air temperature on each side of wall above 32 degrees F. for 48 hours.
 - 2) Do not allow rapid drop in temperature after removal of heat.
- E. Hot Weather Construction:
1. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.
 2. Procedures prior to and during installation:
 - a. Air temperature: Above 100 degrees F or above 90 degrees F with a wind velocity greater than 8 mph.
 - 1) Maintain aggregate piles in damp and loose condition.
 - 2) Produce mortar having a temperature below 120 degrees F.
 - 3) Flush mixer, mortar transport container, and mortar boards with cool water before they come into contact with mortar.
 - 4) Retemper mortar with cool water to maintain proper consistency.

- 5) Use mortar within 2 hours of initial mixing.
 - b. Air temperature: Above 115 degrees F or above 105 degrees F with a wind velocity greater than 8 mph.
 - 1) Implement requirements above plus provide shade for materials and mixing equipment to protect from direct sunlight.
 - c. Air temperature: Above 120 degrees F.
 - 1) Do not place masonry.
3. Procedures after installation:
 - a. Air temperature: Above 100 degrees F or above 90 degrees F with a wind velocity greater than 8 mph.
 - 1) Fog spray newly constructed masonry until damp, at least three times each day until the masonry is three days old.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Source Limitations
 1. Obtain exposed masonry units from single source from a single manufacturer for each product required.
 2. For exposed masonry units obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.
- B. Brick Units
 1. Standard Face Brick, modular in size, 2-1/4 inch by 3-5/8 inch by 7 5-8 inch.
 2. Conform to ASTM C216, Grade SW, Type FBX.
 3. Initial Rate of Absorption: Less than 30g/30 squ. In. per minute when tested per ASTM C67.
 4. Efflorescence: Provide a brick that has been tested according to ASTM C 67 and is rated "not effloresced."
 5. Surface Coating: Brick with color or texture produced by application of coatings shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet or shall have a history of successful use in Project's area.
 6. Provide all units with straight-cut edges and square corners unless otherwise shown or specified.
 7. Color: As selected by Contracting Officer from manufacturer's full range.
 - a. Basis of Design: Mutual Materials – Chestnut.

2.2 APPLICATION: USE WHERE BRICK IS EXPOSED UNLESS OTHERWISE INDICATED. ANCHORS AND TIES

- A. Furnish and install as specified in Section 04 22 00 Concrete Unit Masonry.
- B. Zinc coating for veneer ties to comply with ASTM A153.
- C. General: Ties and anchors extend at least 1-1/2 inches into veneer but with at least a 5/8-inch cover on outside face.

- D. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
 2. Stainless Steel Wire: ASTM A580/A580M, .
 3. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
 4. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
- E. Corrugated-Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of 0.06 to 0.10 inch made from 0.0635-inch-thick, steel sheet, galvanized after fabrication.
- F. Adjustable Masonry-Veneer Anchors:
1. General: Provide anchors that allow vertical adjustment but resist a 100 lbf load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch.
 2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.0785-inch-thick steel sheet, galvanized after fabrication.
 3. Fabricate wire ties from 0.187-inch- diameter, hot-dip galvanized steel wire unless otherwise indicated.
 4. Masonry-Veneer Anchors; Vertical Slotted L-Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting vertical leg with slotted hole for wire tie and washer at face of insulation.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) FERO Corporation.
 - 2) Hohmann & Barnard, Inc.
 - 3) Wire-Bond.

G.

2.3 MORTAR

- A. Furnish and install as specified in Section 04 05 12 Mortar and Grout.
- B. Mortar color to match adjacent existing structures as closely as possible.

2.4 SEALANT

- A. Furnish and install sealants as specified in Section 07 92 00 Joint Sealants

2.5 EMBEDDED FLASHING

- A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
1. Copper: ASTM B370, Temper H00, cold-rolled copper sheet, 16 oz./sq. ft. weight or 0.0216 inch thick.
 2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 ft.. Provide splice plates at joints of formed, smooth metal flashing.

3. Fabricate through-wall metal flashing embedded in masonry from copper, with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cheney Flashing Company.
 - 2) Hohmann & Barnard, Inc.
 - 3) Keystone Flashing Company, Inc.
 4. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
 5. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees.
 6. Fabricate through-wall flashing with sealant stop unless otherwise indicated. Fabricate by bending metal back on itself 3/4 inch at exterior face of wall and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
 7. Fabricate metal drip edges and sealant stops for sawtooth metal flashing from plain metal flashing of same metal as sawtooth flashing and extending at least 3 inches into wall with hemmed inner edge to receive sawtooth flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.
 8. Fabricate metal drip edges from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees.
 9. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
 10. Fabricate metal expansion-joint strips from copper to shapes indicated.
 11. Solder metal items at corners.
- B. Flexible Flashing: Use one of the following unless otherwise indicated:
1. Copper Fabric Flashing: 7 oz./sq. ft. copper sheet bonded between two layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Advanced Building Products Inc.
 - 2) Hohmann & Barnard, Inc.
 - 3) Wire-Bond.
 - 4) York Manufacturing, Inc.
 2. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 30 mil.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Advanced Building Products Inc.
 - 2) Carlisle Coatings & Waterproofing Inc.
 - 3) Heckmann Building Products, Inc.
 - 4) Hohmann & Barnard, Inc.
 - 5) W.R. Meadows, Inc.
 - b. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

3. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hohmann & Barnard, Inc.
 - 2) Hyload, Inc.
 - 3) Mortar Net Solutions.
 - b. Monolithic Sheet: Elastomeric thermoplastic flashing, 40 mil thick.
 - c. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, 25 mil thick, with a 15-mil- thick coating of adhesive.
 - 1) Color: Gray.
 - d. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.
4. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D4637/D4637M, 40 mil thick.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Carlisle Coatings & Waterproofing Inc.
 - 2) Firestone Specialty Products.
 - 3) Heckmann Building Products, Inc.
 - 4) Hohmann & Barnard, Inc.
 - 5) Wire-Bond.
- C. Solder and Sealants for Sheet Metal Flashings: As specified in Division 07 Section "Sheet Metal Flashing and Trim."
 1. Solder for Copper: ASTM B32, Grade Sn50.
 2. Elastomeric Sealant: ASTM C920, chemically curing urethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.
- D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.6

2.7 ACCESSORIES

- A. Weep/Vent Products: Use one of the following unless otherwise indicated:
 1. Wicking Material: Absorbent rope, made from cotton, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch exposure on exterior and 18 inches in cavity. Use only for weeps.
 2. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Advanced Building Products Inc.

- 2) Heckmann Building Products, Inc.
 - 3) Hohmann & Barnard, Inc.
 3. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) CavClear/Archovations, Inc.
 - 2) Hohmann & Barnard, Inc.
 - 3) Keene Building Products.
 - 4) Mortar Net Solutions.
 4. Vinyl Weep Hole/Vent: Units made from flexible PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color selected by Architect.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hohmann & Barnard, Inc.
 - 2) Williams Products, Inc.
 - 3) Wire-Bond.
 - b.
- B. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
- a. Mortar Deflector: Strips, full depth of cavity and 10 inches high, with dimpled surface that prevent clogging with mortar droppings. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Advanced Building Products Inc.
 - 2) Hohmann & Barnard, Inc.
 - 3) Keene Building Products.
 - 4) Mortar Net Solutions.
- C. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene PVC. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Diedrich Technologies, Inc.; a Hohmann & Barnard company.
 - b. EaCo Chem, Inc.
 - c. PROSOCO, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- B. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- C. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
 - 1. Mix units from several pallets or cubes as they are placed.
- D. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.
- E. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested in accordance with ASTM C67/C67M. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

- A. Dimensions and Locations of Elements:
 - 1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
 - 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
 - 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.
- B. Lines and Levels:
 - 1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 ft., or 1/2-inch maximum.
 - 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.
 - 3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch maximum.

4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.
 5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch maximum.
 6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 ft., or 1/2-inch maximum.
 7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
- C. Joints:
1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
 2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
 3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
 4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
 5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.4 LAYING AND SETTING BRICK

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- C. Fill all joints solidly with mortar. Provide tooled concave mortar joints unless otherwise specified or noted on the drawings. Perform tooling when the mortar is partially set but still sufficiently plastic to bond.
- D. Lay units plumb, level, and true to line with accurately spaced level courses. Vertical joints shall fall on the centerline of unit below.
- E. Provide veneer ties with at least 5/8 inch of mortar coverage from exterior surface to prevent corrosion.

3.5 STOPPING AND RESUMING WORK: STOP WORK BY STEPPING BACK UNITS IN EACH COURSE FROM THOSE IN COURSE BELOW; DO NOT TOOTH. WHEN RESUMING WORK, CLEAN MASONRY SURFACES THAT ARE TO RECEIVE MORTAR, REMOVE LOOSE MASONRY UNITS

AND MORTAR, AND WET BRICK IF REQUIRED BEFORE LAYING FRESH MASONRY. MORTAR
BEDDING AND JOINTING

- A. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- B. Lay hollow brick with face shells fully bedded in mortar and with head joints of depth equal to bed joints. At starting course, fully bed entire units, including area under cells.
 - 1. At anchors and ties, fully bed units and fill cells with mortar as needed to fully embed anchors and ties in mortar.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 ANCHORED MASONRY VENEERS

- A. Anchor masonry veneers to masonry backup with masonry-veneer anchors to comply with the following requirements:
 - 1. Fasten screw-attached anchors to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 - 2. Embed tie sections in masonry joints.
 - 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 - 4. Space anchors as indicated, but not more than 18 inches o.c. vertically and 24 inches o.c. horizontally, with not less than one anchor for each 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches, around perimeter.
 - 5. Space anchors as indicated, but not more than 16 inches o.c. vertically and 25 inches o.c. horizontally, with not less than one anchor for each [2.67 sq. ft.] [3.5 sq. ft.] of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.
 - 6. Space anchors as indicated, but not more than 18 inches o.c. vertically and horizontally. Install additional anchors within 12 inches of openings and at intervals, not exceeding 24 inches, around perimeter.
- B. Provide not less than 1 inch of airspace between back of masonry veneer and face of insulation.
 - 1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

3.7 EXPANSION JOINTS

- A. General: Install expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form expansion joints as follows:

1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
 2. Build flanges of factory-fabricated, expansion-joint units into masonry.
 3. Build in compressible joint fillers where indicated.
 4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 07 92 00 Joint Sealants.
- C. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 07 92 00 Joint Sealants, but not less than 3/8 inch.
1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.8 LINTELS

- A. Install steel lintels where indicated.
- B. Provide offset angle supports where indicate and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are indicated without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.9 FLASHINGS, WEEP HOLES, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows unless otherwise indicated:
1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 2. Extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under lapping at least 4 inches.
 3. At lintels and shelf angles, extend flashing 6 inches minimum, to edge of next full unit at each end. At heads and sills, extend flashing 6 inches minimum, to edge of next full unit and turn ends up not less than 2 inches to form end dams.
 4. Interlock end joints of sawtooth sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 5. Install metal drip edges and sealant stops with sawtooth sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 07 92 00 Joint Sealants for application indicated.

6. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
 7. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
 8. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install reglets and nailers for flashing and other related construction where they are indicated to be built into masonry.
- D. Install weep holes in veneers in head joints of first course of masonry immediately above embedded flashing.
1. Use specified weep/cavity vent products to form weep holes.
 2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
 3. Space weep holes 24 inches o.c. unless otherwise indicated.
 4. Trim wicking material flush with outside face of wall after mortar has set.
- E. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Accessories" Article.
- F. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form vents.
1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.10 CONTROL JOINTS

- A. Provide expansion joints in brick veneer at the same locations they occur in substrate construction or as shown on the Drawings. Provide compressible joint filler and sealant as detailed on the Drawings.

3.11 OPENINGS AND HOLES

- A. Provide all openings and holes in masonry Work. Provide all chases and recesses in masonry Work of all types as indicated on the Drawings and as required for pipes, ducts, louvers, and other work of mechanical and electrical contractors. Accurately locate all such Work located by contractor requiring the Work, but masonry Work shall not be constructed without giving other contractors due notice and opportunity to lay-out and install such items as may be required for their Work.
- B. Where required for installation of Work by others, leave openings as indicated on the Drawings or as required to receive a later installation.
- C. After Work of others is in place, neatly fill openings with masonry of the same type as in the adjoining surfaces.

3.12 SEALING

- A. Upon completion of the cleaning operation, and upon approval of Engineer, apply water repellent as specified in Section 07 19 00 Water Repellents

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements will be at Contractor's expense.
- B. Inspections: Special inspections in accordance with Level 2 in TMS 402.
 - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
- C. Testing Prior to Construction: One set of tests.
- D. Clay Masonry Unit Test: For each type of unit provided, in accordance with ASTM C67/C67M for compressive strength.
- E. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.

3.14 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.

5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

3.15 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 1. Crush masonry waste to less than 4 inches in each dimension.
 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
 3. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION

**SECTION 04 22 00
CONCRETE MASONRY UNIT**

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish and install concrete masonry in accordance with Contract Documents.
- B. Work shall include installation of ties, spacers, supports and other appurtenances necessary to meet Specifications and produce finished masonry structures.

1.2 RELATED SECTIONS

- A. Section 03 30 53 – Miscellaneous Cast In Place Concrete.
- B. Section 04 05 12 – Mortar and Grout.
- C. Section 04 01 20 – Masonry Cleaning.
- D. Section 07 92 00 – Joint Sealants.

1.3 REFERENCES

- A. American Concrete Institute (ACI) standards, most recent editions.

ACI SP-66	ACI Detailing Manual
-----------	----------------------

ACI 530	Building Code Requirements for Masonry Structures
---------	---

- B. ASTM International (ASTM) standards, most recent editions:

ASTM A36	Standard Specification for Carbon Structural Steel
----------	--

ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
-----------	--

ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
-----------	--

ASTM C55	Concrete Building Brick
----------	-------------------------

ASTM C90	Loadbearing Concrete Masonry Units
----------	------------------------------------

ASTM C140	Sampling and Testing Concrete Masonry Units and Related Units
-----------	---

ASTM A951	Standard Specification for Steel Wire for Masonry Joint Reinforcement
-----------	---

- | | |
|------------|--|
| ASTM A1064 | Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete |
| ASTM C1314 | Standard Test Method for Compressive Strength of Masonry Prisms |
| ASTM D1056 | Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber |
| ASTM D1752 | Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction |
| ASTM D2000 | Standard Classification System for Rubber Products in Automotive Applications |
| ASTM D2240 | Standard Test Method for Rubber Property—Durometer Hardness |
| ASTM E514 | Standard Test Method for Water Penetration and Leakage Through Masonry |
- C. International Code Council (ICC)
- | | |
|-----|---|
| IBC | International Building Code, 2012 edition |
|-----|---|
- D. Underwriters Laboratories Inc. (UL):
- Building Materials Directory
- 1.4 SYSTEM DESCRIPTION
- A. Provide masonry with a compressive strength, f'_m , of 2000 psi minimum at 28 days of age.
- 1.5 SUBMITTALS
- A. Submit in accordance with Section 01 33 20 – Submittal Procedures.
- B. Product Data
1. Submit masonry accessory product data.
- C. Shop Drawings: Include, but not limit to, the following:
1. Complete bar schedule, bar details and erection drawings to conform to ACI SP-66.
 2. Each type of bar marked with identification corresponding to identification tag on bar.
 3. Length, type, and location of all splices.
 4. Erection drawings shall be clear, easily legible and to a minimum scale of:
 - a. 1/4 inch = 1 foot.
 - b. 1/8 inch = 1 foot if bars in each face are shown in separate views.
 5. Size and location of openings.
 6. Contract Documents shall not be used as erection drawings.
- D. Samples
- BC&A

AMERICAN WATER

JBLM

CONCRETE MASONRY UNIT

PAGE 04 22 00 - 2

1. Submit samples of concrete masonry unit colors with texture ranges for selection of color. Full size samples of the blocks selected shall be submitted for final approval by Engineer after color selection, if requested. If the material specified is a colored and textured unit, the samples submitted shall be colored and textured units. Samples of mortar colors shall be submitted for color selection by Engineer.

E. Test Reports

1. Submit test reports from testing proposed concrete block masonry units showing compliance with ASTM C90 and IBC Table 2105.2.2.1.2, including aggregate data to show conformance to these specifications and cement data to show conformance to ASTM C 150.
2. Submit test reports from testing masonry prisms.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements

1. Concrete masonry shall conform to the International Building Code and ACI 530 (ASCE 5) and other applicable codes and standards of the governing authorities.

B. Mock-ups:

1. Erect an 8-foot minimum high by 16-foot minimum long mock-up panel separate from the Work for approval by Engineer before starting masonry Work. Upon its approval, it shall remain at the Site as a standard for reference until all masonry Work is completed.
2. Each sample panel shall include proportionate quantities of required textures and colors of masonry materials as specified herein, and shall include one inside corner, one outside corner, and one 4-foot by 4-foot penetration. The selected colored mortar shall be used when applicable.
3. If mock-up panel is not acceptable to Engineer, construct additional panels as required.
4. All masonry shall conform to the standard of quality established by Engineer's acceptance of the mock-up panel.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.
- B. Maintain all materials clean, dry and protected against dampness, freezing and foreign matter.
- C. Store masonry units on pallets and protect from contamination and staining. Keep masonry units covered at all times.

1.8 PROJECT ENVIRONMENTAL REQUIREMENTS

A. General:

1. Protect masonry from excessive loading during construction. Provide shoring as necessary.
2. At the end of each day, or at shutdown, cover tops of all walls not enclosed or otherwise sheltered to protect masonry from weather.

- B. Temporary Facilities:
1. Construct and maintain temporary protection required to permit continuous and orderly progress of the Work.
 2. In cold weather, provide and maintain heat sufficient to assure temperature above 32 degrees F within the protected areas.
 3. In hot weather, provide and maintain shade to protect materials and mixing equipment from direct sunlight.
 4. Remove all temporary facilities after completion of the Work.
- C. Cold Weather Construction:
1. Procedures prior to and during installation:
 - a. Air temperature: 30 to 40 degrees F.
 - 1) Heat mixing water and aggregate to produce mortar temperatures between 40 and 120 degrees F at the time of mixing.
 - b. Air temperature: 25 to 30 degrees F.
 - 1) Heat mixing water and aggregate to produce mortar temperatures between 40 and 120 degrees F at time of mixing.
 - 2) Maintain mortar temperatures above freezing until used.
 - 3) Heat grout water and aggregate to produce grout temperatures between 70 and 120 degrees F at the time of mixing.
 - 4) Maintain grout temperatures above 70 degrees F until placed.
 - c. Air temperature: Below 25 degrees F.
 - 1) Do not place masonry.
 2. Procedures after installation:
 - a. Air temperature: 32 to 40 degrees F.
 - 1) Protect from rain or snow for not less than 24 hours by covering with weather-resistant membrane.
 - b. Air temperature: 25 to 32 degrees F.
 - 1) Completely cover with weather-resistant covering for not less than 48 hours.
 - c. Air temperature: 20 to 25 degrees F.
 - 1) Completely cover with weather-resistant insulating blankets for not less than 48 hours or provide other protection approved by Engineer.
 - d. Air temperature: Below 20 degrees F.
 - 1) Provide enclosed shelters and heating to maintain air temperature on each side of wall above 32 degrees F. for 48 hours.
 - 2) Do not allow rapid drop in temperature after removal of heat.
- D. Hot Weather Construction:
1. Procedures prior to and during installation:
 - a. Air temperature: Above 100 degrees F or above 90 degrees F with a wind velocity greater than 8 mph.
 - 1) Maintain aggregate piles in damp and loose condition.
 - 2) Produce mortar having a temperature below 120 degrees F.
 - 3) Flush mixer, mortar transport container, and mortar boards with cool water before they come into contact with mortar.
 - 4) Retemper mortar with cool water to maintain proper consistency.
 - 5) Use mortar within 2 hours of initial mixing.
 - b. Air temperature: Above 115 degrees F or above 105 degrees F with a wind velocity greater than 8 mph.

- 1) Implement requirements above plus provide shade for materials and mixing equipment to protect from direct sunlight.
- c. Air temperature: Above 120 degrees F.
 - 1) Do not place masonry.
2. Procedures after installation:
 - a. Air temperature: Above 100 degrees F or above 90 degrees F with a wind velocity greater than 8 mph.
 - 1) Fog spray newly constructed masonry until damp, at least three times each day until the masonry is three days old.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 1. Integral masonry water repellent:
 - a. ACM Chemistries, Inc.; RainBloc.
 - b. BASF/Master Builders; MasterPel 240.
 - c. Grace Construction Products; Dry Block.
 - d. Krete Industries, Inc.; Krete HQ (S) Plus
 - e. Engineer approved equal.
 2. Masonry accessories and horizontal joint reinforcing:
 - a. AA Wire Products Co.
 - b. Dayton Superior; Dur-O-Wall.
 - c. Heckman Building Products, Inc.
 - d. Hohmann & Barnard, Inc.
 - e. Engineer approved equal.

2.2 MATERIALS

- A. Hollow Load Bearing Concrete Masonry Unit (CMU): ASTM C90, medium weight, color and face as shown on Drawings.
 1. Sizes and shapes as indicated on Drawings or as required for conditions.
 2. Face shell and web thickness: ASTM C90, Table 1.
 3. Water Absorption: ASTM C90, Table 2.
 4. Fire resistive units: UL rated.
 5. Special shapes and faces:
 - a. Closed cell bond beam units over openings.
 - b. Deep knock-out blocks for bond beams in field of the wall.
 - c. Sash units for control joints
 - d. Architectural faces as shown on the Drawings.
- B. Concrete Brick Units:
 1. ASTM C55, of same type and weight as Hollow Load Bearing CMU.
- C. Integral Water Repellent: Provide units made with liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water

repellent manufacturer's mortar additive according to ASTM E514, with test period extended to 24 hours, show no visible water or leaks on the back of the test specimen.

- D. Mortar and Grout: Refer to Section 04 05 12 – Mortar and Grout.
- E. Steel Reinforcement: Refer to Section 03 20 00 – Concrete Reinforcing, and as indicated on Drawings.
- F. Joint Reinforcement: ASTM A951: Welded-wire units prefabricated with deformed continuous side rods and plain cross rods in straight lengths of not less than 10 feet, with prefabricated corner and tee units, and complying with the requirements indicated below:
 - 1. Materials and Finishes:
 - a. Galvanized: ASTM A1064
 - 2. Width: Fabricate joint reinforcement in units with widths a minimum of 2" less than nominal width of walls. Provide mortar coverage over joint reinforcement of not less than 5/8" on joint faces exposed to exterior and 1/2" elsewhere.
 - 3. Wire Size for Side and Cross Rods:
 - a. 9 ga. diameter for both side rods and cross rods
 - 4. For single-wythe masonry provide ladder type with single pair of side rods and cross wires reinforcement spaced no more than 16 inches o.c. horizontally.
- G. Sealants: Refer to Section 07 92 00 – Joint Sealants.
- H. Bond Breaker Strips: 15-pound asphalt saturated felt.
- I. Compressible Joint Filler:
 - 1. Oversized 50 percent to joint width.
 - 2. Closed Cell foam confirming to ASTM D1752, Type I.
- J. Back-up Rod:
 - 1. 30 to 50 percent larger than joint width.
 - 2. Conform to ASTM D1056, round, closed cell foam.
- K. Control Joints:
 - 1. Solid rubber section 5/8 inch thick with 5/16 inch flange conforming to ASTM D2000.
 - 2. Durometer hardness of 80 when tested in accordance with ASTM D2240.
 - 3. Fit neatly, without forcing, in masonry jamb sash grooves.
- L. Embedded Flashing Materials: Reinforced plastic flashing of manufacturer's standard composite plastic flashing as described below.
 - 1. Metal foil, 0.33 mil thick, encapsulated between polyester film and bonded to fiberglass scrim reinforcement, with a total thickness of 7 mil, Dur-O-Wal, "FiberWeb 300", or equal.
 - 2. Joint tape: Reinforced plastic flashing manufacturer's standard polyester tape, 2 inches (50 mm) wide by 2.0 mils thick.
 - 3. Application: Use where flashing is fully concealed in masonry.
 - 4. Adhesive for flashings: Of type recommended by manufacturer of flashing material for use indicated.
- M. Steel Lintels, Shelf Angles, and Miscellaneous Steel Shapes:

1. Steel shapes used in masonry construction shall conform to ASTM A36. Lintels and shelf angles shall be provided when shown on the Drawings. These steel members shall be hot-dip galvanized in accordance with ASTM A123.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that anchors and flashings are correct and in proper location for roughing into masonry work. Beginning of installation means that mason accepts existing conditions.
- B. Lay out walls in advance for uniform and accurate spacing of bond patterns and joints. Properly locate openings, embedded items, movement type joints, returns, and offsets.
- C. Verify that built-in items are in proper location and ready for roughing into masonry work.
- D. Provide temporary bracing during installation of masonry work as required. Maintain in place until building structure provides permanent bracing for the walls.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. General:
 1. Build walls to thickness indicated on Drawings.
 2. Build single-wythe walls to actual thickness of masonry units.
 3. Build in flashing, reinforcing, weeps, and related items.
 4. Perform all cutting with masonry saws.
 5. Drill holes with power drills when required for piping, conduit, etc.
 6. Install all block in running bond. Protect from displacement.
 7. Cut as required to maintain bond pattern.
 8. Avoid use of less than half-size units, whenever possible.
 9. Do not use chipped, cracked, spalled, stained, or otherwise imperfect units exposed in finish work.
 10. Build chases and recesses as indicated and required for work of other trades. Provide not less than 8 inches of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.
- C. Concrete Masonry Lintels and Sills:
 1. For openings which do not show precast concrete or steel lintels, use concrete masonry lintel units and reinforced concrete fill as shown on Drawings.
- D. Laying and Tooling:
 1. Lay masonry units with face shells in completely filled bed and head joints.
 - a. Butter ends with sufficient mortar to fill head joints and shove into place.
 - b. Do not slush head joints.
 2. Head joints in lintels shall be mortared solid for full thickness of the wall.
 3. Maintain nominal 3/8 inch joint widths.
 - a. Tool all joints concave.

- b. During tooling of joints, enlarge any voids or holes and completely fill with mortar.
 - 4. Point-up all joints at corners, openings, and adjacent work to provide neat and uniform appearance.
 - 5. Remove any masonry that is disturbed after laying.
 - a. Clean and relay in fresh mortar.
 - b. Do not pound units to fit.
 - c. If adjustments are required, remove units, clean, and reset in fresh mortar.
 - 6. Toothing of masonry units will not be permitted.
 - 7. Where work is stopped and later resumed, rack back 1/2 masonry unit length in each course.
 - a. Remove loose units and mortar prior to laying fresh masonry.
 - 8. As work progresses, build in items indicated on Drawings and specified.
 - a. Fill in solidly with mortar around built-in items.
 - b. Grout-fill space between door frames and masonry.
- E. Reinforcing:
 - 1. Provide continuous horizontal joint reinforcing where indicated on Drawings.
 - a. Embed longitudinal side rods in mortar for entire length with minimum cover of 5/8 inch on exterior side of walls and 1/2" at other locations.
 - b. Lap reinforcement minimum 12 inches at ends.
 - c. Do not bridge control and expansion joints with joint reinforcing.
 - d. Make corners and wall intersections by use of prefabricated "L" and "T" sections.
 - e. Cut and bend as required.
 - f. Install joint reinforcing at 16 inches on center vertically unless noted otherwise on Drawings.
 - g. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 24-inches each side of opening, unless otherwise shown on Drawings.
 - 2. Install vertical and horizontal reinforcing bars where indicated on Drawings.
 - a. Support and secure reinforcing bars from displacement.
 - 1) Retain vertical reinforcement in position at top and bottom of each bar and at intervals not exceeding 160 bar diameters.
 - b. Unless otherwise shown on the Drawings, the reinforcing bars shall be located as follows:
 - 1) Single vertical bar; centered in cell.
 - 2) Double vertical bars; 2-3/4 inches from face of masonry.
 - 3) Horizontal bars; 4 inches above the bottom of the masonry unit.
 - c. Reinforce horizontal bond beams with 2-#4 bars unless otherwise shown on the Drawings.
 - d. Lap splices a minimum of 54 bar diameters unless otherwise shown on the Drawings.
 - 3. Bar clearances:
 - a. The clear distance between the surface of a bar and any surface of a masonry unit shall not be less than 1/4-inch for fine grout and 1/2-inch for coarse grout. Cross webs of hollow units may be used as support for horizontal reinforcement. All reinforcing bars, except joint reinforcing, shall be completely embedded in mortar or grout and have a minimum cover, including the masonry unit, of at least 3/4-inch when not exposed to weather

or soil, 1½-inches of cover when exposed to weather, and 2-inches of cover when exposed to soil.

F. Horizontal Joint Reinforcement:

1. Provide continuous horizontal joint reinforcement as indicated. Install longitudinal side rods in mortar for their entire length with a minimum cover of 5/8" on exterior side of walls, 1/2" elsewhere. Lap reinforcing a minimum of 12" at splices.
2. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
3. Reinforce walls with continuous horizontal joint reinforcing unless specifically noted to be omitted.
4. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures and other special conditions.
5. Space continuous horizontal reinforcement as follows:
 - a. For single-wythe walls, space reinforcement at 16" o.c. vertically, unless otherwise indicated.
 - b. Reinforce masonry openings greater than 1'-0" wide, with horizontal joint reinforcement placed in two horizontal joints approximately 8" apart, immediately above the lintel and immediately below the sill. Extend reinforcement a minimum of 2'-0" beyond jambs of the opening except at control joints. Horizontal joint reinforcement interrupted by the jamb of an opening shall have the cross rod or side rod bent and hooked at the jamb.
 - c. Provide reinforcement at openings in addition to other specified wall reinforcement.

G. Grout Placement:

1. For masonry grout lifts 4 feet and higher, cure all masonry for a minimum of 24 hours after placement before beginning grouting operations. Grout lifts less than 4 feet may be placed immediately after setting masonry.
2. Grout spaces less than 2 inches in width with fine grout using low lift grouting techniques.
3. Grout spaces 2 inches or greater in width with coarse grout using high or low lift grouting techniques.
4. When grouting is stopped for more than one hour, terminate grout 1-1/2 inch below top of upper masonry unit to form a positive key for subsequent grout placement.
5. Low lift grouting:
 - a. Place first lift of grout to a height of 16 inches and rod for grout consolidation.
 - b. Place subsequent lifts in 8 inch increments and rod for grout consolidation.
6. High lift grouting:
 - a. Clean out masonry cells and cavities.
 - b. Pump grout into spaces. Maintain water content in grout to intended slump without aggregate segregation.
 - c. Limit grout lift to 48 inches and vibrate or rod for grout consolidation.
 - d. Wait 60 minutes before placing next lift.
7. Fill all cells and cavities for solid grout construction.

H. Lintels, Control Joints, and Sealants.

1. Provide vertical expansion, control, and isolation joints where indicated on the Drawings.

2. Refer to Section 07 92 00 – Joint Sealants, for sealant installation requirements.
 - a. Seal all control and expansion joints.
 - b. Provide reinforced masonry lintels whenever openings more than 12 inches wide are indicated on the Drawings without other structural support or other supporting lintels.
 - 1) Allow masonry lintels to attain specified strength before removing temporary supports.

3.3 SITE TOLERANCES

- A. Maximum variation from plumb in vertical lines and surfaces of columns, walls, and arises:
 1. 1/4 inch in 10 feet.
 2. 3/8 inch in a story height not to exceed 20 feet.
 3. 1/2 inch in 40 feet or more.
- B. Maximum variation from plumb for external corners, expansion joints, and other conspicuous lines:
 1. 1/4 inch in any story or 20 feet maximum.
 2. 1/2 inch in 40 feet or more.
- C. Maximum variation from level of grades for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:
 1. 1/4 inch in any bay or 20 feet.
 2. 1/2 inch in 40 feet or more.
- D. Maximum variation from plan location of related portions of columns, walls, and partitions:
 1. 1/2 inch in any bay or 20 feet.
 2. 3/4 inch in 40 feet or more.
- E. Maximum variation in cross-sectional dimensions of columns and thicknesses of walls from dimensions shown on the Drawings:
 1. Minus 1/4 inch.
 2. Plus 1/2 inch.

3.4 FIELD QUALITY CONTROL

- A. Inspection:
 1. Masonry construction shall be inspected by a Special Inspector selected by Engineer and approved by the local Building Official having jurisdiction. Items subject to Special Inspection shall be inspected in accordance with Chapter 17 of the International Building Code (IBC) at the specific frequency listed on the Drawings. The Special Inspector shall work under the direct supervision of Engineer. All costs of such inspection will be borne by Owner.
 2. The Special Inspector will observe the Work for conformance with the design drawings and specifications in accordance with Paragraph 1705.4 of the IBC.
- B. Site Tests:
 1. Concrete block masonry units shall be sampled and tested in accordance with ASTM C140.
 - a. Provide test results minimum of 5 days prior to start of masonry construction.
 - b. Remove CMU immediately from site if CMU fails test requirements.

2. Testing of masonry prisms:
 - a. Testing of Masonry Prisms: Engineer shall have masonry prisms tested to assure compliance with the Specifications and the governing codes by a recognized testing laboratory.
 - 1) Tests shall be made in accordance with IBC Section 2105 at the following times:
 - a) At the time of the construction of the sample panel, at least 5 masonry prisms shall be made for each type of block indicated herein; except, separate prisms are not required for block which only varies by texture.
 - b) At any change in materials during construction, at least 5 masonry prisms shall be made for each type of block affected.
 - c) Minimum of one set of at least 5 masonry prisms shall be made for each masonry structure, besides the structure that the sample panel is part of, or for each week in which block is laid, for each type of block involved; whichever occurs first.
 - d) Additional sets of at least 5 masonry prisms may be required whenever, in the judgment of Engineer, additional tests are necessary to determine the quality of the materials.
 - 2) The prisms shall be constructed by Contractor in the presence of Engineer or Engineer's representative. The same personnel who are laying the block in the structure shall construct the masonry prism.
 - 3) The masonry prisms shall be constructed and tested as specified in ASTM C1314. The prism shall be grouted after the required 24 hour minimum cure period, using the same grout used in the walls.
 - 4) Compression tests made on sets of specimens made during construction shall include 2 prisms tested at 7 days after grouting and 3 prisms tested at 28 days after grouting.
 - 5) The average compressive strength of prisms tested at 28 days after grouting, shall not be less than the specified masonry compressive strength.
3. Corrective Actions: If the compressive strength of the prisms, made during construction of the sample panel and tested as indicated, fails to meet or exceed the strength required, adjustments shall be made to the mix designs for the mortar, or grout, or both, as needed to produce the specified strength. The masonry units shall also be retested to verify compliance to the requirements of ASTM C 90.
4. If the compressive strength of the prism, made during construction and tested as indicated, fails to meet or exceed that required, prisms or cores shall be cut from the walls constructed in sufficient numbers and in sufficient locations to adequately determine the strength of the walls in accordance with IBC Section 2105. Those portions of the walls represented by specimens failing to meet the required compressive strength are subject to being removed and replaced. Corrective actions as indicated above shall be taken.
5. The costs of tests and test reports except for additional tests requested by Engineer shall be paid by Owner. The costs of the additional tests and reports, when reports verify compliance with the Contract Documents will also be paid by Owner. When tests or reports do not verify compliance, the cost of all additional tests and reports shall be paid by Contractor at no increased cost to Owner.
6. Test samples shall be stored in a moist environment until tested, unless directed otherwise by Engineer or the testing laboratory.

3.5 PROTECTION

- A. Protect the exposed faces of the masonry from staining by mortar, grout, weather, or other conditions and materials.
- B. When moisture protection is required, use light fog spray nozzles to cure mortar.
- C. Protect tops of walls at all times. Cover tops of walls with waterproof paper when rain is imminent and when Work is discontinued.
- D. Adequately brace walls until walls and roof are completed. Below grade walls shall not be backfilled until top decks and roofs are in place
- E. Provide sufficient bracing to protect walls against damage from elements, including wind and rain.
- F. Protect masonry against freezing for a minimum of 72 hours after being laid.
- G. Protect masonry from damage until final acceptance of Work. Damaged units will not be accepted.

3.6 CLEANING

- A. Clean masonry in accordance with section 04 01 20 Masonry Cleaning.

END OF SECTION

**SECTION 042613
MASONRY VENEER**

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Face Brick.
2. Mortar materials.
3. Ties and anchors.
4. Embedded flashing.
5. Accessories.
6. Mortar mixes.

B. Products Installed but not Furnished under This Section:

1. Cast-stone trim in masonry veneer.
2. Stone trim units in unit masonry.
3. Steel lintels in masonry veneer.
4. Steel shelf angles for supporting masonry veneer.

1.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For the following:

1. Masonry Units: Indicate sizes, profiles, coursing, and locations of special shapes.
2. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection:

1. Face brick, in the form of straps of five or more bricks.
2. Colored mortar.
3. Weep/cavity vents.

D. Samples for Verification: For each type and color of the following:

1. Face brick, in the form of straps of five or more bricks.
2. Special brick shapes.
3. Pigmented colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.
4. Weep/cavity vents.
5. Cavity drainage material.
6. Accessories embedded in masonry.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of the following:

1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 - c. For exposed brick, include test report for efflorescence in accordance with ASTM C67/C67M.
 - d. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing in accordance with ASTM C67/C67M or a list of addresses of buildings in Project's area where proposed brick has been used successfully and with a history of durability.
2. Cementitious materials. Include name of manufacturer, brand name, and type.
3. Grout mixes.
4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
5. Anchors, ties, and metal accessories.

B. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.6 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of veneer, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down face of veneer, and hold cover securely in place.
- B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry. Immediately remove grout, mortar, and soil that come in contact with masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain exposed masonry units from single source from a single manufacturer for each product required.

- B. For exposed masonry units obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 BRICK

- A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units.

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including corners, movement joints, bond beams, sashes, and lintels.
3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

- B. Face Brick: Facing brick complying with ASTM C 216

1. Grade: SW.
2. Type: FBX.
3. Initial Rate of Absorption: Less than 30g/30 sq. in. per minute when tested per ASTM C 67.
4. Efflorescence: Provide a brick that has been tested according to ASTM C 67 and is rated "not effloresced."
5. Surface Coating: Brick with color or texture produced by application of coatings shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet or shall have a history of successful use in Project's area.
6. Size (Actual Dimensions): Modular, 3 5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long.
7. Application: Use where brick is exposed unless otherwise indicated.
8. Color: As selected by Contracting Officer from manufacturer's full range.
 - a. Basis of Design: Mutual Materials - Chestnut.

2.3 MORTAR MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Masonry Cement: ASTM C91/C91M.

- D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Davis Colors.
 - b. Lanxess Corporation.
 - c. Solomon Colors, Inc.
- E. Colored Cement Products: Packaged blend made from and mortar pigments, all complying with specified requirements, and containing no other ingredients.
1. Colored Portland Cement-Lime Mix:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Argos USA LLC.
 - 2) Holcim (US) Inc.
 - 3) Lehigh Hanson; HeidelbergCement Group.
 2. Colored Masonry Cement:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Argos USA LLC.
 - 2) Cemex S.A.B. de C.V.
 - 3) Holcim (US) Inc.
 - 4) Lafarge North America Inc.
 - 5) Lehigh Hanson; HeidelbergCement Group.
 3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
 4. Pigments do not exceed 10 percent of portland cement by weight.
 5. Pigments do not exceed 5 percent of masonry cement or mortar cement by weight.
- F. Aggregate for Mortar: ASTM C144.
1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
 3. White-Mortar Aggregates: Natural white sand or crushed white stone.

4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with , and recommended by manufacturer for use in masonry mortar of composition indicated.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Euclid Chemical Company (The); an RPM company.
 - b. GCP Applied Technologies Inc.
- H. Water: Potable.

2.4 TIES AND ANCHORS

- A. General: Ties and anchors extend at least 1-1/2 inches into veneer but with at least a 5/8-inch cover on outside face.
- B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
 2. Stainless Steel Wire: ASTM A580/A580M, .
 3. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
 4. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
- C. Corrugated-Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of 0.06 to 0.10 inch made from 0.0635-inch- thick, steel sheet, galvanized after fabrication.
- D. Adjustable Masonry-Veneer Anchors:
1. General: Provide anchors that allow vertical adjustment but resist a 100 lbf load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch.
 2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.0785-inch- thick steel sheet, galvanized after fabrication.
 3. Fabricate wire ties from 0.187-inch- diameter, hot-dip galvanized steel wire unless otherwise indicated.
 4. Masonry-Veneer Anchors; Vertical Slotted L-Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting vertical leg with slotted hole for wire tie and washer at face of insulation.

- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 1) FERO Corporation.
- 2) Hohmann & Barnard, Inc.
- 3) Wire-Bond.

2.5 EMBEDDED FLASHING

- A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

- 1. Copper: ASTM B370, Temper H00, cold-rolled copper sheet, 16 oz./sq. ft. weight or 0.0216 inch thick.
- 2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 ft.. Provide splice plates at joints of formed, smooth metal flashing.
- 3. Fabricate through-wall metal flashing embedded in masonry from copper, with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cheney Flashing Company.
 - 2) Hohmann & Barnard, Inc.
 - 3) Keystone Flashing Company, Inc.
- 4. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
- 5. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees.
- 6. Fabricate through-wall flashing with sealant stop unless otherwise indicated. Fabricate by bending metal back on itself 3/4 inch at exterior face of wall and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
- 7. Fabricate metal drip edges and sealant stops for sawtooth metal flashing from plain metal flashing of same metal as sawtooth flashing and extending at least 3 inches into wall with hemmed inner edge to receive sawtooth flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.
- 8. Fabricate metal drip edges from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees.

9. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
10. Fabricate metal expansion-joint strips from copper to shapes indicated.
11. Solder metal items at corners.

B. Flexible Flashing: Use one of the following unless otherwise indicated:

1. Copper Fabric Flashing: 7 oz./sq. ft. copper sheet bonded between two layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Advanced Building Products Inc.
 - 2) Hohmann & Barnard, Inc.
 - 3) Wire-Bond.
 - 4) York Manufacturing, Inc.
2. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 30 mil.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Advanced Building Products Inc.
 - 2) Carlisle Coatings & Waterproofing Inc.
 - 3) Heckmann Building Products, Inc.
 - 4) Hohmann & Barnard, Inc.
 - 5) W.R. Meadows, Inc.
 - b. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.
3. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymers alloy.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hohmann & Barnard, Inc.
 - 2) Hyload, Inc.
 - 3) Mortar Net Solutions.

- b. Monolithic Sheet: Elastomeric thermoplastic flashing, 40 mil thick.
 - c. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, 25 mil thick, with a 15-mil- thick coating of adhesive.
 - 1) Color: Gray.
 - d. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.
- 4. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D4637/D4637M, 40 mil thick.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Carlisle Coatings & Waterproofing Inc.
 - 2) Firestone Specialty Products.
 - 3) Heckmann Building Products, Inc.
 - 4) Hohmann & Barnard, Inc.
 - 5) Wire-Bond.
- C. Solder and Sealants for Sheet Metal Flashings: As specified in Division 07 Section "Sheet Metal Flashing and Trim."
 - 1. Solder for Copper: ASTM B32, Grade Sn50.
 - 2. Elastomeric Sealant: ASTM C920, chemically curing urethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.
- D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.6 ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene PVC.
- B. Weep/Vent Products: Use one of the following unless otherwise indicated:
 - 1. Wicking Material: Absorbent rope, made from cotton, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch exposure on exterior and 18 inches in cavity. Use only for weeps.
 - 2. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.

- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Advanced Building Products Inc.
 - 2) Heckmann Building Products, Inc.
 - 3) Hohmann & Barnard, Inc.
- 3. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) CavClear/Archovations, Inc.
 - 2) Hohmann & Barnard, Inc.
 - 3) Keene Building Products.
 - 4) Mortar Net Solutions.
- 4. Vinyl Weep Hole/Vent: Units made from flexible PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color selected by Architect.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hohmann & Barnard, Inc.
 - 2) Williams Products, Inc.
 - 3) Wire-Bond.
- C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
 - 1. Mortar Deflector: Strips, full depth of cavity and 10 inches high, with dimpled surface that prevent clogging with mortar droppings.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Advanced Building Products Inc.
 - 2) Hohmann & Barnard, Inc.
 - 3) Keene Building Products.
 - 4) Mortar Net Solutions.

- D. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Diedrich Technologies, Inc.; a Hohmann & Barnard company.
 - b. EaCo Chem, Inc.
 - c. PROSOCO, Inc.

2.7 MORTAR MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
1. Do not use calcium chloride in mortar or grout.
 2. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Use Type N unless another type is indicated.
- D. Pigmented Mortar: Use colored cement product.
1. Pigments do not exceed 10 percent of portland cement by weight.
 2. Pigments do not exceed 5 percent of masonry cement or mortar cement by weight.
 3. Mix to match Architect's sample.
 4. Application: Use pigmented mortar for exposed mortar joints with the following units:
 - a. Face brick.
- E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
1. Mix to match Architect's sample.
 2. Application: Use colored-aggregate mortar for exposed mortar joints with the following units:

- a. Face brick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- B. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- C. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
 - 1. Mix units from several pallets or cubes as they are placed.
- D. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.
- E. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested in accordance with ASTM C67/C67M. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

- A. Dimensions and Locations of Elements:
 - 1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
 - 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.

3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 ft., or 1/2-inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 ft., or 1/2-inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

- C. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- E. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

3.5 MORTAR BEDDING AND JOINTING

- A. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- B. Lay hollow brick with face shells fully bedded in mortar and with head joints of depth equal to bed joints. At starting course, fully bed entire units, including area under cells.
 - 1. At anchors and ties, fully bed units and fill cells with mortar as needed to fully embed anchors and ties in mortar.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 ANCHORED MASONRY VENEERS

- A. Anchor masonry veneers to masonry backup with masonry-veneer anchors to comply with the following requirements:
 - 1. Fasten screw-attached anchors to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 - 2. Embed tie sections in masonry joints.
 - 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 - 4. Space anchors as indicated, but not more than 18 inches o.c. vertically and 24 inches o.c. horizontally, with not less than one anchor for each 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches, around perimeter.
 - 5. Space anchors as indicated, but not more than 16 inches o.c. vertically and 25 inches o.c. horizontally, with not less than one anchor for each [2.67 sq. ft.] [3.5 sq. ft.] of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

6. Space anchors as indicated, but not more than 18 inches o.c. vertically and horizontally. Install additional anchors within 12 inches of openings and at intervals, not exceeding 24 inches, around perimeter.
- B. Provide not less than 1 inch of airspace between back of masonry veneer and face of insulation.
1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

3.7 EXPANSION JOINTS

- A. General: Install expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form expansion joints as follows:
1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
 2. Build flanges of factory-fabricated, expansion-joint units into masonry.
 3. Build in compressible joint fillers where indicated.
 4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."
- C. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than 3/8 inch.
1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.8 LINTELS

- A. Install steel lintels where indicated.
- B. Provide offset angle supports where indicate and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are indicated without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.9 FLASHING, WEEP HOLES, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 - 2. Extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under lapping at least 4 inches.
 - 3. At lintels and shelf angles, extend flashing 6 inches minimum, to edge of next full unit at each end. At heads and sills, extend flashing 6 inches minimum, to edge of next full unit and turn ends up not less than 2 inches to form end dams.
 - 4. Interlock end joints of sawtooth sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 - 5. Install metal drip edges and sealant stops with sawtooth sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 - 6. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
 - 7. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
 - 8. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install reglets and nailers for flashing and other related construction where they are indicated to be built into masonry.
- D. Install weep holes in veneers in head joints of first course of masonry immediately above embedded flashing.
 - 1. Use specified weep/cavity vent products to form weep holes.
 - 2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
 - 3. Space weep holes 24 inches o.c. unless otherwise indicated.
 - 4. Trim wicking material flush with outside face of wall after mortar has set.

- E. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Accessories" Article.
- F. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form vents.
 - 1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements will be at Contractor's expense.
- B. Inspections: Special inspections in accordance with Level 2 in TMS 402.
 - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
- C. Testing Prior to Construction: One set of tests.
- D. Clay Masonry Unit Test: For each type of unit provided, in accordance with ASTM C67/C67M for compressive strength.
- E. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.

3.11 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

3.12 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 1. Crush masonry waste to less than 4 inches in each dimension.
 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
 3. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042613

DIVISION 05
METALS

**SECTION 05 50 00
METAL FABRICATIONS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish, fabricate, and install metal fabrications in accordance with Contract Documents.

1.2 REFERENCES

- A. ASTM International (ASTM) standards, most recent editions:

ASTM A6	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A36	Specification for Structural Steel
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings
ASTM A48	Gray Iron Castings
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
ASTM A197	Standard Specification for Cupola Malleable Iron
ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325	Specification for Structural Bolts, Steel Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A563	Specification for Carbons and Alloy Steel Nuts
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A536	Standard Specification for Ductile Iron Castings

ASTM A666	Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTMA668	Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A992	Standard Specification for Steel for Structural Shapes for Use in Building Framing
ASTM A1085	Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)
ASTM B209	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B211	Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire
ASTM B221	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B308	Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B429	Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM F593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Standard Specification for Stainless Steel Nuts
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
B.	American National Standards Institute (ANSI) standards, most recent editions:
ANSI A14.3	Standard for Ladders - Fixed - Safety Requirements
C.	American Welding Society (AWS) Standards, most recent editions:
AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code – Aluminum
AWS D1.6	Structural Welding Code – Stainless Steel

Specification for AWS Certification of Welding Inspectors

AWS Welding Handbook

D. American Water Works Association (AWWA) standards, most recent editions:

AWWA C105

American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems

AWWA C217

Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines

E. National Sanitation Foundation (NSF), most recent edition:

NSF 61

Drinking Water System Components, Health Effects.

F. Federal Specifications:

MIL-A-907E

Anti-seize Thread Compound, High Temperature

G. Occupational Safety and Health Administration (OSHA), most recent editions:

OSHA 1910.27

Fixed Ladders

H. Society for Protective Coatings (SSPC):

SSPC-PA 1

Shop, Field, and Maintenance Painting of Steel

1.3 DEFINITIONS

A. Metal Fabrications: Defined as items to be fabricated from metal shapes, plates, or bars and their products.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop Drawings: Submit shop drawings of all metal fabrications to the Engineer for review.

1. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
2. Submit layout drawings for grating showing the direction of span, type and depth of grating, size and shape of grating panels, seat angle details, and details of grating hold down fasteners. Submit load and deflection tables for each style and depth of grating used.

C. Submit ICC-ES report listing the ultimate load capacity in tension and shear for each size and type of concrete anchor submitted. Submit manufacturer's recommended installation

instructions and procedures for adhesive anchors. Upon review, by Engineer, these instructions shall be followed specifically.

- D. No substitution for the indicated adhesive anchors will be considered unless accompanied by an ICC-ES report verifying strength and material equivalency, including temperature at which load capacity is reduced to 90 percent of that determined at 75 degrees F.

1.5 QUALITY ASSURANCE

- A. All weld procedures and welder qualifications shall be available in the Contractor's field office for review.
- B. Qualification of Welders: Use welders with current certifications (previous 12 months) for the material, type, and position of welding used. Certify in accordance with AWS Specifications according to the following:
 - 1. AWS D1.1, Structural Welding Code – Steel.
 - 2. AWS D1.2, Structural Welding Code – Aluminum.
 - 3. AWS D1.6, Structural Welding Code – Stainless Steel.
- C. All welding shall be inspected by a Contractor-furnished inspector qualified in accordance with AWS requirements and approved by the Engineer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Metal fabrications shall be loaded for transport in such a manner that they may be transported and unloaded without being excessively stressed, deformed, or otherwise damaged.
- B. Protect metal fabrications from corrosion and deterioration.
- C. Store material in a dry area and do not place in direct contact with the ground.
 - 1. Do not place materials on the structure in a manner that might cause distortion or damage to the members or supporting structures.
 - 2. Repair or replace damaged materials or structures as directed.

1.7 PROJECT CONDITIONS

- A. Check actual locations of walls and other construction to which metal fabrications must fit by accurate field measurements before fabrication. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabricating products without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
1. Concrete and masonry anchors:
 - a. Hilti, Inc.
 - b. ITW Ramset/Redhead.
 - c. Simpson Strong Tie Company, Inc.
 - d. Engineer approved equal.
 2. Castings, trench covers, and accessories:
 - a. D&L Foundry and Supply
 - b. Deeter Foundry company.
 - c. Neenah Foundry Company.
 - d. Engineer approved equal.
 3. All purpose metal framing
 - a. Allied Tube and conduit.
 - b. B-Line Systems.
 - c. Unistrut Building Systems.
 - d. Engineer approved equal.
 4. Anti-seize lubricant:
 - a. AS-470 by Dixon Ticonderoga
 - b. PURE WHITE by Anti-Seize Technology
 - c. Engineer approved equal.

2.2 MATERIALS

- A. Steel:
1. Welded anchor studs shall be headed concrete anchor studs (HAS), or deformed bar anchors (DBA), or threaded studs (TAS), as indicated in the Contract Documents.
- B. Bolts and Anchors:
1. Standard Service (non-corrosive applications): Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be steel as indicated herein. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, steel for bolt material, anchor bolts, and cap screws shall be in accordance with the following:
 - a. Anchor bolts: ASTM F1554, Grade 36, of dimensions indicated, with nuts conforming to ASTM A563 and flat washers where indicated.
 - b. Install high-strength structural connections using ASTM A325 bolts and nuts per ASTM A563, coated to match material being connected.
 2. Corrosive Service: All bolts, nuts, and washers in the locations listed below shall be stainless steel.
 - a. All buried locations except as noted below for pipe flange, fitting and coupling connections.
 - b. All submerged locations.
 - c. Inside hydraulic structures, below the top of the structure.

- d. Inside buried vaults, manholes, and structures that do not have a forced-air ventilation system and either a gravity drain or a sump with a sump pump.
 - e. All chemical handling areas.
 - f. Other locations indicated by the Contract Documents or designated by the Engineer to be provided with stainless steel bolts.
- 3. Stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel, conforming to ASTM F593 for bolts and to ASTM F594 for nuts. Protect all threads on stainless steel bolts with an anti-seize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E and classified as acceptable for potable water use by NSF. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.
- 4. Pipe Flange, Fitting and Coupling Connection Applications: Unless otherwise noted, all pipe flange, fitting and coupling connection bolts shall be carbon steel per ASTM A307, Grade A hex bolts, with nuts per ASTM A563. All bolts, nuts and washers shall be zinc plated. Protect all threads on bolts and nuts with anti-seize lubricant.
 - a. Exposed Connections: For exposed pipe connections in buried vaults, manholes, and structures with forced-air ventilation and which drain through a gravity sewer or to a sump with a pump, prepare and coat bolts and nuts after installation with the same system as the adjacent flanged piping, in accordance with Section 09 90 00 – Painting and Coating.
 - b. Buried Connections: Coat all buried connections in accordance with Section 09 97 01 – Pipeline Coatings and Linings. Provide wax tape coating per AWWA C217 for steel pipe connections, including sleeve couplings and restrained sleeve couplings. For other pipe materials, grease and wrap connections per AWWA C105.
- 5. Bolt Requirements:
 - a. The bolt and nut material shall be free-cutting steel.
 - b. The nuts shall be capable of developing the full strength of the bolts.
 - c. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.
 - d. Provide bolts with hexagon heads. Provide nuts conforming to Heavy Hexagon Series.
 - e. Install all bolts and nuts with washers fabricated of material matching the base material of bolts, except that hardened washers for high strength bolts shall conform to the requirements of the AISC Specification.
 - f. Install lock washers with washers where indicated and fabricated of material matching the bolts.
- C. Provide bolts of length such that after joints are made up, each bolt shall extend through the entire nut, but in no case more than 1/2-inch beyond the nut.
- D. Epoxy Anchors: Unless otherwise indicated, all drilled concrete or masonry anchors shall be epoxy anchors. No substitutions will be considered unless accompanied with ICC-ES reports verifying strength and material equivalency.
 - 1. Epoxy anchors are required for drilled anchors where exposed to weather, in submerged, wet, splash, overhead, and corrosive conditions, and for anchoring handrails, pumps, mechanical equipment, and reinforcing bars. Provide threaded stainless steel rod, Type 316.

2. Unless otherwise indicated, epoxy anchors will also be permitted in locations not indicated above.
 3. Products for concrete anchorage:
 - a. HIT-RE 500-V3, Hilti.
 - b. Set XP, Simpson Strong-Tie.
 - c. Red Head C6+, ITW Ramset/Redhead.
 - d. Engineer approved equal.
 4. Products for masonry anchorage:
 - a. HIT-HY 270, Hilti.
 - b. Set XP, Simpson Strong-Tie.
 - c. Red Head C6+, ITW Ramset/Redhead.
 - d. Engineer approved equal.
- E. Expansion Anchors: Expansion anchors will only be permitted when specifically approved by the Engineer. Expansion anchors that are to be fully encased in grout may be carbon steel. For non-encased buried or submerged anchors, provide stainless steel anchors. When expansion anchors are indicated or permitted, provide the following:
1. Kwik-Bolt TZ, Hilti.
 2. Strong-Bolt 2, Simpson Strong-Tie.
 3. Trubolt, ITW Ramset/Redhead.
 4. Engineer approved equal.
- F. Corrosion Protection:
1. Hot-dip galvanize all miscellaneous steel metalwork after fabrication.
 - a. Galvanizing: ASTM A123 or A653 with minimum coating of 1.5 ounce per square foot.

2.3 MANUFACTURED UNITS

- A. Metal Grating:
1. Metal grating shall be of the design, sizes, and types indicated. Completely band at all edges and cutouts using material and cross section equivalent to the bearing bars. Such banding shall be welded to each cut bearing bar. Support grating at bearings by support members. Where grating is supported on concrete, embedded support angles matching grating material shall be used unless indicated otherwise. Such angles shall be mitered and welded at corners.
 2. Bearing Bars:
 - a. Type: Rectangular bar.
 - b. Thickness: 3/16 inch minimum.
 - c. Depth: 1-1/2 inch unless otherwise indicated on Contract Documents.
 - d. Spacing: 1 3/16 inch maximum.
 - e. Configuration of top surface: Plain unless otherwise indicated on Contract Documents.
 3. Cross Bars:
 - a. Cross bars shall be welded or mechanically locked tightly into position so that there is no movement allowed between bearing and cross bars.
 - b. Spacing: 4 inches maximum.
 4. All pieces of grating shall be fastened in at least two locations to each support.

5. Where grating forms the landing at the top of a stairway, the edge of the grating, which forms the top riser, shall have an integral non-slip nosing, width equal to that of the stairway.
 6. Where grating depth is not given, grating shall be provided which will be within allowable stress levels, and which shall not exceed a deflection of $\frac{1}{4}$ -inch or the span divided by 180, whichever is less. For standard duty plank, and safety grating, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100 psf, whichever is greater or a concentrated moving load of 1000 pounds.
 7. Material:
 - a. Galvanized Steel: Except where indicated otherwise, bar grating shall be fabricated entirely of hot-dip galvanized carbon steel.
 - b. Aluminum: Bearing and banding bars, alloy 6063-T5.
 - c. Grating which may be partially or wholly submerged shall be fabricated entirely of stainless steel.
 8. No single piece of grating shall weigh more than 80 pounds or be wider than 3 feet, unless indicated otherwise on Contract Documents.
- B. All Purpose Metal Framing:
1. Material: Carbon Steel.
 2. Channels and inserts:
 - a. Minimum 12 gage.
 - b. Channels to have one side with a continuous slot and inturned lips.
 3. Fittings: Hot-rolled steel strip and plate.
 4. Nuts: Steel, ASTM A563, with toothed grooves in top of nuts to engage the inturned lips of channels.
 5. Finish: Epoxy coated. Galvanize items which cannot be epoxy coated.

2.4 FABRICATION

- A. Verify field conditions and dimensions prior to fabrication.
- B. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.
- C. Form exposed work true to line and level with accurate angles and surfaces straight and sharp edges.
- D. Drill and punch holes with smooth edges.
- E. Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.
 1. Temperature Range: 0 degrees F minimum to 110 degrees F maximum ambient temperature.

- F. Shear and punch metals cleanly and accurately. Remove burrs.
- G. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- H. Remove sharp or rough areas on exposed traffic surfaces.
- I. Welding
 - 1. Welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.
 - 2. In assembly and during welding, the component parts shall be adequately clamped, supported and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as indicated by the AWS Code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material that are to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.
 - 3. Weld corners and seams continuously to comply with the following:
 - a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - b. Obtain fusion without undercut or overlap.
 - c. Remove welding flux immediately.
 - d. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.
- J. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners whenever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
- K. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- L. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- M. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- N. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.5 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of the required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Hot-dip galvanize after fabrication.

2.6 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel studs for embedding into concrete.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

- A. Provide steel framing and supports for applications indicated that are not a part of structural steel framework as required to complete the Work.
- B. Fabricate units to sizes, shapes, and profiles indicated and required to receive other adjacent construction retained by framing and supports.
- C. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection.
- D. Cut, drill, and tap units to receive hardware, hangers, and similar items.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.
- B. Inspect and verify condition of substrate. Correct any surface defects or conditions which might interfere with or prevent a satisfactory installation.
- C. Set sleeves in concrete with tops flush with finish surface elevations. Protect sleeves from water and concrete entry.

3.2 INSTALLATION

- A. Set metal work level, true to line, plumb.
- B. In fabrication and erection of structural steel, conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."
- C. Shim and grout as necessary.

- D. To the maximum extent possible, use bolted field connections. Where practicable, conceal the fastenings. When field welding is warranted, comply with the following requirements:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish/grind exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.
- E. Unless notes or specified otherwise:
1. Connect steel members to steel members with 3/4-inch diameter high strength bolts.
 2. Connect aluminum to aluminum with 3/4-inch diameter aluminum bolts.
 3. Connect aluminum to structural steel using 3/4-inch diameter stainless steel bolts.
 4. Connect aluminum and steel members to concrete and masonry using 3/4-inch stainless steel epoxy anchors. Provide a minimum of 5 1/2 inches of embedment into concrete or masonry.
- F. Do not field splice fabricated items unless said items exceed standard shipping length or change of direction requires splicing. Provide fully welded splices where continuity is required.
- G. Provide each fabricated item complete with attachment devices as indicated or required to install.
- H. Anchor metal items so that items will not be distorted nor fasteners overstressed from expansion and contraction.
- I. Install bollards in concrete as detailed. Fill pipe with concrete and round off at top of pipe.
- J. Center abrasive stair nosings in stair.
- K. Attach grating to end and intermediate supports with grating saddle clips and bolts.
1. Maximum spacing: 2 feet on center with a minimum of two attachments per support.
 2. Attach individual units of grating together with clips or attachments at 2 feet on center maximum with a minimum of two clips per side.
- L. Coat ferrous metals in accordance with Section 09 90 00 – Painting and Coating.
- M. Coat surfaces of aluminum that will come in contact with grout, concrete, masonry, wood or dissimilar metals with the following:
1. Cast Aluminum: Heavy coat of bituminous paint.
 2. Extruded Aluminum: Two coats of clear lacquer.

3.3 DRILLED ANCHORS

- A. Drilled-in anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a power drill, cleaned and dried. Drilled anchors shall not be installed until the concrete has reached the specified

28-day compressive strength. Epoxy anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

3.4 SETTING LOOSE PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.
- B. Set loose level and bearing plates on wedges or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before packing with grout.
 - 1. Use non-shrink grout in concealed locations where not exposed to moisture.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780

END OF SECTION

DIVISION 6
WOODS, PLASTICS, AND COMPOSITES

**SECTION 06 10 00
ROUGH CARPENTRY**

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Framing with dimension lumber.
2. Wood blocking and nailers.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of process and factory-fabricated product.
2. For preservative-treated wood products.

1.3 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Post-installed anchors.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
3. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber:

1. Dimension Lumber: 19 percent for 2-inch nominal thickness or less; no limit for more than 2-inch nominal thickness unless otherwise indicated.

2.2 DIMENSION LUMBER FRAMING

A. Non-Load-Bearing Interior Partitions by Grade: Construction or No. 2 grade.

1. Application: All interior partitions.
2. Species:
 - a. Northern species; NLGA.
 - b. Western woods; WCLIB or WWPA.

2.3 MISCELLANEOUS LUMBER

A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.

2.4 FASTENERS

A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- C. Do not splice structural members between supports unless otherwise indicated.
- D. Comply with AWP A M4 for applying field treatment to cut surfaces of preservative-treated lumber.

- E. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- F. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
 - 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
 - 3. ICC-ES evaluation report for fastener.

3.2 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet enough that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 06 17 53
SHOP-FABRICATED WOOD TRUSSES

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide and install wood trusses as shown on the Contract Drawings and as specified herein.
- B. Section Includes:
1. Wood roof trusses.
 2. Wood floor trusses.
 3. Wood girder trusses.
 4. Wood truss bracing.
 5. Metal truss accessories.
- C. Related Sections
1. Section 05 50 00 – Metal Fabrications
 2. Section 06 10 00 – Rough Carpentry
 3. Section 06 10 53 – Miscellaneous Rough Carpentry

1.2 REFERENCES

- A. American Society of Mechanical Engineers (ASME) standards, most recent editions:
- | | |
|--------------|---|
| ASME B18.2.1 | Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series) |
| ASME B18.6.1 | Wood Screws (Inch Series) |
- B. ASTM International (ASTM) standards, most recent editions:
- | | |
|-----------|--|
| ASTM A153 | Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A307 | Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength |
| ASTM A563 | Standard Specification for Carbon and Alloy Steel Nuts |
| ASTM A653 | Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A780 | Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |

- | | |
|------------|--|
| ASTM D5664 | Standard Test Method for Evaluating the Effects of Fire-Retardant Treatments and Elevated Temperatures on Strength Properties of Fire-Retardant Treated Lumber |
| ASTM F1667 | Standard Specification for Driven Fasteners: Nails, Spikes, and Staples |
- C. American Wood Council (AWC) standards, most recent editions:
- National Design Specification (NDS) for Wood Construction with Commentary
- D. American Wood Protection Association (AWPA) standards, most recent editions:
- | | |
|---------|--|
| AWPA U1 | Use Category System: User Specification for Treated Wood |
|---------|--|
- E. Society For Protection of (SSPC) standards, latest editions:
- | | |
|---------------|---|
| SSPC Paint 20 | SSPC-Paint 20, Zinc-Rich Coating (Type I Inorganic and Type II Organic) |
|---------------|---|
- F. Truss Plate Institute (TPI) standards, most recent editions
- | | |
|---------|--|
| TPI 1 | National Design Standard for Metal Plate Connected Wood Truss Construction |
| TPI DSB | Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses |
| TPI HIB | Commentary and Recommendations for Handling, Installing and Bracing Metal Plate Connected Wood Trusses |
- G. U.S. Department of Commerce, National Institute of Standards and Technology, (NIST) standards, latest editions:
- | | |
|-------|--|
| PS 20 | American Softwood Lumber Standard (ASLS) |
|-------|--|

1.3 DEFINITIONS

- A. Fabricated wood Trusses: Planar structural units consisting of metal plate connected members fabricated from dimensional lumber and cut and assembled before delivery to Project site.
- B. TPI: Truss Plate Institute, Inc.
- C. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.
- D. Lumber grading agencies, and the abbreviations used to reference them, include the following:
1. ALSC: American Lumber Standard Committee.

2. WCLIB: West Coast Lumber Inspection Bureau.
 3. WWPA: Western Wood Products Association.
- E. ICC-ESR: International Code Council Evaluation Service Report.
- F. S4S: Surfaced four sides.
- 1.4 SUBMITTALS
- A. Submit in accordance with Section 01 33 20 – Contractor Submittals.
- B. Product Data: For wood preservative treated lumber, fire-retardant treated lumber, metal-plate connectors, metal truss accessories, and fasteners.
1. Include data for wood preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 2. Include data for fire retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 3. For fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
 4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to truss fabricator.
 5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
- C. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer. Show fabrication and installation details for trusses.
1. Prepare shop drawings at the minimum scale shown on the Contract Drawings.
 2. Prepare shop drawings which are not reproductions of the Contract Drawings.
 3. Include individual truss drawings, signed and sealed by a professional engineer licensed to practice in the state of Utah, verifying accordance with the building code and design requirements shown on the Contract Drawings. As a minimum, include the following information.
 - a. Description of design criteria
 - b. Engineering analysis depicting member forces/stresses and truss deflection.
 - c. Truss member grades and sizes and connections at truss joints.
 - d. Truss support reactions for each load case.
 - e. Top chord, bottom chord, and web bracing requirements.
 - f. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.
 - g. Show splice details and bearing details.
 4. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.

5. Plan and details for the type and location of all permanent lateral and diagonal bracing and/or blocking required in the top chord, bottom chord, and web planes – diaphragms excluded.
 6. Provide templates or location drawings for installation of any required anchor bolts.
 7. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer licensed to practice in Utah, and responsible for their preparation.
- D. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
- E. Qualification Data: For metal-plate manufacturer and truss fabricator.
- F. Research/Evaluation Reports: ICC-ESR reports for the following, showing compliance with building code in effect for Project:
1. Wood-preservative-treated lumber.
 2. Fire-retardant-treated wood.
 3. Metal-plate connectors.
 4. Metal truss accessories.

1.5 QUALITY ASSURANCE

- A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with quality-control procedures in TPI 1 for manufacture of connector plates.
1. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
 2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
- B. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program that complies with quality-control procedures in TPI 1 and that involves third-party inspection by an independent testing and inspecting agency acceptable to Engineer.
- C. Source Limitations for Connector Plates: Obtain metal connector plates from a single manufacturer.
- D. Comply with applicable requirements and recommendations of TPI 1, TPI DSB, and TPI HIB.
- E. Wood Structural Design Standard: Comply with applicable requirements in AWC's "National Design Specifications for Wood Construction" and its "Supplement."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handle and store trusses to comply with recommendations of TPI HIB, "Commentary and Recommendations for Handling, Installing & Bracing Metal Plate Connected Wood Trusses."
1. Store trusses flat, off of ground, and adequately supported to prevent lateral bending.
 2. Protect trusses from weather by covering with waterproof sheeting, securely anchored.

3. Provide for air circulation around stacks and under coverings.
4. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.
5. Time delivery and erection of trusses to avoid extended on-site storage and to avoid delaying progress of other trades whose work must follow erection of trusses.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable.
 1. Metal Connector Plates
 - a. Alpine Engineered Products, Inc.
 - b. CompuTrus, Inc.
 - c. Eagle Metal Products.
 - d. MiTek Industries, Inc.; a subsidiary of Berkshire Hathaway, Inc.
 - e. Engineer approved equal.
 2. Metal Truss Accessories
 - a. Simpson Strong-Tie Co., Inc.
 - b. Engineer approved equal.

2.2 DESIGN CRITERIA

- A. Structural Performance: Provide metal-plate-connected wood trusses capable of withstanding design loads within limits and under conditions indicated. Comply with requirements in TPI 1 unless more stringent requirements are specified below.
- B. Design Loads: As indicated on Drawings.
- C. Connector Plate Design
 1. Proportion for full member design loads without considering wood-to-wood bearing.
 2. Stress increase for the value of a connector will not be allowed in any circumstance.
 3. Increase net area of connector plates by 25 percent above that required by calculated stresses. Increase area of connector plate by increasing the plate dimension in each direction.
 4. Design for a single connection per joint per side.
 5. Minimum size of any plate connector is 15 square inches.
 6. Minimum bite of any connector on a truss member is 2-1/2 inches.
- D. Maximum Deflection Under Design Loads
 1. Roof Trusses: Live load vertical deflection of 1/360 of span.
 2. Floor Trusses: Live load vertical deflection of 1/480 of span.

2.3 DIMENSION LUMBER

- A. Lumber: Document PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-

writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
 3. Where nominal sizes are indicated, provide actual sizes required by document PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 4. Provide dressed lumber, S4S, unless otherwise indicated.
 5. Provide dry lumber with 19 percent maximum moisture content at time of dressing.
- B. Grade and Species: Provide dimension lumber of any species for truss chord and web members, graded as follows and of the following minimum design values for size of member required according to AWC's "National Design Specifications for Wood Construction" and its "Supplement;"
1. Grading Method: Visual or mechanical.
 2. Design Values: Modulus of elasticity of at least 1,400,000 psi and an extreme fiber stress in bending of at least 700 psi
- C. Minimum Chord Size for Roof Trusses: 2 by 6 inches nominal for both top and bottom chords.
- D. Minimum Web Size for Roof Trusses: 2 by 4 inches nominal.
- E. Permanent Bracing: Provide wood bracing that complies with requirements of truss manufacturer and as specified in Section 06 10 53 – Miscellaneous Rough Carpentry.

2.4 WOOD PRESERVATIVE TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWPAC U1, Use Category 2, except that trusses that are not in contact with the ground and are continuously protected from liquid water may be treated according to AWPAC U1, Use Category 1 with inorganic boron (SBX).
- B. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- C. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- D. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- E. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.
- F. Application: Treat trusses where indicated on Drawings.

2.5 FIRE RETARDANT TREATED WOOD

- A. General: Comply with performance requirements in AWPA U1, Use Category UCFA (Interior) and UCFB (exterior).
- B. Use treatment that does not promote corrosion of metal fasteners.
- C. Use Exterior type for exterior locations and where otherwise indicated.
- D. Use Interior Type A, High Temperature (HT) for enclosed roof trusses and where otherwise indicated.
- E. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. For exposed trusses and bracing indicated to receive a stained or natural finish, mark end or back of each piece.
 - 2. For exposed trusses and bracing indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
- F. Application: Treat items indicated on Drawings.

2.6 METAL CONNECTOR PLATES

- A. General: Fabricate connector plates to comply with TPI 1.
- B. Hot-Dip Galvanized Steel Sheet: ASTM A653; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G60 coating designation; and not less than 0.036 inch thick.
- C. Use for all trusses unless otherwise indicated on the Drawings.

2.7 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
 - 1. Where trusses are exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: ICC ESR 1539.
- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts: ASME B18.2.1.
- F. Bolts: Steel bolts complying with ASTM A307, Grade A; with ASTM A563 hex nuts and, where indicated, flat washers.

G. Concrete and Masonry Anchors: Refer to Section 05 50 00 – Metal Fabrications.

2.8 METAL TRUSS ACCESSORIES

- A. Basis-of-Design Products: Subject to compliance with requirements, provide products indicated on Drawings. Design is based on products of Simpson Strong-Tie Co., Inc. Substitutions from other manufacturers must include ICC-ESR evaluation reports with test capacities that equal or exceed those of the Simpson product indicated.
- B. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653, G60 coating designation.
 - 1. Use for all trusses unless otherwise indicated on the Drawings.

2.9 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: SSPC-aPaint 20, with dry film containing a minimum of 94 percent zinc dust by weight.

2.10 FABRICATION

- A. Cut truss members to accurate lengths, angles, and sizes to produce close fitting joints.
- B. Fabricate metal connector plates to sizes, configurations, thicknesses, and anchorage details shown on the Contractor's submittal drawings.
- C. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.
- D. Fabricate wood trusses within manufacturing tolerances in TPI 1.
- E. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install wood trusses only after supporting construction is in place and is braced and secured.
- B. If trusses are delivered to Project site in more than one piece, assemble trusses before installing.
- C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.
- D. Install and brace trusses according to TPI recommendations and as indicated.

- E. Install trusses plumb, square, and true to line and securely fasten to supporting construction.
- F. Space trusses as indicated on the Drawings; adjust and align trusses in location before permanently fastening.
- G. Anchor trusses securely at bearing points; use metal truss tie-downs or floor truss hangers as applicable. Install fasteners through each fastener hole in truss accessories according to manufacturer's fastening schedules and written instructions.
- H. Securely connect each truss ply as shown on Contractor's submittal drawings when required for forming built-up girder trusses.
- I. Support trusses at girder trusses as indicated on the Drawings.
- J. Install and fasten temporary and permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.
- K. When floor trusses are required, install and fasten strongback bracing vertically against vertical web of parallel-chord floor trusses at centers indicated.
- L. Install wood trusses within installation tolerances in TPI 1.
- M. Do not cut or remove truss members.
- N. Replace wood trusses that are damaged or do not meet requirements.
- O. Do not alter trusses in field.

3.2 REPAIRS AND PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Repair damaged galvanized coatings on exposed surfaces with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

~~THIS PAGE INTENTIONALLY BLANK~~

DIVISION 7
THERMAL AND MOISTURE PROTECTION

SECTION 07 14 00
FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide and apply single-component, fluid-applied liquid waterproofing system to below grade concrete slabs, walls, foundations, and footings, including surface preparation.

1.2 RELATED SECTIONS

- A. Section 03 30 00 Cast-in-Place Concrete
- B. Section 04 22 00 Concrete Unit Masonry
- C. Section 07 92 00 Joint Sealants.

1.3 REFERENCES

- A. ASTM International (ASTM) standards, most recent editions:

ASTM C836	Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course
ASTM D41	Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
ASTM D1644	Standard Test Methods for Nonvolatile Content of Varnishes
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 20 – Submittal Procedures.
- B. Product Data: For each type of product indicated. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.

- C. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions which may be required.
- D. Qualification Data: For qualified Installer.
- E. Product Test Reports: For waterproofing, based on evaluation of comprehensive tests performed by a qualified testing agency.
- F. Field quality-control reports.
- G. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that is approved or licensed by manufacturer for installation of waterproofing required for this Project and is eligible to receive special warranties specified.
- B. Source Limitations: Obtain waterproofing materials from single source from single manufacturer.
- C. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, installation procedures, testing and inspection procedures, and protection and repairs.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.
- C. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- D. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, or when temperature is below 0 Degrees F.
 - 1. Do not apply membrane when air, material, or surface temperatures are expected to fall below 30 Degrees F within four hours of completed application.
 - 2. Do not apply membrane if rainfall is forecast or imminent within 12 hours.
 - 3. Do not apply waterproofing membrane to any surfaces containing frost.
 - 4. Consult manufacturer for applications to green concrete.

- B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.8 WARRANTY

- A. Special Warranty: The special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents, and shall be in addition to, and run concurrent with, other warranties made under requirements of the Contract Documents.
- B. Provide written warranty signed by waterproofing manufacturer and installer agreeing to repair or replace waterproofing that does not meet requirements or that does not remain watertight within the specified warranty period.
- C. Warranty Period: 3 years after date of Substantial Completion.
- D. Warranty does not include failure of waterproofing due to failure of substrate or formation of new joints and cracks in substrate that exceed 1/16 inch in width.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers and products are acceptable:
 - 1. Fluid Applied Waterproofing:
 - a. Epro Services, Inc., Ecobase Waterproofing Membrane.
 - b. Tremco Barrier Solutions, Tuff-N-Dri H8 Waterproofing.
 - c. Engineer approved equal.

2.2 PERFORMANCE CRITERIA

- A. Waterproofing Membrane:
 - 1. Single-component, polymer-enhanced liquid-applied membrane with the following minimum properties:
 - a. Solids content, ASTM D1644, 60% minimum.
 - b. Tensile Strength, ASTM D412: 15 psi, minimum.
 - c. Elongation, ASTM D412: 1100%, minimum.
 - d. Water Vapor Transmission, ASTM E96: 1 perms maximum (40 mil dry coat).
 - e. Hydrostatic Pressure Resistance, 8 feet water head, minimum.
 - f. Adhesion, ASTM C836, minimum 11 lb/inch to peel from concrete and masonry.
- B. Sealants and Accessories: Manufacturer's recommended sealants and accessories.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
 - 2. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D4263.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and prepare substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Close off penetrations to prevent spillage and migration of waterproofing fluids.
- D. Remove grease, oil, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- E. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

3.3 JOINTS, CRACKS, AND TERMINATIONS

- A. Prepare and treat substrates to receive waterproofing membrane, including expansion joints, construction joints, cracks, deck drains, corners, and penetrations according to manufacturer's written instructions.

3.4 MEMBRANE APPLICATION

- A. Apply using appropriate equipment and nozzles, per manufacturer's recommendations. Start application with manufacturer's authorized representative present.
- B. Membrane: Spray apply asphalt emulsion membrane to substrates and adjoining surfaces indicated. Spread to a minimum wet thickness per manufacturer's specification to achieve listed hydrostatic resistance, minimum of 60 mils.
- C. Apply waterproofing over prepared joints and up wall terminations and vertical surfaces to heights indicated or required by manufacturer.
- D. Allow product to cure prior to backfilling.

- E. When buried surfaces that have been waterproofed are not backfilled within 30 days of membrane applications, membrane shall be coated with whitewash. Any formula for mixing the whitewash may be used which is not detrimental to the membrane and produces a uniformly coated white surface which remains until backfill is placed.

3.5 FIELD QUALITY CONTROL

- A. Engage a full-time site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions; surface preparation; and application of the membrane, flashings, protection, and drainage components; furnish daily reports to Engineer.

3.6 CLEANING AND PROTECTION

- A. Protect waterproofing from damage and wear during remainder of construction period.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

**SECTION 07 19 00
WATER REPELLENTS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes exterior water repellent coatings for concrete unit masonry (unpainted and unglazed).
 - 1. Silicone Water Repellents
- B. Related Sections
 - 1. Section 04 22 00 – Concrete Unit Masonry

1.2 REFERENCES

- A. ASTM International (ASTM) standards, most recent editions:

ASTM D3278	Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus
ASTM D5095	Standard Test Method for Determination of the Nonvolatile Content in Silanes, Siloxanes and Silane-Siloxane Blends Used in Masonry Water Repellent Treatments

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 20 – Submittal Procedures.
- B. Product Data: Manufacturer's technical data to include the following:
 - 1. Detailed installation instructions.
 - 2. Protection and cleaning instructions.
 - 3. Certified test reports indicating compliance with requirements specified herein.
 - 4. Data substantiating that materials are recommended by manufacturer for applications included in this Work.
- C. Samples: Provide samples of each substrate indicated to receive water repellent, 8 inches square, with specified repellent treatment applied to half of the sample.
- D. Applicator Certificates: Provide letter on Manufacturer's letterhead certifying that the applicator is approved to apply products supplied.
- E. Test and Evaluation Reports: Results of rilem tube testing and application rates determined therefrom.
- F. Warranty Documentation.

1.4 QUALITY ASSURANCE

A. Qualifications

1. Manufacturers: Use products from manufacturer with not less than 5 years' experience.
2. Applicators: Firm experienced in application of systems similar in complexity to those required for this Project, plus the following:
 - a. Acceptable to, or licensed by manufacturer.
 - b. Not less than 3 years' experience with systems.
 - c. Successfully completed not less than 5 comparable scale projects using the same system.

B. Test Area: Test a minimum 4 feet by 4 feet area on each type of masonry surface in the Work.

1. Use the manufacturer's application instructions.
2. Let test area protective treatment cure before inspection.
3. Perform rilem tube testing to determine coverage rate to be used.
4. Obtain Engineer's approval of test areas and resulting application rates to be used before proceeding with full scale application.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.
- B. Packaging and Shipping: Deliver products in original unopened packaging with legible manufacturer's identification.
- C. Storage and Handling Requirements: Comply with manufacturer's instructions.

1.6 SITE CONDITIONS

- A. Maintain surface and ambient temperature above 40 degrees F during, and 24 hours after application.
- B. Do not proceed with application on materials where ice and snow exist.
- C. Do not proceed with application if surface temperature exceeds 100 degrees F.
- D. Do not proceed with application when windy conditions exist that may cause water repellent to be blown onto vegetation or surfaces not intended to be coated.
- E. Do not proceed with the application of materials in rainy conditions or when rain is anticipated within 6 hours after application.

1.7 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

- B. Special Warranty: Submit a written warranty, executed by the applicator and water repellent manufacturer, covering materials and labor, agreeing to repair or replace materials that fail to provide water repellency within the specified warranty period. Warranty does not include deterioration or failure of coating due to unusual weather phenomena, failure of prepared and treated substrate, formation of new joints and cracks in excess of 1/16 inch wide, fire, vandalism, or abuse by maintenance equipment.
- C. Warranty Period: 5 years from date of Substantial Completion.
- D. Retreat all defective areas as identified by the Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. Silicone Water Repellent:
 - a. Weather Seal Blok-Guard & Graffiti Control II; ProSoCo, Inc.
 - b. Engineer approved equal

2.2 MATERIALS

- A. Masonry: Refer to Section 04 22 00 – Concrete Unit Masonry.
- B. Silicone Sealer:
 - 1. Silicone emulsion water repellent for dense substrates.
 - 2. Water-based solution containing not less than 6% solids per ASTM D5095.
 - 3. Flash Point: Greater than 212 degrees F per ASTM D3278.
 - 4. Freeze Point: 32 degrees F.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine system components, substrate, and conditions where water repellents are to be installed. If unsatisfactory conditions exist, notify Engineer in writing of unsatisfactory conditions and do not begin this Work until such conditions have been corrected.
- B. Commencing installation of this Work constitutes acceptance of conditions.

3.2 PREPARATION

- A. Clean substrate of substances that might interfere with penetration or performance of water repellents.

- B. Test for moisture content, according to repellent manufacturer's written instructions, to ensure surface is sufficiently dry.
- C. Test for pH level, according to water repellent manufacturer's written instructions, to ensure chemical bond to silicate minerals.
- D. Protect adjoining work, including sealant bond surfaces, from spillage or blow over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live plants and grass.
- E. Coordination with Sealants: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water repellent treatment have been installed and cured.

3.3 APPLICATION

- A. Apply product as supplied by the manufacturer without dilution or alteration unless dilution is specifically included in the manufacturer's instructions.
 - 1. Apply using low pressure spray equipment (<50 psi).
 - 2. Saturate the surface in a "wet-on-wet" application from the bottom up, creating a 6 inch to 8 inch rundown below the spray contact point.
 - 3. Avoid excessive overlapping.
 - 4. Allow the application to penetrate the masonry surface and immediately brush out runs and drips to prevent build-up.
- B. Brush apply water repellent only at locations where overspray would affect adjacent materials and where not practicable for spray application.
- C. Apply 2 coats at rate determined by the manufacturer as a result of the test panel evaluations. Comply with manufacturer's written instructions on limitations on drying time between coats.

3.4 RESTORATION

- A. Repair, restore, or replace to the satisfaction of Engineer, any materials, landscaping, and nonmasonry surfaces damaged by exposure to water repellents.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer Services: Provide services of a manufacturer-authorized technical service representative to approve the substrate before application and to instruct the applicator on the application rates and methods.

3.6 CLEANING

- A. While Work Progresses: Clean spillage and overspray from adjacent surfaces using materials and methods as recommended by water repellent manufacturer.
- B. Remove and dispose of all materials used to protect surrounding areas and nonmasonry surfaces, following completion of the work of this Section.

- C. Clean site of all unused water repellents, residues, rinse water, wastes, and effluents in accordance with environmental regulations.

3.7 EXTERIOR SCHEDULE

- A. Provide water repellent to exterior masonry surfaces of the following structures:
 - 1.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

**SECTION 07 21 00
THERMAL INSULATION**

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board insulation.
2. Polyisocyanurate foam-plastic board insulation.
3. Glass-fiber blanket insulation.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Extruded polystyrene foam-plastic board insulation.
2. Polyisocyanurate foam-plastic board insulation.
3. Glass-fiber blanket insulation.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION

A. Extruded Polystyrene Board Insulation, Type X <XPS>: ASTM C578, Type X, 15-psi minimum compressive strength; unfaced.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. DiversiFoam Products.
 - b. Dow Chemical Company (The).
 - c. MBCI.
 - d. Owens Corning.
2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.

4. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
5. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.2 POLYISOCYANURATE FOAM-PLASTIC BOARD INSULATION

A. Polyisocyanurate Board Insulation, Foil Faced <Polyiso>: ASTM C1289, foil faced, Type I, Class 1 or 2.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Atlas Molded Products; a Division of Atlas Roofing Corporation.
 - b. Atlas Roofing Corporation.
 - c. Carlisle Coatings & Waterproofing Inc.
 - d. Dow Chemical Company (The).
 - e. Firestone Building Products.
 - f. Hunter Panels.
 - g. Johns Manville; a Berkshire Hathaway company.
 - h. Rmax, Inc.
2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
3. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.3 GLASS-FIBER BLANKET INSULATION

A. Glass-Fiber Blanket Insulation, Unfaced <Fiberglass Insulation>: ASTM C665, Type I; passing ASTM E136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corporation.
 - b. CertainTeed Insulation.
 - c. Johns Manville; a Berkshire Hathaway company.
 - d. Knauf Insulation.
 - e. Owens Corning.
2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.4 ACCESSORIES

- A. Insulation Anchors, Spindles, and Standoffs: As recommended by manufacturer.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Install insulation with manufacturer's R-value label exposed after insulation is installed.
- D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.2 INSTALLATION OF SLAB INSULATION

- A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
 - 1. If not otherwise indicated, extend insulation a minimum of 24 inches below exterior grade line.

3.3 INSTALLATION OF FOUNDATION WALL INSULATION

- A. Butt panels together for tight fit.
- B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors.
- C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.4 INSTALLATION OF CAVITY-WALL INSULATION

- A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face and as recommended by manufacturer.
 - 1. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions, and with faces flush.
 - 2. Press units firmly against inside substrates.
 - 3. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 042000 "Unit Masonry."

3.5 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 - 3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.

END OF SECTION

SECTION 07 26 00 VAPOR RETARDERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polyethylene vapor retarders.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for under-slab vapor retarders.
2. Section 072100 "Thermal Insulation" for vapor retarders integral with insulation products.

1.2 ACTION SUBMITTALS

- A. Product Data:** For each type of product.

1.3 INFORMATIONAL SUBMITTALS

- A. Product test reports.**

PART 2 - PRODUCTS

2.1 POLYETHYLENE VAPOR RETARDERS

- A. Polyethylene Vapor Retarders:** ASTM D 4397, 6-mil- thick sheet, with maximum permeance rating of 0.1 perm.

PART 3 - EXECUTION

3.1 INSTALLATION OF VAPOR RETARDERS ON FRAMING

- A. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives, vapor retarder fasteners, or other anchorage system as recommended by manufacturer. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.**

- B. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs and sealing with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Locate all joints over framing members or other solid substrates.
- C. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.
- D. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

END OF SECTION

SECTION 07 27 15
NONBITUMINOUS SELF-ADHERING SHEET AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Self-adhering air barrier.
 - 1. Vapor-retarding nonbituminous sheet.

1.2 DEFINITIONS

- A. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
- B. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.
- C. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.

1.3 ACTION SUBMITTALS

- A. Product Data: Self-adhering air barrier. Include manufacturer's written instructions for evaluating, preparing, and treating each substrate; technical data; and tested physical and performance properties of products.
 - 1. Vapor-retarding nonbituminous sheet.
- B. Shop Drawings: For air-barrier assemblies.
 - 1. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of nonbituminous self-adhering sheet air barrier.
- B. Product Test Reports:

- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- B. Protect stored materials from direct sunlight.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended in writing by air-barrier manufacturer.
 - 1. Protect substrates from environmental conditions that affect air-barrier performance.
 - 2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction to be capable of performing as a continuous air barrier. Air-barrier assemblies to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested in accordance with ASTM E2357.

2.3 NONBITUMINOUS SHEET AIR BARRIER

- A. Vapor-Retarding Nonbituminous Sheet: Minimum 10-mil- thick, self-adhering sheet consisting of 5 mils of air-barrier film and a 5-mil- thick, acrylic adhesive with release liner on adhesive side.

- 1. 3M Air and Vapor Barrier 3015 or equal.

2.4 ACCESSORY MATERIALS

- A. Requirement: Provide primers, transition strips, termination strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
 - 2. Verify that substrates have cured and aged for minimum time recommended in writing by air-barrier manufacturer.
 - 3. Verify that substrates are visibly dry and free of moisture.
 - 4. Verify that masonry joints are flush and completely filled with mortar.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate in accordance with manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.
- E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.
- H. Bridge isolation joints with air-barrier accessory material that accommodates joint movement in accordance with manufacturer's written instructions and details.

3.3 INSTALLATION OF NONBITUMINOUS SHEET AIR BARRIER

- A. Install materials in accordance with air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.
 - 1. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
- B. Prepare, treat, and seal inside and outside corners and vertical and horizontal surfaces at terminations and penetrations with termination mastic.
- C. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier sheet on same day. Reprime areas exposed for more than 24 hours.
- D. Apply and firmly adhere air-barrier sheets over area to receive air barrier. Accurately align sheets and maintain uniform 2-1/2-inch- minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure airtight installation.
 - 1. Apply sheets in a shingled manner to shed water.
 - 2. Roll sheets firmly to enhance adhesion to substrate.
- E. Apply continuous air-barrier sheets over accessory strips bridging substrate cracks, construction, and contraction joints.

- F. CMU: Install air-barrier sheet horizontally against the CMU beginning at base of wall. Align top edge of air-barrier sheet immediately below protruding masonry ties or joint reinforcement or ties, and firmly adhere in place.
1. Overlap horizontally adjacent sheets a minimum of 2 inches and roll seams.
 2. Apply overlapping sheets with bottom edge slit to fit around masonry reinforcing or ties. Roll firmly into place.
 3. Seal around masonry reinforcing or ties and penetrations with termination mastic.
 4. Continue the sheet into all openings in the wall, such as doors and windows, and terminate at points to maintain an airtight barrier that is not visible from interior.
- G. Seal top of through-wall flashings to air-barrier sheet with an additional 6-inch-wide, transition strip.
- H. Seal exposed edges of sheet at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- I. Install air-barrier sheet and accessory materials to form a seal with adjacent construction and to maintain a continuous air barrier.
1. Coordinate air-barrier installation with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.
- J. Connect and seal exterior wall air-barrier sheet continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- K. At end of each working day, seal top edge of air-barrier material to substrate with termination mastic.
- L. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- M. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of contact over firm bearing to perimeter frames, with not less than 1 inch of full contact.
1. Transition Strip: Roll firmly to enhance adhesion.
 2. Preformed Silicone Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.

- N. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of air-barrier material with foam sealant.
- O. Repair punctures, voids, and deficient lapped seams in air barrier. Slit and flatten fishmouths and blisters. Patch with air-barrier sheet extending 6 inches beyond repaired areas in all directions.
- P. Do not cover air barrier until it has been tested and inspected by testing agency.
- Q. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.4 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, in accordance with manufacturer's written instructions.

END OF SECTION 072715

SECTION 07 41 13.16
STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standing-seam metal roof panels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.

C. Samples: For each type of metal panel indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Warranties: Sample of special warranties.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Finish Warranty Period: 20 years from date of Substantial Completion.

- C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
 - 1. Warranty Period: 20 years from date of Substantial Completion.
 - 2. Warranty shall cover damage from wind speeds up to 72mph actual.
- D. Special Project Warranty: Submit roofing installer's warranty, signed by installer, covering the Work of this section, including all components of roofing system such as roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarder and walkway products, for the following warranty period:
 - 1. Warranty Period: Two (2) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings.
 - 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E1680 or ASTM E283 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft..
- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 or ASTM E331 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft..
- D. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E2140.
- E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
 - 1. Uplift Rating: UL 60.
- F. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A-90.
2. Hail Resistance: MH.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 STANDING-SEAM METAL ROOF PANELS

A. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.

B. Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AEP Span; A BlueScope Steel Company. Basis of Design: Span-Lok
 - b. ATAS International, Inc.
 - c. CENTRIA Architectural Systems.
 - d. Firestone Building Products.
 - e. MBCI.
2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
3. Joint Type: Double folded As standard with manufacturer.
4. Panel Coverage: 16 inches.
5. Panel Height: 2.0 inches.
6. Color: As indicated on drawings or As selected by government from manufacturers full range.

2.3 HIGH TEMP UNDERLAYMENT

- A. Self-Adhering Membrane: High temperature, minimum; with slip-resisting, polymer-film-reinforced top surface laminated to layer of butyl or SBS-modified asphalt adhesive; with release backing; cold applied:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Henry Company. Basis of Design: "Blueskin®RF200"
 - b. Carlisle SynTec. "VapAir Seal 725TR."
 - c. Approved Equal.
- B. Adhesive/Primer: Self adhering membrane Manufacturers recommended adhesive/primer to enhance adhesion during cold weather applications or as required for adhesion for substrates encountered:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Henry Company. Basis of Design: "HE571" – Blueskin®Adhesive.
 - b. Carlisle. "CCW-702."
 - c. Approved Equal.

2.4 WATER-RESISTIVE BARRIER

- A. Building Wrap: ASTM E1677, Type I air barrier; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested according to ASTM E84; UV stabilized; and acceptable to authorities having jurisdiction.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Chemical Company (The); Styrofoam Weathermate Plus Brand Housewrap.
 - b. DuPont Building Innovations: E. I. du Pont de Nemours and Company; .
 - c. Ludlow Coated Products; .
 - d. Pactiv Corporation; .
 - e. Raven Industries, Inc; Fortress Pro Weather Protective Barrier.
 - f. Reemay, Inc; Typar HouseWrap.
 - 2. Water-Vapor Permeance: Not less than 75 perms (4300 ng/Pa x s x sq. m) per ASTM E 96/E 96M, Desiccant Method (Procedure A).
 - 3. Flame Propagation Test: Materials and construction shall be as tested according to NFPA 285.

4. Location: To be placed directly underneath standing seam metal panel on top of roof deck. See drawings for further information.
- B. Building-Wrap Tape: Pressure-sensitive plastic tape recommended by building-wrap manufacturer for sealing joints and penetrations in building wrap.

2.5 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 coating designation or ASTM A792/A792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- C. Gutters and Downspouts: Formed from same material as roof panels according to SMACNA's "Architectural Sheet Metal Manual." Finish to match metal roof panels roof fascia and rake trim.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads.
- E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/2 inch wide and 1/8 inch thick.
 2. Joint Sealant: ASTM C920; as recommended in writing by metal panel manufacturer.
 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.6 FABRICATION

- A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.7 FINISHES

- A. Panels and Accessories:
 - 1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.2 INSTALLATION OF HIGH TEMP UNDERLAYMENT

- A. Fully adhere a single layer of High Temp membrane, side and end lapping each sheet a minimum of 2-inches and 6-inches respectively. Prime roof substrates as required for complete bond of membrane to substrates encountered.
 - 1. Seal all laps and penetrations in High Temp membrane air/vapor/water tight.
- B. Flashings: Install flashings to cover High Temp membrane to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.3 INSTALLATION OF WATER-RESISTIVE BARRIER INSTALLATION

- A. Cover sheathing with water-resistive barrier as follows:
 - 1. Cut back barrier 1/2 inch on each side of the break in supporting members at expansion or control joint locations.

2. Apply barrier to cover vertical flashing with a minimum 4-inch overlap unless otherwise indicated.
- B. Building wrap: Comply with manufacturer's written instructions and warranty requirements.

3.4 INSTALLATION OF STANDING SEAM METAL ROOF PANELS

- A. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
1. Install clips to supports with self-tapping fasteners.
 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
 3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
 4. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
 5. Watertight Installation:
 - a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
 - b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 - c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.
- B. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
- C. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

3.5 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION

SECTION 07 42 93
SOFFIT PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal soffit panels.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Metal soffit panels.

B. Product Data Submittals:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data:** For metal panels to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:** An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A.** Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B.** Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C.** Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D.** Retain strippable protective covering on metal panels during installation.

- E. Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.6 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.7 COORDINATION

- A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings.
 - 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft.
- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:
 1. Test-Pressure Difference: 6.24 lbf/sq. ft.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METAL SOFFIT PANELS

- A. Provide metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.
- B. Metal Soffit Panels: Match profile and material of metal wall roof panels.
 1. Finish: Match finish and color of metal roof panels.
 2. Sealant: Factory applied within interlocking joint.
- C. Flush-Profile Metal Soffit Panels: Solid panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced between panel edges; with flush joint between panels.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AEP Span a brand of ASC Profiles LLC, a part of BlueScope.
 - b. ATAS International, Inc.
 - c. Berridge Manufacturing Company.
 - d. CENTRIA, a Nucor Brand.
 - e. Dimensional Metals, Inc.
 - f. Drexel Metals.
 - g. Englert, Inc.
 - h. Fabral; a brand of OmniMax International.
 - i. Firestone Building Products.
 - j. Innovative Metals Company, Inc.
 - k. MBCI; Cornerstone Building Brands.
 - l. McElroy Metal, Inc.
 - m. Merchant & Evans Inc.
 - n. Metal Sales Manufacturing Corporation.

- o. PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company.
 - p. Ultra Seam, Inc.
2. Material: Same material, finish, and color as metal roof panels.
 3. Panel Coverage: 12 inches (with intermediate beads in the panel at every 4 inches).
 4. Panel Height: 1.5 inches.

2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 1. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

2.4 FABRICATION

- A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 - 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 - 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal soffit panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Steel Panels and Accessories:
 - 1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 - 1. Examine framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal panel manufacturer.
 - 2. Examine sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal panel manufacturer.
 - a. Verify that air- or water-resistive barriers been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.
 - 1. Soffit Framing: Wire tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

3.3 INSTALLATION OF METAL SOFFIT PANELS

- A. Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Shim or otherwise plumb substrates receiving metal panels.
 - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
 - 3. Install screw fasteners in predrilled holes.
 - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 5. Install flashing and trim as metal panel work proceeds.

6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- D. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
1. Apply panels and associated items true to line for neat and weathertight enclosure.
 2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
 3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
 4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
- E. Watertight Installation:
1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels and elsewhere as needed to make panels watertight.
 2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 3. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.
- F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal panel system including trim, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.
- G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling, and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.4 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074293

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Roof-drainage sheet metal fabrications.
 2. Steep-slope roof sheet metal fabrications.
 3. Wall sheet metal fabrications.

1.2 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
 3. Review requirements for insurance and certificates if applicable.
 4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.4 ACTION SUBMITTALS

- A. Product Data: For each of the following
1. Underlayment materials.
 2. Butyl sealant.
- B. Shop Drawings: For sheet metal flashing and trim.
1. Include plans, elevations, sections, and attachment details.
 2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.

3. Include identification of material, thickness, weight, and finish for each item and location in Project.
4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Include details of roof-penetration flashing.
9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
10. Include details of special conditions.
11. Include details of connections to adjoining work.
12. Detail formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches.

- C. Samples: For each exposed product and for each color and texture specified, 12 inches long by actual width.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.
- B. Special warranty.

1.7 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
 2. Protect stored sheet metal flashing and trim from contact with water.

- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.9 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

- 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

- a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

- 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Sheet Metal Standard for Copper: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
- D. SPRI Wind Design Standard: Manufacture and install copings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:
 - 1. Design Pressure: As indicated on Drawings.

- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

- A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 coating designation aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 coating designation, Grade 40; prepainted by coil-coating process to comply with ASTM A755/A755M.
 1. Surface: Smooth, flat and with manufacturer's standard clear acrylic coating on both sides.
 2. Exposed Coil-Coated Finish:
 - a. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 3. Color: As selected by Contracting Officer from manufacturer's full range.
 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer in accordance with underlayment manufacturer's written instructions.

2.4 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal.
1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 2. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.
- C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- D. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

2.5 FABRICATION, GENERAL

- A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
 4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances:
1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
 2. Use lapped expansion joints only where indicated on Drawings.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.
- G. Seams:
1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
 3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.
- H. Do not use graphite pencils to mark metal surfaces.
- 2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS
- A. Hanging Gutters:
1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.
 2. Fabricate in minimum 96-inch- long sections.
 3. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than dimension indicated on Drawings.
 4. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters. Shop fabricate interior and exterior corners.
- B. Downspouts: Fabricate rectangular downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from . Shop fabricate elbows.
1. Fabricate from the following materials:

- a. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

2.7 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following materials:
 - 1. Aluminum-Zinc Alloy-Coated Steel: 24 gage.
- B. Valley Flashing: Fabricate from the following materials:
 - 1. Aluminum-Zinc Alloy-Coated Steel: 24 gage.
- C. Drip Edges: Fabricate from the following materials:
 - 1. Aluminum-Zinc Alloy-Coated Steel: 24 gage.
- D. Eave, Rake, Ridge, and Hip Flashing: Fabricate from the following materials:
 - 1. Aluminum-Zinc Alloy-Coated Steel: 24 gage.
- E. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
 - 1. Aluminum-Zinc Alloy-Coated Steel: 24 gage.

2.8 WALL SHEET METAL FABRICATIONS

- A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- long, but not exceeding 12-foot- long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch- high, end dams. Fabricate from the following materials:
 - 1. Stainless Steel: 0.0156 inch thick.
- B. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch- high, end dams. Fabricate from the following materials:
 - 1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.
5. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

3.3 INSTALLATION, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder.
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
6. Space individual cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
8. Do not field cut sheet metal flashing and trim by torch.
9. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
 1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
 2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
 3. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
 1. Use sealant-filled joints unless otherwise indicated.
 - a. Embed hooked flanges of joint members not less than 1 inch into sealant.
 - b. Form joints to completely conceal sealant.
 - c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
 - d. Adjust setting proportionately for installation at higher ambient temperatures.
 - 1) Do not install sealant-type joints at temperatures below 40 deg F.
 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.
 1. Pretin edges of sheets with solder to width of 1-1/2 inches; however, reduce pretinning where pretinned surface would show in completed Work.
 2. Do not solder metallic-coated steel sheet.
 3. Do not pretin zinc-tin alloy-coated copper.
 4. Do not use torches for soldering.
 5. Heat surfaces to receive solder, and flow solder into joint.
 - a. Fill joint completely.
 - b. Completely remove flux and spatter from exposed surfaces.
 6. Stainless Steel Soldering:
 - a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
 - b. Promptly remove acid-flux residue from metal after tinning and soldering.

- c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
 - 7. Copper Soldering: Tin edges of uncoated sheets, using solder for copper.
 - 8. Copper-Clad Stainless Steel Soldering: Tin edges of uncoated sheets, using solder for copper-clad stainless steel.
- H. Rivets: Rivet joints in zinc where necessary for strength.

3.4 INSTALLATION OF ROOF-DRAINAGE SYSTEM

- A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Hanging Gutters:
 - 1. Join sections with riveted and soldered joints.
 - 2. Provide for thermal expansion.
 - 3. Attach gutters at eave or fascia to firmly anchor them in position.
 - 4. Provide end closures and seal watertight with sealant.
 - 5. Slope to downspouts.
 - 6. Fasten gutter spacers to front and back of gutter.
 - 7. Anchor and loosely lock back edge of gutter to continuous cleat.
 - 8. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches apart.
 - 9. Anchor gutter with spikes and ferrules spaced not more than 24 inches apart.
 - 10. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, 50 feet apart. Install expansion-joint caps.
- C. Downspouts:
 - 1. Join sections with 1-1/2-inch telescoping joints.
 - 2. Provide hangers with fasteners designed to hold downspouts securely to walls.
 - 3. Locate hangers at top and bottom and at approximately 60 inches o.c.
 - 4. Provide elbows at base of downspout to direct water away from building.
 - 5. Connect downspouts to underground drainage system.

3.5 INSTALLATION OF ROOF FLASHINGS

- A. Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard.
 - 1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
 - 2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing:

1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.
3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.

C. Copings:

1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated.
 - a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 16-inch centers.
 - b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch centers.
3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.

1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
2. Extend counterflashing 4 inches over base flashing.
3. Lap counterflashing joints minimum of 4 inches.
4. Secure in waterproof manner by means of anchor and washer spaced at 12 inches o.c. along perimeter and 6 inches o.c. at corners areas unless otherwise indicated.

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with butyl sealant and clamp flashing to pipes that penetrate roof.

3.6 INSTALLATION OF WALL FLASHINGS

- A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

- B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

3.7 INSTALLATION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.8 CLEANING

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.

3.9 PROTECTION

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.
- C. Maintain sheet metal flashing and trim in clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Contracting Officer.

END OF SECTION 076200

SECTION 07 92 00 JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes sealant work associated with joints between similar and dissimilar materials in the Work.
- B. Work included consists of, but is not necessarily limited to the following:
 - 1. Sealing all joints which would otherwise permit penetration of moisture, unless sealing work is specifically required under other sections.
 - a. Flashing reglets and retainers.
 - b. Exterior wall joints.
 - c. Flooring joints.
 - d. Isolation joints.
 - e. Joints between paving and sidewalks and building.
 - f. Concrete control and expansion joints, exterior and interior.
 - g. Joints at penetrations of walls, floors, and decks by piping and other services and equipment.
 - h. Exterior and interior perimeters of exterior and interior door and window frames, louvers, grilles, etc.
 - i. Thresholds at exterior doors.
 - j. Sealing of plumbing fixtures to floor or wall.
 - k. Other joints where calking, sealant, or compressible sealant is indicated.

1.2 REFERENCES

- A. ASTM International (ASTM) standards, most recent editions:

ASTM C920	Standard Specification for Elastomeric Joint Sealants
ASTM C1087	Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems
ASTM C1193	Standard Guide for Use of Joint Sealants
ASTM C1247	Standard Test Method for Durability of Sealants Exposed to Continuous Immersion in Liquids
- B. Federal Specification (FS), most recent editions:

TT-S-001543A	Sealing Compound: Silicone Rubber Base (for Caulking, Sealing, and Glazing in Buildings and Other Structures)
--------------	---

TT-S-00230C Sealing Compound: Elastomeric Type, Single Component (For Calking, Sealing, and Glazing in Buildings and Other Structures)

TT-S-00227E Sealing Compound: Elastomeric Type, Multi-Component (for Caulking, Sealing, and Glazing in Buildings and Other Structures)

C. Underwriters Laboratories Inc. (UL):

Building Materials Directory

D. National Sanitation Foundation (NSF), most recent edition:

NSF 61 Drinking Water System Components, Health Effects

1.3 DEFINITIONS

A. Words "calk," "sealant," and "calking" mean sealant Work.

B. "Interior wet areas" mean toilets, showers, sinks, and similar areas.

C. "Applicator" means the individual actually on site performing the installation.

D. "Vertical" means any surface with a slope greater than 1.5 horizontal to 1.0 vertical.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product Data

1. Letter of certification that products submitted meet requirements of standards referenced.
2. Manufacturer's installation instructions.
3. Manufacturer's recommendations for joint cleaner, primer, backer rod, tooling, and bond breaker.
4. Applicator qualifications.
5. Warranty.
6. Certification from sealant manufacturer stating that product being used is recommended for and is best suited for joint in which it is being applied.

C. Field Samples

1. Cured sample of each color for Engineer's color selection. Color chart not acceptable.

D. Preconstruction field test reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in below in QUALITY ASSURANCE.

E. Product test reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.

F. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Sealant applicator shall have a minimum of five years of experience on projects with similar scope.

B. Mock-ups:

1. Before calking work is started, a sample of each type of joint shall be calked where directed by Engineer. The approved samples shall show the workmanship, bond, and color of calking materials as specified or selected for the Work and shall be the minimum standard of quality on the entire Project.

C. Preconstruction compatibility and adhesion testing:

1. Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
 - a. Use ASTM C1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - b. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
 - c. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - d. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
 - e. Testing will not be required if sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

D. Preconstruction field-adhesion testing: Before installing elastomeric sealants, field test their adhesion to joint substrates found in the Work as follows:

1. Locate test joints where indicated in the Work or, if not indicated, as directed by the Engineer.
2. Conduct tests for each application indicated below:
 - a. Each type of elastomeric sealant and joint substrate indicated.
3. Notify Engineer a minimum of 7 days in advance of dates and times when test joints will be evaluated.
4. Test method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 of ASTM C1193.
5. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of preconstruction field-adhesion test results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with

requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.
- B. Deliver material in manufacturer's original unopened containers with labels intact. Labels shall indicate contents and expiration date of material.
- C. Store all materials off the ground and protect from rain, freezing, or excessive heat until ready for use.
- D. Condition the specified products before use as recommended by the manufacturer.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Schedule Work to be performed when temperature and humidity are as recommended by the sealant manufacturer during and after installation until products are fully cured.

1.8 WARRANTY

- A. Material and Labor Warranty:
 - 1. Sealant work shall be free of defects for a period of 5 years from date of final acceptance.
 - 2. Failure of watertightness constitutes defect.
 - 3. Remove any defective work and/or materials and replace with new materials.
 - 4. Warranty must be signed jointly by applicator and sealant manufacturer.
- B. Special installer's warranty:
 - 1. Installer's standard form in which installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified herein within specified warranty period.
 - a. Warranty period: Five years from date of final acceptance.
 - 2. Special warranties herein specified exclude deterioration or failure of elastomeric joint sealants from the following:
 - a. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design.
 - b. Disintegration of joint substrates from natural causes exceeding design specifications.
 - c. Mechanical damage by individuals, tools, or other outside agents.
 - d. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
1. Polyurethane sealants.
 - a. Pecora.
 - b. PSI Polymeric Systems, Inc.
 - c. Sika Chemical Corporation.
 - d. BASF Master Builders.
 - e. Engineer approved equal.
 2. Silicone sealants:
 - a. Dow Corning Corporation.
 - b. General Electric.
 - c. Tremco
 - d. Engineer approved equal.

2.2 MATERIALS

- A. Sealants – General:
1. Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
 2. Where compound is exposed to view in finished Work, provide colors matching materials being sealed.
 3. Where compound is not exposed to view in finished Work, provide manufacturer's color with best performance.
 4. For joints in potable water reservoirs, provide only 2-component polyurethane sealant with NSF 61 certification.
 5. Provide non sagging sealant for vertical and overhead joints.
 6. Sealants for horizontal joints:
 - a. Self-leveling pedestrian/traffic grade.
 7. Suitability for immersion in liquids: Where elastomeric sealants are indicated for submerged use, provide products that have undergone testing according to ASTM C1247 and qualify for the length of exposure indicated by reference to ASTM C920 for Classes 1 or 2. Liquid used for testing sealants is chlorinated potable water, unless otherwise noted.
- B. Polyurethane Sealant:
1. One or two components.
 2. Meet ASTM C920; F.S. TT-S-00230C, Type I or Type II, Class A, or TT-S-00227E, Type I or Type II, Class A.
 - a. Pecora Dynatrol I, Dynatrol II, Urexpam NR-200 or NR-201.
 - b. PSI PSI-270.
 - c. Sika Sikaflex-1A, Sikaflex-2C.
 - d. Master Builders MasterSeal NP-1, NP-II, SL-1.
- C. Silicone Sealant:

1. One component.
 2. Meet F.S. TT-S-001543A, Class A:
 - a. Dow Corning 790, 795, 786.
 - b. General Electric Silpruf, Silglaze, Sanitary SCS 1700 sealant.
 - c. Tremco Spectrem.
- D. Bond breaker tape: Polyethylene tape of other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint surfaces of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.
1. Unless specifically shown on the Drawings, bond breaker shall not be used in joints within the reservoir.
- E. Joint Cleaner, Primer, Bond Breaker:
1. As recommended by sealant manufacturer.
- F. Sealant Backer Rod: Closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, non-absorbent, non-bituminous material recommended by sealant manufacturer to:
1. Control joint depth
 2. Break bond of sealant at bottom of joint
 3. Provide proper shape of sealant bead.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before using any sealant, investigate its compatibility with adjacent joint surfaces, fillers, and other materials in the joint system.
- B. Use only compatible materials.
- C. Clean and prime joint surfaces in accordance with manufacturer's instructions.
 1. Limit application to surfaces to receive sealant.
 2. Mask off adjacent surfaces.
- D. Commencing sealant installation constitutes acceptance of joints and surfaces.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Where finish coating or covering is to be applied to surface, wait until such coating or covering has been applied before installing sealant; e.g., paint, wall covering, glazed coatings.
- C. Make all joints water and air tight.
- D. Make depth of sealing compounds not more than one-half width of joint, but in no case less than 1/4 inch nor more than 5/8 inch.

- E. Provide correctly sized backer rod in all joints to proper depth
- F. Apply bond breaker where required.
- G. Tool sealants using sufficient pressure to fill all voids.
- H. Upon completion, leave sealant with smooth even neat finish.

3.3 CLEANING

- A. Clean adjacent soiled surfaces free of sealant.

3.4 PROTECTION

- A. Protect finished installation.
- B. Protect sealants until fully cured.

3.5 SCHEDULES

- A. Furnish sealant as indicated for the following areas:
 - 1. Exterior areas:
 - a. Joints in concrete and masonry:
 - 1) Use 2-component polyurethane only.
 - b. All other joints:
 - 1) Single or 2-component Polyurethane or.
 - 2) Silicone.
 - 2. Interior wet areas:
 - a. Joints in concrete and masonry:
 - 1) Use 2-component polyurethane only.
 - b. All other joints:
 - 1) Single or 2-component Polyurethane or.
 - 2) Silicone.
 - 3. Interior non-wet, drywall and plaster noncorrosive areas:
 - a. All Joints:
 - 1) Single or 2-component Polyurethane or.
 - 2) Silicone.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

DIVISION 8
OPENINGS

SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes:
 - 1. Exterior standard steel doors and frames.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door type.
 - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
- C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.4 INFORMATIONAL SUBMITTALS

- A. Product test reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Apex Industries, Inc.
2. Ceco Door; ASSA ABLOY.
3. Curries Company; ASSA ABLOY.
4. Steelcraft; an Allegion brand.

2.2 PERFORMANCE REQUIREMENTS

- A. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.40 deg Btu/F x h x sq. ft. when tested according to ASTM C 518.

2.3 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2; SDI A250.4, Level B.
 1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches .
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch, with minimum A60 coating.
 - d. Edge Construction: Model 1, Full Flush.
 - e. Edge Bevel: Bevel lock and hinge edges 1/8 inch in 2 inches.
 - f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
 - g. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
 - h. Core: Manufacturer's standard insulation material.
 2. Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 2.1 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
 3. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
 - b. Construction: Full profile welded.
 4. Exposed Finish: Primed

2.4 FRAME ANCHORS

- A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.
- D. Material: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M; hot-dip galvanized according to ASTM A 153/A 153M, Class B.

2.5 MATERIALS

- A. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
- B. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- C. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- D. Glazing: Comply with requirements in Section 088000 "Glazing."

2.6 FABRICATION

- A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum **3/4 inch** beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 2. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

- b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

2.7 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

- A. Hollow-Metal Frames: Comply with NAAMM-HMMA 840.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - b. Install frames with removable stops located on secure side of opening.
 - 2. Floor Anchors: Secure with postinstalled expansion anchors.

- a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
- 3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
- 4. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- B. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
 - 1. Non-Fire-Rated Steel Doors: Comply with NAAMM-HMMA 841 and NAAMM-HMMA guide specification indicated.

3.3 CLEANING AND TOUCHUP

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION

SECTION 08 71 11
DOOR HARDWARE (DESCRIPTIVE SPECIFICATION)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mechanical door hardware for the following:
 - a. Swinging doors.
2. Cylinders for door hardware specified in other Sections.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For electrified door hardware.

1. Include diagrams for power, signal, and control wiring.
2. Include details of interface of electrified door hardware and building safety and security systems.

C. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Submittal Sequence: Submit door hardware schedule submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
3. Content: Include the following information:
 - a. Identification number, location, hand, fire rating, size, and material of each door and frame.
 - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.

- d. Fastenings and other installation information.
- e. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
- f. Mounting locations for door hardware.
- g. List of related door devices specified in other Sections for each door and frame.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:
 - a. Exit Devices: Two years from date of Substantial Completion.
 - b. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- B. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the ABA standards of the Federal agency having jurisdiction.
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
 - 2. Comply with the following maximum opening-force requirements:

- a. Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.
5. Adjust spring hinges so that, from an open position of 70 degrees, the door will take at least 1.5 seconds to move to the closed position.

2.2 HINGES

A. Hinges: BHMA A156.1.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allegion plc.
 - b. Lawrence Hardware Inc.
 - c. PAMEX Inc.
 - d. Stanley Commercial Hardware; a division of Stanley Security Solutions.

B. Antifriction-Bearing Hinges:

1. Mounting: Full mortise (butts).
2. Bearing Material: Ball bearing.
3. Base and Pin Metal: Stainless steel with stainless steel pin
4. Pins: Non-rising loose unless otherwise indicated.
5. Tips: Flat button.
6. Corners: Square.

2.3 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Mortise Locks: Minimum 3/4-inch latchbolt throw.
2. Deadbolts: Minimum 1-inch bolt throw.

C. Lock Backset: 2-3/4 inches unless otherwise indicated.

D. Lock Trim:

1. Description: Contour / Angle Return Lever.
2. Levers: Cast.

- a. Construction: Solid.
 - b. Finish 626 Satin Chrome.
 - c. Trim Style: 2 3/4" Flat Trim Style (H).
- 3. Dummy Trim: Match lever lock trim.
- E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
- F. Mortise Locks: BHMA A156.13; Operational Grade 1; stamped steel case with steel or brass parts; Series 1000.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Accurate Lock & Hardware Co.
 - b. Allegion plc.
 - c. Arrow USA; an ASSA ABLOY Group company.
 - d. Best Access Systems; Stanley Security Solutions, Inc.
 - e. DORMA USA, Inc.
 - f. Lawrence Hardware Inc.
 - g. SARGENT Manufacturing Company; ASSA ABLOY.
 - h. Stanley Commercial Hardware; a division of Stanley Security Solutions.

2.4 AUXILIARY LOCKS

- A. Mortise Auxiliary Locks: BHMA A156.36; Grade 1; with strike that suits frame.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Accurate Lock & Hardware Co.
 - b. Allegion plc.
 - c. Arrow USA; an ASSA ABLOY Group company.
 - d. Best Access Systems; Stanley Security Solutions, Inc.
 - e. SARGENT Manufacturing Company; ASSA ABLOY.
 - f. Stanley Commercial Hardware; a division of Stanley Security Solutions.
 - 2. Backset: 2-3/4 inches.
 - 3. Material: Stainless steel.
 - 4. Deadlocks: Deadbolt operated by key outside and turn inside.

2.5 EXIT DEVICES AND AUXILIARY ITEMS

- A. Exit Devices and Auxiliary Items: BHMA A156.3.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allegion plc.
 - b. C.R. Laurence Co., Inc.
 - c. DORMA USA, Inc.
 - d. Lawrence Hardware Inc.
 - e. PAMEX Inc.
 - f. SARGENT Manufacturing Company; ASSA ABLOY.
 - g. Stanley Commercial Hardware; a division of Stanley Security Solutions.
- B. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing in accordance with UL 305.
- C. Rim Exit Devices: Grade 1.
 - 1. Type: 4, narrow stile.
 - 2. Actuating Bar: Narrow-stile push pad.
- D. Exit Device Outside Trim: Lever; material and finish to match locksets unless otherwise indicated.
 - 1. Match design for lock trim unless otherwise indicated.

2.6 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. Provide cylinder from same manufacturer of locking devices.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allegion plc.
 - b. ASSA, Inc.
 - c. Best Access Systems; Stanley Security Solutions, Inc.
 - d. PAMEX Inc.
 - e. SARGENT Manufacturing Company; ASSA ABLOY.
 - f. Stanley Commercial Hardware; a division of Stanley Security Solutions.
- B. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.

1. Core Type: Removable.
2. Number of Pins: Six.
3. Lock Type: Mortise type.

2.7 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock. Incorporate decisions made in keying conference.

1. Existing System:
 - a. Master key or grand master key locks to Government's existing system.

2.8 OPERATING TRIM

- A. Operating Trim: BHMA A156.6; stainless steel unless otherwise indicated.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allegion plc.
 - b. Burns Manufacturing Incorporated.
 - c. Trimco.
- B. Flat Push Plates: With square corners and beveled edges; secured with exposed screws.
1. Thickness: 0.050 inch.
 2. Size: 4 inches wide by 16 inches high.
- C. Straight Door Pulls:
1. Type: 3/4-inch constant-diameter pull.
 2. Mounting: Surface applied with concealed fasteners.
 3. Minimum Clearance: 1-1/2 inches from face of door.
 4. Overall Length: 9 inches.

2.9 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Allegion plc.
- b. DORMA USA, Inc.
- c. Norton Door Controls; an ASSA ABLOY Group company.
- d. PAMEX Inc.
- e. SARGENT Manufacturing Company; ASSA ABLOY.
- f. Stanley Commercial Hardware; a division of Stanley Security Solutions.

- B. Surface Closer with Cover: Grade 1; Modern type with mechanism enclosed in cover.

1. Mounting: top jamb.
2. Type: Regular arm.
3. Backcheck: Adjustable, effective between 60 and 85 degrees of door opening.
4. Cover Material: Aluminum.
5. Closing Power Adjustment: At least 35 percent more than minimum tested value.

2.10 MECHANICAL STOPS AND HOLDERS

- A. Wall- and Floor-Mounted Stops: BHMA A156.16.
- B. Dome-Type Floor Stop: Grade 1; with minimum 1-inch- high bumper for doors without threshold and 1-3/8-inch- high bumper for doors with threshold.
 1. Provide with extruded-aluminum riser for carpet installations.
- C. Wall Bumpers: Grade 1; with rubber bumper; 2-1/2-inch diameter, minimum 3/4-inch projection from wall; with backplate for concealed fastener installation.
 1. Bumper Configuration: Concave.

2.11 DOOR GASKETING

- A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
- B. Maximum Air Leakage: When tested in accordance with ASTM E283 with tested pressure differential of 0.3-inch wg, as follows:
 1. Gasketing on Single Doors: 0.3 cfm/sq. ft. of door opening.
 2. Gasketing on Double Doors: 0.50 cfm per ft. of door opening.
- C. Adhesive-Backed Perimeter Gasketing: Neoprene bulb gasket material applied to frame rabbet with self-adhesive.

- D. Door Sweeps: Neoprene gasket material held in place by flat housing or flange; surface mounted to face of door with screws.

- 1. Housing or Flange Material: Aluminum.

2.12 THRESHOLDS

- A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

- B. Saddle Thresholds:

- 1. Type: Thermal break and fluted top, barrier free.
 - 2. Base Metal: Aluminum.

2.13 AUXILIARY DOOR HARDWARE

- A. Silencers for Metal Door Frames: Grade 1; neoprene or rubber; minimum diameter 1/2 inch; fabricated for drilled-in application to frame.

2.14 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames in accordance with ANSI/SDI A250.6.
- B. Wood Doors: Comply with door and hardware manufacturers' written instructions.

3.3 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

3.4 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

END OF SECTION 08 71 11

DIVISION 09
FINISHES

**SECTION 09 29 00
GYPSUM BOARD**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each texture finish indicated on same backing indicated for Work.

PART 2 - PRODUCTS

2.1 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.2 INTERIOR GYPSUM BOARD

- A. Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Gypsum.
 - b. CertainTeed Corporation.
 - c. Georgia-Pacific Building Products.
 - d. United States Gypsum Company.
 - 2. Core: 5/8 inch, Type X.
 - 3. Long Edges: Tapered.

2.3 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. L-Bead: L-shaped; exposed long flange receives joint compound.
 - d. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - e. Expansion (control) joint.
 - f. Curved-Edge Cornerbead: With notched or flexible flanges.

2.4 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 1. Interior Gypsum Board: Paper.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
 5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.

2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

PART 3 - EXECUTION

3.1 APPLYING AND FINISHING PANELS

- A. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- B. Comply with ASTM C 840.
- C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- D. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- E. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- F. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- G. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: Not used.
 - 3. Level 3: Not used.
 - 4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 09 90 00 "Coatings and Painting."
 - 5. Level 5: Not used.

3.2 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION

**SECTION 09 90 00
PROTECTIVE COATINGS**

PART 1 GENERAL

1.1 WORK INCLUDED

- A. This section covers surface preparation, furnishing, and application of protective coatings, complete.
- B. It is the intent of this specification that all new or existing expose metal surfaces, shall be coated with a protective coating, unless specifically excluded.
- C. Shop or existing surface preparation methods, cleanliness, and existing paint, rust, and mill scale removal is not known nor documented. Contractor shall be solely responsible for determining work effort, abrasive blast requirements, and any other factors that may affect work productivity as required to provide the specified surface preparation cleanliness; regardless of prior system preparation or coating application.

1.2 RELATED SECTIONS:

- A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
- B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
- C. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 01 33 20 - Submittal Procedures.
 - 2. Section 09 90 10 - Pipeline Coating and Lining

1.3 GENERAL:

- A. See section GENERAL CONDITIONS, which contain information and requirements that apply to the work specified and are mandatory for this project.

1.4 ABBREVIATIONS

AMPP	Association for Materials Protection and Performance
ANSI	American National Standards Institute
AWWA	American Water Works Association
MDFT	Minimum Dry Film Thickness

MDFTPC	Minimum Dry Film Thickness Per Coat
mil	Thousandths of an Inch
NACE	National Association of Corrosion Engineers
OSHA	Occupational Safety and Health Act
PSDS	Paint System Data Sheet
SFPG	Square Feet Per Gallon
SFPGPC	Square Feet Per Gallon Per Coat
SP	Surface Preparation
SSPC	Steel Structures Painting Council

1.5 REFERENCE STANDARDS

- A. This specification recognizes AWWA, AMPP (NACE and SSPC) standards as minimum industry standards and they are referenced for purpose of conformance, except where modified in this section. The requirements of this specification section have been written to a higher design standard with the intent of achieving a long-term coating performance of 100 years.

NACE SP0188	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
NACE RP-0274	High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation.
SSPC-SP-1	Solvent Cleaning Surface Preparation
SSPC-SP-2	Hand Tool Cleaning Surface Preparation
SSPC-SP-3	Power Tool Cleaning Surface Preparation
SSPC-SP-5	White metal Abrasive Blast Surface Preparation
SSPC-SP-6	Commercial Abrasive Blast Surface Preparation
SSPC-SP-10	Near White Metal Abrasive Blast Surface Preparation
SSPC-SP-11	Power Tool Cleaning to Bare Metal
SSPC-SP-13	Surface Preparation of Concrete

1.6 SUBMITTAL REQUIREMENTS

- A. Contractor submittals shall be made in accordance with Division 1 of the Owner Standards.
- B. Shop Drawings: Catalog cuts and other information for all products proposed. Provide copy of approved coating system submittals to the coating applicator.
- C. Quality Control Submittals: Furnish the following:
1. Applicator's Experience with list of references substantiating compliance.

2. Coating manufacturer's certification stating the individual coating applicators have met the qualification certification requirements as specified this section.
 3. Coating manufacturer shall provide a copy of the manufacturer's coating application quality assurance manual.
 4. If the manufacturer of field-applied coating differs from that of the shop applied primer, provide written confirmation from both manufacturers' that the two coating materials are compatible.
- D. Product Data: Furnish the following Data Sheets:
1. For each paint system used herein, furnish a Paint System Data Sheet (PSDS), Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system, except for products applied by equipment manufacturers. A sample PSDS form is appended at the end of this section.
 2. The required information shall be submitted on a system-by-system basis.
 3. The Contractor shall also provide copies of the paint system submittals to the coating applicator.
 4. Indiscriminate submittal of manufacturer's literature only is not acceptable.
- E. Where ANSI/NSF Standard 60 and 61 approvals is required, submit ANSI/NSF certification letter for each coating in the system indicating product application limits on size of tank or piping, dry film thickness, number of coats, specific product tested, colors certified, and approved additives.
- F. Provide TCLP test data for lead and other regulated heavy metals in non-recyclable, slag type abrasive blast media to be used on the project. Acceptable abrasive test data shall indicate the abrasive manufacturer, location of manufacture, and media gradation and type. Surface preparation will not be permitted to begin until acceptable test data has been submitted.

1.7 QUALITY ASSURANCE

- A. Coating Applicator's Experience and Certification:
1. Coating Application Company and coating application supervisor (Certified Applicator) shall have a minimum of 5 years' experience applying the specified coating system.
 2. Coating application personnel, whom have direct coating application responsibility, shall have a minimum of 2 years practical experience in application of the indicated coating system.
 3. Coating applicator shall be certified by the coating manufacturer as an approved applicator.
- B. Continuity of Contractor: Contractor's site supervisor shall be coordinated with the Engineer. Any replacement of the supervisor on site will require notification of Engineer 72 hours in advance and will be subject to approval by the Owner.
- C. Coating and/or lining manufacturer shall provide a technical representative to visit the jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and these Specifications, and as may be necessary to resolve field problems

attributable to, or associated with, the manufacturer's products furnished under this Contract. Sale representatives are not acceptable as a technical representative unless written authorization from the coating manufacture is provided which states the sales representative has full authority to act on the behalf of the coating manufacturer.

1.8 WARRANTY

- A. The Contractor and coating manufacturer shall jointly and severally warrant to the Owner and guarantee the work under this section against defective workmanship and materials for a period of 2 year(s) commencing on the date of final acceptance of the work.

1.9 ENGINEER OBSERVATIONS

- A. The Contractor shall give the Owner Representative notice a minimum of 14 days prior to start of work for scheduling shop or field observation.
- B. Provide Owner Representative a minimum 3 days' notice for actual start of surface preparation and coating application work.
- C. Provisions shall be made to allow Owner's representative full access to facilities and appropriate documentation regarding coating application.
- D. Observation by the Owner's representative or the waiver of observation of any portion of the work shall not be construed to relieve the Contractor of his responsibility to perform the work in accordance with these Specifications.
- E. Materials shall be subject to testing for conformance with this specification as the Owner's representative may elect, prior to or during incorporation into the work.
- F. Perform work in the presence of ENGINEER or Owner Representative, unless prior approval to perform such work is granted. Approval to perform work is limited to the current day unless specifically noted to extend beyond the completion of the workday.

PART 2 PRODUCTS

2.1 GENERAL

- A. Coatings and linings will be stored and handled per manufacturer's written directions.
- B. All metallic surfaces shall be prepared and coated in accordance with referenced standards, written instructions of the coating or lining manufacturer, and these specifications, whichever is more stringent, unless specified otherwise.
- C. Coatings shall be the product of a single manufacturer. Product substitutions during the project will not be permitted, without ENGINEER approval.

2.2 PAINT DELIVERY, STORAGE, AND HANDLING

- A. Delivered paint to the project site in unopened containers that plainly show, at the time of use, the designated name, date of manufacture, color, and name of manufacturer.
- B. Stored paints in a suitable protected area that is heated or cooled as required to maintain temperatures within the range recommended by the paint manufacturer.
- C. Shipping:
 - 1. Where shop finish coated or primed items are to be shipped to the jobsite, protect coating from damage. Batten coated items to prevent abrasion.
 - 2. Use nonmetallic or padded slings and straps in handling.
 - 3. Items will be rejected for excessive damage.

2.3 PAINT AND COATINGS MANUFACTURERS

- A. A manufacturer letter code as follows will be found following the generic descriptions of materials outlined in the Specifications. Address is that of the general offices. Contact these offices for information regarding the location of representative nearest the project site.
- B. MANUFACTURER CODE A - COATINGS MANUFACTURERS (Able to supply most heavy-duty industrial coatings and architectural paints):
 - 1. Carboline Coatings Company, St. Louis, MO.
 - 2. ICI Devoe Coatings Company, Louisville, KY.
 - 3. International Coatings,
 - 4. Pittsburgh Paints (PPG), Pittsburgh, PA.
 - 5. Sherwin Williams, Cleveland, OH
 - 6. Tnemec Coatings, Kansas City, MO

2.4 PAINT MATERIALS

- A. Products shall meet federal, state, and local requirements limiting the emission of volatile organic compounds. Specific information may be secured through the local office of the Air Pollution Control Officer.
- B. Materials Including Primer and Finish Coats: Produced by same paint manufacturer.
- C. Thinners, Cleaners, Driers, and Other Additives: As recommended by paint manufacturer of the coating system. Where coatings are required to meet ANSI/NSF Standard 60 and 61, addition of thinners, driers, and other paint additives not approved under the ANSI/NSF certification letter will not be permitted without written approval from the Engineer.
- D. Paint products are listed according to their approximate order of appearance in the paint systems. The letter designating the manufacturer code refers to Article PAINT AND COATING MANUFACTURERS.

Products	Description
Epoxy, NSF	Amine or polyamine epoxy coating, two parts, suitable for immersion service, 75% volume solids minimum, capable of 4

	to 8 MDFT per coat, approved for potable water contact in conformance to ANSI/NSF Standard 60 and 61, and suitable for the application temperatures and conditions. MANUFACTURER CODE: A
Epoxy	Polyamine or polyamide epoxy, two parts, suitable for immersion service, 75% volume solids minimum, capable of 4 to 8 MDFT per coat, and suitable for the application temperatures and conditions. MANUFACTURER CODE: A
Polysiloxane	Acrylic polysiloxane hybrid coating, single component, suitable for shop or field application at 32 degrees F, minimum, recoat window of not less than 12 months with preference for products with unlimited overcoat capability, solids content of 85% minimum, high gloss, and tintable colors. Tinted colors shall be capable of storage for 30 days or longer prior to application. Coating shall be capable of spray, roller, or brush application on all metal substrates and specified prime and intermediate coats. MANUFACTURER CODE: A
Zinc Rich Primer	Solvent or water based, 14 lbs. metallic zinc content per gallon minimum; unlimited recoat window, conform to manufacturer's recommended top coats as specified herein. MANUFACTURER CODE: A
Wash Primer	Vinyl butyral acid or equivalent coating for enhancing finish coat adhesion to galvanized steel surfaces. MANUFACTURER CODE: A
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish, suitable for continuous dry service at 200 degrees F without discoloration or peeling. MANUFACTURER CODE: A

2.5 COLORS

- A. Provide as selected by the Owner.
- B. Formulated with colorants free of lead, lead compounds, or other materials which might be affected by the presence of hydrogen sulfide or other gas likely to be present at the project.
- C. Proprietary identification of colors is for identification only. Any authorized manufacturer may supply matches.
- D. Equipment Colors:
 - 1. Equipment shall be meant to include the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
 - 2. Paint non-submerged portions of equipment in the same color as the process piping it serves, except as itemized below:
 - a. Dangerous parts of equipment and machinery: OSHA Orange
 - b. Fire protection equipment and Apparatus: OSHA Red
 - c. Radiation hazards: OSHA Purple

- d. Physical hazards in normal operating area: OSHA Yellow
 - 3. Fiberglass reinforced plastic (FRP) equipment with an integral colored gel coat does not require painting, provided the color is as specified.
- E. Pipe Identification Painting:
 - 1. Color code non-submerged metal piping except electrical conduit. Paint fittings and valves the same color as the pipe.
 - 2. Piping color coding: In accordance with the Piping Schedule as shown.
 - 3. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at all connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along the piping not greater than 9 feet on center, with identification labels applied to each exposed run of pipe as specified herein.
 - 4. Pipe supports: Mild steel, painted No. 70 light gray as specified in ANSI Z35.1.
 - 5. Fiberglass reinforced plastic (FRP) pipe and polyvinyl chloride (PVC) pipe located outside of buildings and enclosed structures will not require painting, except as noted.
- F. Labels for Piping:
 - 1. Identification labels shall bear the full piping system name as specified in the Piping Schedule shown.
 - 2. Install separate flow directional arrows with each label.
 - 3. Include black lettering on OSHA safety yellow self-adhesive vinyl or vinyl cloth.
 - 4. Lettering height: Meet ANSI A13.1.
 - 5. Label and Adhesive: Long lasting, resistant to moisture, oils, solvents, and weathering, meeting OSHA requirements.
 - 6. Locate labels at all connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along the piping not greater than 18 feet on center, with at least one label applied to each exposed run of pipe.
 - 7. Manufacturers:
 - a. W. H. Brady Co., Milwaukee, WI
 - b. Seton Nameplate Corp., New Haven, CT
 - c. or Equal.

2.6 QA/QC TESTING AND INSPECTION

- A. General
 - 1. Applicator shall inspect and test the coating system in accordance with referenced standards and these specifications, whichever is more stringent.
 - 2. Quality control testing as specified in AWWA standards are minimum industry standards and it is the intent of this specification to provide a higher level of quality control for the objective of achieving maximum coating performance.
 - 3. If any conflict between this specification and referenced standards occurs, the more stringent requirement shall apply and any interpretation of this requirement or results shall be with the objective of achieving maximum coating performance.
 - 4. The frequency of the testing shall be determined by the applicator but shall not be less than the requirements of this specification.
- B. Surface Profile Testing

1. Surface profile of abrasive blasted surfaces to be tested with "Press-O-Film" tester tape or equivalent in accordance with NACE RP287.
 2. Tester tape shall be suitable for the intended profile height.
 3. Profile shall be measured to a minimum tolerance of 0.1 mils, maximum.
 4. Electronic surface profilometer shall be used, where deemed necessary, to verify tester tape measurements.
- C. Adhesion testing: As specified in Section 09 90 10, where directed by the Engineer for assessing coating application problems.
- D. Holiday Testing
1. Holiday tests on polyurethane coatings or linings will be conducted on the completed coating or lining after cure or 24-hours, whichever is less, using a high voltage spark test in accordance with NACE SP-0188 and these specifications.
 2. Coating thickness used for high voltage holiday testing setting shall be the average dry coating thickness.
- E. Dry Film Thickness Testing
1. Coatings shall be tested for dry film thickness using a properly calibrated magnetic pull off, eddy current, or ultrasonic equipment.
 2. Coating thickness measurements shall be conducted as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this specification.

PART 3 EXECUTION

3.1 GENERAL

- A. The intention of this specification is for all existing and new, interior and exterior surfaces are painted, whether specifically mentioned or not, except as modified herein. Concealed structural steel surfaces shall receive prime coat only unless modified herein. Exterior concrete surfaces will not be painted unless specifically indicated hereinafter.
- B. Surface preparation and coating application shall be in conformance with these specifications and the coating manufacturer's written product data sheets and written recommendations of the manufacturer's technical representative. Where conflicts occur between the manufacturer's recommendations and these specifications, the more stringent of the two shall apply unless otherwise approved by the Engineer.
- C. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating for any purpose until completion of curing cycle.

3.2 REGULATORY REQUIREMENTS

- A. Meet federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposures.

- B. Protect workers and comply with applicable federal, state, and local air pollution and environmental regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, coating application and dust prevention including, but not limited to the following Acts, Regulations, Standards, and Guidelines:
 - 1. Clean Air Act
 - 2. National Ambient Air Quality Standard
 - 3. Resource Conservation and Recovery Act (RCRA)
- C. Comply with applicable federal, state, and local regulations for confined space entry.
- D. Provide and operate equipment that meets explosion proof requirements.

3.3 ENVIRONMENTAL CONDITIONS

- A. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent, whenever surface temperature is less than 5 degrees F above the dew point of the ambient air.
- B. Surface preparation power tools and blast equipment shall contain dust collection equipment that will prevent discharge of dust particles into the atmosphere.
- C. Do not apply paint when:
 - 1. Surface temperatures exceeds the maximum or minimum temperature recommended by the paint manufacturer,
 - 2. In dust, smoke-laden atmosphere, damp or humid weather, or under conditions which could cause icing on the metal surface.
 - 3. When it is expected that surface temperatures will drop below 5 degrees above dew point within 8 hours after application of coating.

3.4 DEHUMIDIFICATION

- A. Where environmental conditions cannot be met or controlled, Contractor shall provide and operate desiccant dehumidification equipment to maintain environmental conditions for 24 hours a day during abrasive blasting and coating application and cure. Liquid, granular, or loose lithium chloride drying systems will not be acceptable.
- B. Contractor shall provide dehumidification equipment sized to maintain dew point temperature 17 degrees or more below surface temperature of metal surfaces to be cleaned and coated. System shall provide ventilation within the environmentally controlled areas as required for the following requirements:
 - 1. One air exchange per hour, minimum,
 - 2. Maintenance of personnel exposures limits (PEL) at 50 percent of OSHA PEL limits for all chemicals used in the performance of the work, and
 - 3. Maintenance of lower explosive limits (LEL) to less than 50 percent of the most volatile solvent used in the performance of the work.
- C. Dehumidification equipment type, size, air flow, and power requirements shall be designed by a qualified company knowledgeable in dehumidification equipment, and its operation based on project requirements and anticipated seasonal weather conditions for the project

schedule. Design to include evaluation of existing conditions, humidity, and temperature, proper air exchange requirements, ventilation requirements, ducting requirements for adequate air flow, and any other issues necessary to achieve the specified performance and environmental conditions throughout the duration of the project.

- D. Contractor to submit written recommendations from dehumidification subcontractor for bulkhead locations, bulkhead venting, duct work for each bulkhead section, any secondary ventilation requirements for coating cure, dust collection equipment CFM requirements, and drying requirements for blast hose compressed air necessary to maintain environmental control as specified herein.
- E. Dehumidification subcontractor shall either operate the equipment or provide training to Contractor on the proper operation and setup of dehumidification equipment. Dehumidification subcontractor shall provide a technical representative on site for a minimum of two 8-hour days to ensure proper operation of the equipment, achievement of desired environmental control, and to insure Contractor can properly setup, operate, monitor, and maintain the equipment.
- F. Dehumidification shall be operated in a manner that prevents all condensation or icing throughout surface preparation and coating application and cure.
- G. Reblasting of flash rusted metal surfaces or removal of damaged coatings, as a result of equipment malfunction, shutdown, or other events that result in the loss of environmental control, will be at the sole expense of the Contractor. Cleaned metal surfaces subject to flash rusting shall be cleaned to the same cleanliness as prior to the flash rust formation and shall be approved by the Engineer.
- H. Contractor shall monitor ambient temperature, humidity, dew point temperature, and pipe surface temperature both outdoors and within the work area at the start, midpoint, and end of each work shift, minimum, but not greater than 5 hours between measurements.
- I. Daily environmental condition monitoring and maintenance of the equipment shall be documented in writing and posted near the equipment for review by the Engineer.

3.5 VENTILATION AND ILLUMINATION

- A. Adequate illumination shall be provided while work is in progress. Whenever required by the inspector, the Contractor shall provide additional illumination and necessary supports to cover all areas to be inspected. The level of illumination for inspection purposes shall be determined by the inspector.
- B. Ventilation shall be used to control potential dust and hazardous conditions within the tank. Ventilation flow rates shall be in accordance with OSHA regulations and as required to reduce air contamination to nonhazardous conditions.

3.6 SURFACES NOT REQUIRING PAINTING

- A. Unless otherwise stated herein or shown, the following areas or items will not require painting:

1. Concrete and masonry surfaces
2. Nonferrous and corrosion-resistant ferrous alloys such as copper, bronze, monel, aluminum, chromium plate, atmospherically exposed weathering steel, and stainless steel, except where:
 - a. Required for electrical insulation between dissimilar metals.
 - b. Aluminum and stainless steel are embedded in concrete or masonry, or aluminum is in contact with concrete or masonry.
 - c. Color coding of equipment and piping is required.
3. Nonmetallic materials such as glass, PVC, wood, porcelain, and plastic (FRP) except as required for architectural painting or color coding.
4. Prefinished electrical and architectural items such as motor control centers, switchboards, switchgear, panel boards, transformers, disconnect switches, acoustical tile, cabinets, elevators, building louvers, wall panels, etc.; color coding of equipment is required.
5. Non-submerged electrical conduits attached to unpainted concrete surfaces.
6. Cathodic protection anodes.
7. Items specified to be galvanized after fabrication unless specifically required elsewhere or subject to immersion.
8. Insulated piping and/or insulated piping with jacket will not require exterior coating, except as required for architectural painting or color coding.

3.7 PREPARATION OF SURFACES

A. Surface Preparation Inspection:

1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of paint manufacturer whose product is to be applied.
2. Provide Engineer minimum 3 days' notice prior to start of surface preparation work or coating application work.
3. Perform such work only in the presence of Engineer, unless Engineer grants prior approval to perform such work in Engineer's absence.

B. Metal Surface Preparation:

1. General:
 - a. Do not perform a surface preparation blast prior to submission of samples. Workmanship for metal surface preparation as specified shall meet current Steel Structures Painting Council (SSPC) Specifications as follows:
 - (1) Solvent Cleaning: SP 1
 - (2) Hand Tool Cleaning: SP 2
 - (3) Power Tool Cleaning: SP 3
 - (4) White Metal Blast Cleaning: SP 5
 - (5) Commercial Blast Cleaning: SP 6
 - (6) Brush-Off Blast Cleaning: SP 7
 - (7) Pickling: SP 8
 - (8) Near-White Blast Cleaning: SP 10
 - (9) Bare Metal Power Tool Cleaning: SP 11
 - b. All surface preparation shall be assumed to be on a SSPC Grade A steel surface condition, unless specifically noted otherwise.

- c. Wherever the words "solvent cleaning", "hand tool cleaning", "wire brushing", or "blast cleaning", or similar words of equal intent are used in these Specifications or in paint manufacturer's specifications, they shall be understood to refer to the applicable SSPC Specifications listed above.
 - d. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply. Wet blasting methods shall be approved by the Engineer.
 - e. Hand tool clean areas that cannot be cleaned by power tool cleaning.
- 2. Welds and adjacent areas:
 - a. Prepared such that there is:
 - (1) No undercutting or reverse ridges on the weld bead.
 - (2) No weld spatter on or adjacent to the weld or any other area to be painted.
 - (3) No sharp peaks or ridges along the weld bead.
 - b. Grind embedded pieces of electrode or wire flush with the adjacent surface of the weld bead.
- 3. Preblast Cleaning Requirements:
 - a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
 - b. Cleaning methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
 - c. Clean small isolated areas as above or solvent cleaned with suitable solvents and clean cloths.
 - d. Round or chamfered all sharp edges and grind smooth burrs, jagged edges, and surface defects.
- 4. Blast Cleaning Requirements:
 - a. General:
 - (1) Type of Equipment and Speed of Travel: Designed to obtain specified degree of cleanliness.
 - (2) Select type and size of abrasive to produce a surface profile that meets the coating manufacturer's recommendations for the particular coating to be applied or not less than 20 percent of the specified coating thickness, whichever is more stringent.
 - (3) Meet applicable federal, state, and local air pollution control regulations for blast cleaning and disposition of spent aggregate and debris.
 - (4) Do not reuse abrasive, unless abrasive is recyclable steel grit or shot abrasive.
 - b. Shop Blasting
 - (1) Notify Engineer at least 7 days prior to start of shop blast cleaning to allow for inspection of the work during surface preparation and shop application of paints. Work shall be subject to the Engineer's approval before shipment to the jobsite.
 - (2) Items such as structural steel, metal doors and frames, metal louvers, and similar items as reviewed by the Engineer may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternate to shop blast cleaning. Blast clean and prime in accordance with these Specifications.

- c. Field Blasting
 - (1) Perform sandblasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed. Materials, equipment, procedures, shall meet requirements of Steel Structures Painting Council.
 - (2) Field blasting in areas with electrical or mechanical equipment, within buildings, or on coated surfaces with lead paint greater than 2,000 mg/L total lead shall be performed with dustless abrasive systems such as "Sponge-Jet", dry ice abrasive blasting.
 - 5. Post-Blast Cleaning and Other Cleaning Requirements:
 - a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wiped with a tack cloth.
 - b. Paint surfaces the same day they are sandblasted. Reblast surfaces that have started to rust before they are painted.
- C. Concrete Surface Preparation:
- 1. Do not begin until 30 days after the concrete has been placed.
 - 2. Remove grease, oil, dirt, salts or other chemicals, loose materials or other foreign matter by solvent, detergent, or other suitable cleaning methods.
 - 3. Clean concrete using mechanical or chemical methods for the degree of cleaning specified for the coating system in accordance with SSPC SP-13, Surface preparation of Concrete.
 - 4. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to coating.
 - 5. Bug holes, air pockets, and other voids in the concrete will be filled or patched in chemical exposure areas, secondary containment, and where specifically required.
 - 6. Concrete Surface Preparation Inspection:
 - a. Adhesion Testing:
 - (1) Tensile testing of the surface preparation shall be performed by the Engineer as necessary using Type 4 or Type 5 pneumatic adhesion testing equipment in accordance with ASTM D4541 using 2-inch diameter dollies for concrete surface adhesion testing.
 - (2) Applied coating greater than 20 mils in thickness or with a tensile strength greater than 2,500 psi shall be scored for concrete adhesion testing.
 - (3) Adhesive failure greater than 50 percent of the dolly surface area shall indicate inadequate surface preparation.
 - (4) Cohesive failures which results in loss of sound concrete will be acceptable provided the loss is greater than 50 percent of the dolly surface area.
 - (5) Low adhesion cohesive failures with a thin layer of concrete due to weak concrete or laitance over 50 percent of the dolly surface will be rejected.
 - b. Concrete Soundness:
 - (1) Concrete soundness shall be determined using the scratching or hammer impact methods as defined in SSPC SP-13.
 - c. Moisture Content:

- (1) Moisture shall be tested as Specified in SSPC SP-13 and shall not exceed the moisture content recommended by the coating manufacturer.

D. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet SSPC-SP 7, Brush-off Blast Cleaning and shall achieve a profile on the coating equivalent to 80 grit sandpaper with no exposed metal. Profile shall be uniform over the surface with no glossy areas visible.
2. Where metal substrate is exposed, Contractor shall apply full coating system as specified for new metal surfaces.
3. Repair or replace surfaces damaged by blast cleaning, where damage is defined as visible metal substrate. If less than 5 percent of prepared surface has the metal substrate visible, the coating shall be repaired by application of a brush applied intermediate coat. If greater than 5 percent the coating shall be fully removed to meet the specified surface cleanliness and recoated with the specified coating system.
4. Abrasive: Either conventional abrasive blasting with sand, grit, or nut shells or specialized abrasive blasting. Abrasives shall be 60 mesh grit, maximum.
5. Select various surface preparation parameters such as size and hardness of the abrasive, nozzle size, air pressure, and nozzle distance from the surface such that the surface is cleaned without pitting, chipping, or other damage.
6. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
7. The Engineer shall approve trial blast cleaned area and shall use area as a representative sample of surface preparation.

E. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods which involve a solvent or cleaning action.
2. Method meets SSPC-SP 1.

3.8 PROTECTION OF MATERIALS NOT TO BE PAINTED

- A. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.
- B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
- C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
- D. Mask openings in motors to prevent paint and other materials from entering the motors.

3.9 PAINT MIXING

- A. Multiple-component coatings:
1. Prepare using all the contents of the container for each component as packaged by the paint manufacturer.
 2. No partial batches will be permitted.
 3. Do not use multiple-component coatings that have been mixed shall not be used beyond their pot life.
 4. Provide small quantity kits for touchup painting and for painting other small areas.
 5. Mix only components specified and furnished by the paint manufacturer.
 6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.
 7. Fast set or plural component products shall be applied using an appropriate multipart pump that properly mixes both components at the recommended ratio using equipment recommended by the coating manufacturer. Hot mixing of fast set or plural component products will not be permitted.
- B. Keep paint materials sealed when not in use and provide nitrogen blanket on fast set, plural, or moisture cured coatings on opened product containers when stored or not in use more than 8 hours.
- C. Where more than one coat of a material is applied within a given system, alternate color to provide a visual reference that the required number of coats have been applied.

3.10 APPLICATION OF PAINT

- A. General:
1. Inspection: Schedule with Engineer in advance for cleaned surfaces and all coats prior to the succeeding coat.
 2. Apply coatings in accordance with the paint manufacturer's recommendations. Allow sufficient time between coats to assure thorough drying of previously applied paint.
 3. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
 4. Paint units to be bolted together and to structures prior to assembly or installation.
 5. Shop Primed or Factory Finished Surfaces:
 - a. Inspection: Schedule with Engineer in advance for shop primed or factory-finished items delivered to jobsite for compliance with these Specifications.
 - b. Hand or power sand areas of chipped, peeled, or abraded coating, feathering the edges. Follow with a spot primer using specified primer.
 - c. For two-package or converted coatings, consult the coatings manufacturer for specific procedures as relates to top coating of these products.
 - d. Prior to application of finish coats, clean shop primed surfaces of dirt, oil, and grease, and apply a mist coat of specified primer, 1.0 mil dry film thickness.
 - e. After welding, prepare and prime holdback areas as required for the specified paint system. Apply primer in accordance with manufacturer's instructions.
 6. Manufacturer Applied Paint Systems:
 - a. Repair abraded areas on factory-finished items in accordance with the equipment manufacturer's directions.

- b. Carefully blend repaired areas into the original finish.
- B. Application Safety
 - 1. Performed painting in accordance with recommendations of the following:
 - a. Paint manufacturer's instructions.
 - b. NACE contained in the publication, Manual for Painter Safety.
 - c. Federal, state, and local agencies having jurisdiction.
 - 2. Contractor will be solely and completely responsible for condition of the project site, including safety of all persons (including employees) and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. Safety provisions will conform to U.S. Department of Labor, Occupational Safety and Health Act, any equivalent state law, and all other applicable federal, state, county, and local laws, ordinances, and codes.
 - 3. Contractor will comply with all safety-training requirements promulgated or required for this project.
- C. Film Thickness:
 - 1. Coverage is listed as either total minimum dry film thickness in mils (MDFT) or the spreading rate in square feet per gallon (SFPG). Per coat determinations are listed as MDFTPC or SFPGPC.
 - 2. Applied coating system film thickness per coat shall be applied at the specified coating thickness or the manufacturer's recommended minimum thickness, whichever is greater. Where the manufacturer has not specified a minimum coating thickness on the product data sheets, the minimum recommended coating application thickness shall apply.
 - 3. Maximum film build per coat shall not exceed the coating manufacturer's recommendations.
- D. Stripe Coats:
 - 1. Surfaces that are subject to immersion, condensing environments, or where specifically specified shall be stripe coated on all angles, edges, corners, threads, welds, and similar type surfaces.
 - 2. Stripe coat shall be an extra coat of the intermediate coating material and shall be applied between the prime and intermediate coats.
 - 3. The stripe coat shall be a separate coat from coats specified under the coating system.
 - 4. Stripe coats shall be alternated in color like a full coat.
- E. Number of coats:
 - 1. Apply specified number of coats, minimum, irrespective of the coating thickness.
 - 2. Additional coats may be required to obtain the minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
- F. Porous Surfaces, Such as Concrete, Masonry:
 - 1. Prime Coat:
 - a. May be thinned to provide maximum penetration and adhesion.
 - b. Type and Amount of Thinning: Determined by the paint manufacturer and is dependent on surface density and type of coating.

- c. Surfaces Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of the coating.
- G. Existing Coated Surfaces:
 - 1. General:
 - a. Equipment or components with shop primer or shop finish coated surfaces shall be reviewed with the Engineer to determine coating damage, repair methods, surface preparation requirements, and conformance with color uniformity, where required.
 - b. All shop primed or finished coated surfaces shall be verified to be chemically compatible with field applied finish coats.
 - c. If a cured epoxy, polyurethane, or plural-component material is to be top coated, contact the coating manufacturer for additional surface preparation requirements. Existing coated surfaces shall be prepared as follows"
 - (1) Existing coated surfaces shall be brush-off blasted as specified herein to remove all gloss and provide a uniform profile on existing coating for adhesion of subsequent coats.
 - (2) Power or hand sanding will not be allowed as a surface preparation procedure for existing coatings, unless reviewed and approved by the Engineer.
 - (3) Where coating manufacturer surface preparation recommendations conflict with this section, the more stringent requirements shall apply.
 - (4) Profile shall be as specified for by the manufacturer or equivalent of 80 grit sandpaper; whichever is more stringent. Profile shall be visible and uniform over existing coated surfaces.
 - d. All existing coated surfaces, where demolition of equipment was specified or required, shall be surface prepared, touch-up coating repairs completed, and a cosmetic overcoat applied using the specified coating system on all existing coated surfaces associated with the demolition work, unless otherwise specified.
 - e. Existing coatings on immersed equipment shall be removed to bare metal and recoated with the specified coating system where demolition work was specified.
 - f. Apply sealer/primer where recommended by coating manufacturer for coating compatibility.
 - 2. To be Recoated or Final Coated:
 - a. Detergent wash and freshwater rinse.
 - b. Perform touch-up repairs of existing coating.
 - c. Asphaltic varnish coated ductile iron pipe will require an application of a seal coat prior to the application of a cosmetic finish coat.
 - 3. Touch-up Repairs:
 - a. Clean loose, abraded, or damaged coatings to substrate by Power Tool (SP 3).
 - b. Feather surrounding intact coating.
 - c. Apply one spot coat of the specified primer to bare areas overlapping the prepared existing coating.
 - d. Apply one full finish coat of the specified primer or finish coat(s) overall.
 - 4. Application of a Cosmetic Coat:

- a. The exact nature of shop-applied coatings is not known in all cases.
- b. Check compatibility by application to a small area prior to starting the coating.
- c. If lifting or other problems occur, request disposition from the Engineer.
- d. Cured epoxy, polyurethane, plural component materials or any other coating system that has exceeded its maximum recoat window shall be prepared as specified this section.

H. Damaged Coatings, Pinholes, and Holidays:

- 1. Feather edges and repaired in accordance with the recommendations of the paint manufacturer.
- 2. Repair fusion bonded coatings to be as recommended by the original applicator. Applicator shall provide liquid repair kits for this purpose as recommended by the coating manufacturer.
- 3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

I. Unsatisfactory Application:

- 1. If the item has an improper finish color, or insufficient film thickness, clean and topcoat surface with specified paint material to obtain the specified color and coverage. Obtain specific surface preparation information from the coating manufacturer.
- 2. Hand or power sand visible areas of chipped, peeled, or abraded paint and feather the edges. Follow with primer and finish coat in accordance with the Specifications. Depending on the extent of repair and its appearance, a finish sanding and topcoat may be required.
- 3. Evidence of runs, bridges, shiners, laps, or other imperfections shall be cause for rejection.
- 4. Repair defects in coating system per written recommendations of coating manufacturer.
- 5. Leave all staging up until the Engineer has inspected the surface or coating. Replace staging removed prior to approval by Engineer.

3.11 COATING INSPECTION

A. General

- 1. Film thickness measurements and electrical inspection of the coated surfaces:
- 2. Perform with properly calibrated instruments.
- 3. Recoat and repair as necessary for compliance with the Specifications.
- 4. All coats will be subject to inspection by the Engineer and the coating manufacturer's representative.
- 5. Visually inspect concrete, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
- 6. Give particular attention to edges, angles, flanges, and other areas where insufficient film thicknesses are likely to be present and ensure proper milage in these areas.

B. Coating Thickness Testing:

1. Engineer shall conduct coating thickness testing as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this specification.
 2. Measure coating thickness specified in mils with a magnetic type dry film thickness gauge as specified.
 3. Check each coat for the correct milage. Do not make measurement before a minimum of 8 hours after application of the coating.
 4. Tests for concrete coating thickness shall be with a Tooke Gauge, a destructive test. Contractor shall repair coating after thickness testing.
- C. Coating Continuity Testing
1. Holiday detect coatings with high voltage units in accordance with NACE SP-0188. High voltage detector shall have adjustable voltages in 100 volt increments and shall be operated in accordance with the manufacturer's instructions and the specified standard.
 2. Use of an electrical holiday detector, low voltage, wet sponge type holiday detector will be permitted for coating systems less than 20 mils total dry film thickness and are not for immersion or condensing environments.
 3. Holiday detect coatings on pipe for buried application with high voltage spark tester in accordance with NACE RP0274.

3.12 CLEANUP

- A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroyed at the end of each day.
- B. Upon completion of the work, remove staging, scaffolding, and containers from the site or destroyed in a legal manner.
- C. Completely remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.
- D. Damages due to over spray on buildings, vehicles, trees, or other surfaces not specified to be painted would be the responsibility of the Contractor.

3.13 MANUFACTURER' SERVICES

- A. Furnish paint manufacturer's representative to visit jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and these specifications, and as may be necessary to resolve field problems attributable to, or associated with, manufacturer's products furnished under this Contract.

3.14 PROTECTIVE COATING SYSTEMS AND APPLICATION SCHEDULE:

- A. Unless otherwise shown or specified in these Specifications painted or coated the work in accordance with the following application schedule.

- B. In the event of discrepancies or omissions in the following, request clarification from the Engineer before starting the work in question.

System No.	Title
1	SUBMERGED METAL - IMMERSION
4	EXPOSED METAL – HIGHLY CORROSIVE
5	EXPOSED METAL – ATMOSPHERIC
10	GALVANIZED METAL
21	EPOXY FLOOR, CONCRETE
27	ALUMINUM AND DISSIMILAR METAL INSULATION
29	FUSION BONDED COATING

- C. System No. 1 - Submerge Metal, Immersion
1. Surface Preparation and Coating System

Surface Prep.	Coating Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 5) Cement Mortar Prep: see Interior Linings, this section	Epoxy, NSF	3 coats, 16 MDFT

2. Application:
- All metal surfaces subject to immersion or contact with potable water.
 - Use on the following areas:
 - Coat the exposed portion of pipe ends at flexible pipe couplings with high solids epoxy lining, this section.
 - Access manhole interior surfaces.
 - All steel pipe without a cement mortar lining.
3. Material Requirements:
- Polyamide Epoxy: Amine or polyamine epoxy coating, two parts, suitable for immersion, application temperatures, and environmental exposures and conditions, 75% volume solids minimum, capable of 4 to 8 MDFT per coat.
 - Epoxy coating shall be NSF certified for potable water contact in conformance to ANSI/NSF Standard 60 and 61.
4. Special Requirements:
- Epoxy coating applied to immersed surfaces that contact potable water shall be NSF certified for potable water contact.
 - NSF certified fusion bonded epoxy linings will be permitted as alternative lining for small diameter pipes, valves, and couplings. FBE coating to be applied as specified for FBE coatings this section and in accordance with the manufacturer's recommendations.

- c. All welds, angles, edges, and bolted connections shall be stripe coated as specified this section.

D. System No. 4 - Exposed Metal, Highly Corrosive
1. Surface Preparation and Coating System

Surface Prep.	Coating Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Zinc Rich Primer	1 coat, 3.0 to 4.0 DFT
	Epoxy	1 coat, 4 MDFT
	Polyurethane Enamel	2 coats, 6 to 8 DFT
	Or Polysiloxane	2 coats, 4 to 6 DFT

2. Application:
- All exposed piping and metal surfaces, new and existing, located inside of vaults or structures.
 - Use on the following areas:
 - Inlet/Outlet Valve Vaults
 - All other vaults
 - Manways and miscellaneous exposed piping located in vaults.
 - Exposed metal piping in pump station building
 - Contractor choice of top coat material shall not be changed. Only one top coat materials will be permitted on the project.
3. Special Requirements:
- Surface preparation and primer shall be shop applied to all surfaces prior to installation.
 - DFT thicknesses greater than manufacturer's recommendations shall be subject to rejection and removal.
 - Intermediate and top coats shall be field applied after installation.
 - All shop primed or finish coated surfaces shall be prepared as an existing coated surface as specified herein and shall be top coated with intermediate and/or finish coats as required to provide color uniformity throughout the vault or structure.
 - Color uniformity requirements shall apply to all components installed within the vault and visibly part of completed installation regardless of shop applied coating system.

E. System No. 5 - Exposed Metal, Atmospheric:
1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Zinc Rich Primer	1 coat, 2.5 MDFT
	Polysiloxane	2 coats, 6 MDFT

2. Application:
 - a. Exposed metal surfaces, new and existing, located outside of structures and exposed to weather and the following specific surfaces unless otherwise specified.
 - b. Use on the following items or surfaces:
 - (1) Exposed surfaces of blowoff piping, unless hot dipped galvanized
 - (2) Exposed surfaces of air vent piping, unless hot dipped galvanized.
 - (3) Hollow metal doors and frames per architectural drawings.
3. Special Requirements:
 - a. All shop primed or finish coated surfaces shall be prepared as an existing coated surface as specified herein and shall be top coated with intermediate and/or finish coats as required to provide color uniformity.
 - b. Color uniformity requirements shall apply to all components visibly part of the completed installation regardless of shop applied coating system.
 - c. Galvanized steel surfaces shall be coated per the coating manufacturer's requirements.
 - d. Polysiloxane coating to overlap buried pipe coating a minimum of 4 inches below top of concrete.
 - e. Aliphatic polyurethane will not be allowed as a substitute for polysiloxane due to restrictive overcoat requirements.
 - f. Dry film coating thickness of polysiloxane, including touch up repairs, shall not exceed the manufacturer's recommended maximum film thickness.

F. System No. 10 - Galvanized Metal Conditioning:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1) Followed by Hand Tool (SP 2) or Power Tool (SP 3)	Wash Primer	1 Coat, 0.4 MDFT
	Finish Coats to Match Existing Paint	As Required to Match Surrounding Area

2. Application:
 - a. All galvanized surfaces requiring painting and the following specific surfaces unless otherwise specified.
3. Special Requirements:
 - a. Sweep blast as specified this section, may be used in lieu of hand or power tool cleaning of galvanized surfaces provided Contractor can demonstrate that damage to the zinc coating will not result. Engineer approval of sweep blasting locations, methods, and surface cleanliness and profile results is required.
 - b. See applicable coating systems for finish coating system and coating requirements based on area and/or surface to be coated.

G. System No. 27 Aluminum and Dissimilar Metal Insulation:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Wash Primer	1 coat, 0.4 MDFT
	Epoxy	1 coat, 8 MDFT

2. Application:
 - a. Use on all non-submerged concrete embedded aluminum surfaces, and the following specific surfaces unless otherwise specified.
 - b. Use on the following surfaces:
 - (1) All concrete embedded components of vault hatches
 - (2) All concrete embedded surfaces where electrical isolation from concrete reinforcement is required.

H. System No. 29 Fusion Bonded Coating:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10) or Acid Pickling (SP 8)	Fusion Bonded 100% solids Epoxy or Polyurethane	1 or 2 coats, 10 MDFT

2. Application:
 - a. Use where specified.
 - b. Use on the following items or surfaces:
 - (1) Concrete embedded anchor bolts, except threads.
 - (2) Removable handrail sleeves.
3. Special Requirements:
 - a. System 1 may be used as alternative coating system at Contractor's option

PAINT SYSTEM DATA SHEET

Attached products' Technical Data Sheet (if applicable) to this sheet for each paint system submittal.

Paint System Number (from spec.):		
Paint System Title (from spec.):		
Coatings Manufacturer:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	Product Name/Number Proprietary)	Min. Coats, Coverage

Additional Information Required (check applicable items):

- ☐ ANSI/NSF Certification letter for each paint material listed above requiring ANSI/NSF Standard 60 and 61 approvals.
- ☐ Manufacturer's minimum and maximum recommended coating thickness per coat and for total coating system.
- ☐ Immersion coating cure requirements from minimum coating application temperature to 100 degrees in 15-degree temperature increments.

END OF SECTION

SECTION 09 91 13
EXTERIOR PAINTING

PART 1–GENERAL

1.01 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following exterior substrates:
 - 1. Steel and iron.
 - 2. Galvanized metal.

1.02 DEFINITIONS

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- D. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- E. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- F. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
- B. Samples: For each type of paint system and each color and gloss of topcoat.

1.04 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
 - b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

PART 2-PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Behr Process Corporation.
 2. Benjamin Moore & Co.
 3. Coronado Paint; Benjamin Moore Company.
 4. Diamond Vogel Paints.
 5. Dulux (formerly ICI Paints); a brand of AkzoNobel.
 6. Glidden Professional.
 7. Kelly-Moore Paint Company Inc.
 8. Kwal Paint; Comex Group.
 9. Parker Paint; Comex Group.
 10. PPG Architectural Coatings.
 11. Pratt & Lambert.
 12. Rodda Paint Co.
 13. Rust-Oleum Corporation; a subsidiary of RPM International, Inc.
 14. Sherwin-Williams Company (The).
 15. Valspar Corporation - Architectural (Pro).
 16. Zinsser; Rust-Oleum Corporation.
- B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to products listed in the Exterior Painting Schedule for the paint category indicated.

2.02 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Colors: As Selected by Contracting Officer from manufacturer's full range.

1. Basis-of-Design Color: PT-2 – Federal Standard 595B #20062, Dark Brown.

PART 3–EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected.
 1. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

3.03 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."
- B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.04 CLEANING AND PROTECTION

1. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
2. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.05 EXTERIOR PAINTING SCHEDULE

- A. Steel Substrates:

1. Water-Based Light Industrial Coating System MPI EXT 5.1M:
 - a. Prime Coat: Primer, rust inhibitive, water based MPI #107.
 - b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
 - c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.
- B. Galvanized-Metal Substrates:
 1. Water-Based Light Industrial Coating System MPI EXT 5.3J:
 - a. Prime Coat: Primer, galvanized, water based, MPI #134.
 - b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
 - c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.

END OF SECTION

SECTION 09 91 23
INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Steel.
 - 2. Gypsum board.

1.2 DEFINITIONS

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
- B. Samples: For each type of paint system and in each color and gloss of topcoat.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Behr Process Corporation.
 - 2. Benjamin Moore & Company.
 - 3. Kelly-Moore Paint Company Inc.
 - 4. Sherwin-Williams Company.

2.2 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
 - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base:
 - 1. Flat Paints and Coatings: 50 g/L.
 - 2. Nonflat Paints and Coatings: 150 g/L.
 - 3. Dry-Fog Coatings: 400 g/L.
 - 4. Primers, Sealers, and Undercoaters: 200 g/L.
 - 5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 - 6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
 - 7. Pretreatment Wash Primers: 420 g/L.
 - 8. Floor Coatings: 100 g/L.
 - 9. Shellacs, Clear: 730 g/L.
 - 10. Shellacs, Pigmented: 550 g/L.
- D. Colors: As Selected by Contracting Officer from manufacturer's full range.
 - 1. Basis-of-Design Color: PT-1 – Sherwin-Williams SW Custom, Match #8264-10961.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
- B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 INTERIOR PAINTING SCHEDULE

- A. Steel Substrates:

1. Alkyd System MPI INT 5.1E:

- a. Prime Coat: Shop primer specified in Section where substrate is specified.
- b. Intermediate Coat: Alkyd, interior, matching topcoat.
- c. Topcoat: Alkyd, interior, semi-gloss (MPI Gloss Level 5), MPI #47.

B. Gypsum Board Substrates:

1. Latex over Latex Sealer System MPI INT 9.2A:

- a. Prime Coat: Primer sealer, latex, interior, MPI #50.
- b. Intermediate Coat: Latex, interior, matching topcoat.
- c. Topcoat: Latex, interior (MPI Gloss Level 3), MPI #52.

END OF SECTION 099123

**DIVISION 10
SPECIALTIES**

SECTION 10 14 23
PANEL SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Panel signs.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For panel signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.

C. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the ABA standards of the Federal agency having jurisdiction.

2.2 PANEL SIGNS

- A. Panel Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ACE Sign Systems, Inc..
 - b. Advance Corporation.
 - c. APCO Graphics, Inc.
 - d. Best Sign Systems, Inc..
 - e. Clarke Systems.
 - f. Cosco.
 - g. Mohawk Sign Systems.
 - h. Signs & Decal Corp.
 - i. Vista System.
 - j. Vomar Products, Inc.
 - 2. Mounting: Surface mounted to door with adhesive.

2.3 PANEL-SIGN MATERIALS

- A. Acrylic Sheet: ASTM D 4802, Type UVF (UV filtering).

2.4 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 2. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 - 3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 4. Internally brace signs for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
 - 5. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
- B. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 - 4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Mounting Methods:
 - 1. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
- C. Remove temporary protective coverings and strippable films as signs are installed.

END OF SECTION

SECTION 10 44 16
FIRE EXTINGUISHERS

PART 1–GENERAL

1.01 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.06 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Six years from date of Substantial Completion.

PART 2–PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Ansul Incorporated; Tyco International.
 - b. Fire End & Croker Corporation.
 - c. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - d. Kidde Residential and Commercial Division.
 - e. Larsens Manufacturing Company.
 - f. Nystrom, Inc.
 - g. Pem All Fire Extinguisher Corp.; Pem Systems, Inc.
 - h. Potter Roemer LLC.
 - i. Pyro-Chem; Tyco Fire Suppression & Building Products.
 - j. Strike First Corporation of America.
 - 2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
- B. Multipurpose Dry-Chemical Type: UL-rated 2.5 gallon nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

2.03 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Amerex Corporation.
 - b. Ansul Incorporated; Tyco International.
 - c. Badger Fire Protection.
 - d. Buckeye Fire Equipment Company.
 - e. Fire End & Croker Corporation.
 - f. Guardian Fire Equipment, Inc.
 - g. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - h. Larsens Manufacturing Company.
 - i. Nystrom, Inc.
 - j. Potter Roemer LLC.
 - k. Strike First Corporation of America.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
- 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

- a. Orientation: Vertical.

PART 3-EXECUTION

3.01 INSTALLATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
 - 1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.
- C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION

DIVISION 11
EQUIPMENT

SECTION 11 00 00
EQUIPMENT GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide all tools, supplies, materials, equipment, and all labor necessary for the furnishing, construction, installation, testing, and operation of all equipment and appurtenant Work, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all equipment specified and where referred to, except where otherwise indicated.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Commercial Standards: All equipment, products, and their installation shall be in accordance with the following standards, as applicable, and as indicated in each Section of these Specifications:

American Gear Manufacturers Association (AGMA).

American Society for Testing and Materials (ASTM).

American Public Health Association (APHA).

American National Standards Institute (ANSI).

American Society of Mechanical Engineers (ASME).

American Water Works Association (AWWA).

American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).

Mechanical Power Transmission Association (MPTA).

American Welding Society (AWS).

National Fire Protection Association (NFPA).

Federal Specifications (FS).

National Electrical Manufacturers Association (NEMA).

Manufacturer's published recommendations and specifications.

General Industry Safety Orders (OSHA).

Rubber Manufacturers Association (RMA).

B. The following standards have been referred to in this Section of the Specifications:

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and Other Special Alloys
ANSI B46.1	Surface Texture
ANSI S12.6	Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors
ANSI/ASME B1.20.1	General Purpose Pipe Threads (Inch)
ANSI/ASME B31.1	Power Piping
ANSI/AWWA D100	Welded Steel Tanks for Water Storage
AWWA C206	Field Welding of Steel Water Pipe
ASTM A 48	Specification for Gray Iron Castings
ASTM A 108	Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The Contractor shall furnish complete shop drawings for all equipment specified in the various Sections, together with all piping, valves, and controls for review by the Engineer in accordance with Section 01 33 20 – Submittals Procedures.
- B. Tools: The Contractor shall supply one complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the equipment. All tools shall be of best quality hardened steel forgings with bright, finish wrench heads shall have work faces dressed to fit nuts. All tools shall be suitable for professional work and manufactured by a recognized supplier of professional tools such as Snap On, Crescent, Stanley, or equal. The set of tools shall be neatly mounted in a labeled tool box of suitable design provided with a hinged cover. For each microprocessor-based equipment system requiring a handheld device for configuration, furnish one handheld device.
- C. Spare Parts: The Contractor shall obtain and submit from the manufacturer a list of suggested spare parts for each piece of equipment. After approval, Contractor shall furnish such spare parts suitably packaged, identified with the equipment number, and labeled. Contractor shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment. All spare parts are intended for use by the OWNER only, after expiration of the guaranty period.

- D. Torsional Analysis: The Contractor shall submit to the Engineer a torsional and lateral vibration analysis of the following equipment, in accordance with Section 01 33 20 - Contractor Submittals. The analysis has to be performed by a specialist experienced in this type of Work and approved by the Engineer.
1. All engine drives.
 2. All blowers and compressors with drives of 100 horsepower and over.
 3. All vertical pumps with universal joints and extended shafts.
 4. All other equipment where indicated.
 5. The torsional natural frequency of the drive train must be avoided by plus and minus 25 percent by any exciting frequency of the equipment, throughout the entire operating range.
- E. Vibration Analysis: In the bid price the Contractor shall include at least two site visits of the above mentioned specialist, during construction and testing of the equipment, to analyze and measure the amount of equipment vibration and make his written recommendation for keeping the vibration at a safe limit.
- F. Operation and Maintenance Manuals: Submit in accordance with Section 01 33 20 - Contractor Submittals.

1.4 QUALITY ASSURANCE

- A. Inspection, Startup, and Field Adjustment: The Contractor shall demonstrate that all equipment meets the specified performance requirements. Contractor shall provide the services of an experienced, competent, and authorized service representative of the manufacturer of each item of major equipment who shall visit the site to perform the following tasks:
1. Assist the Contractor in the installation of the equipment.
 2. To inspect, check, adjust if necessary and approve the equipment installation.
 3. To start-up and field-test the equipment for proper operation, efficiency, and capacity.
 4. To perform necessary field adjustments during the test period until the equipment installation and operation are satisfactory to the Engineer.
 5. To instruct the Owner's personnel in the operation and maintenance of the equipment. Instruction shall include step-by-step trouble shooting procedures with all necessary test equipment.
- B. Costs: The costs of all inspection, startup, testing, adjustment, and instruction Work performed by said factory-trained representatives shall be borne by the Contractor. The Owner will pay for costs of power and water. When available, the Owner's operating personnel will provide assistance in the field testing.
- C. Public Inspection: It shall be the responsibility of the Contractor to inform the local authorities, such as building and plumbing inspectors, Fire Marshall, OSHA inspectors, and others, to witness all required tests for piping, plumbing, fire protection systems, pressure vessels, and safety systems to obtain all required permits and certificates, and pay all fees.
- D. Tolerances: Tolerances and clearances shall be as shown on the shop drawings and shall be closely adhered to. Machine Work shall in all cases be of high-grade workmanship and finish,

with due consideration to the special nature or function of the parts. Members without milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30 feet or less in length, and not greater than 1/8-inch for members over 30 feet in length.

- E. Machine Finish: The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following finishes shall be used:
 - 1. Surface roughness not greater than 63 micro-inches shall be required for all surfaces in sliding contact.
 - 2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.
 - 3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.
 - 4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.
- F. Manufacturer's Experience: Unless otherwise directed by the ENGINEER, all equipment furnished shall have a record of at least 5 years of successful, trouble free operation in similar applications, from the same manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. High Noise Level Location: The Contractor shall provide one personal hearing protection station, as indicated herein, at each high noise level location. Said locations are defined as follows:
 - 1. Outdoor Location: Any single equipment item or any group of equipment items that produce noise exceeding OSHA noise level requirements for a 2-hour exposure. Where such equipment is separated by a distance of more than 20 feet, measured between edges of footings, each group of equipment shall be provided with a separate hearing protection station.
 - 2. Indoor Location
 - a. Any single equipment item, or any group of equipment items, located within a single room not normally occupied, that produces noise exceeding OSHA noise level requirements for a 2-hour exposure.
 - b. Any single equipment item, or any group of equipment items, located within a single room normally occupied by workers, that produces noise exceeding OSHA noise level requirements for an 8-hour exposure.
 - 3. Personal Hearing Protection: The Contractor shall supply, in their original unopened packaging, three pairs of high attenuation hearing protectors. The ear protectors shall be capable of meeting the requirements of ANSI S12.6 and shall produce a noise level reduction of 25 dBA at a frequency of 500 Hz. The hearing protectors shall have fluid filled ear cushions and an adjustable, padded headband. The protectors shall be stored in a weatherproof, labeled, steel cabinet, furnished by the Contractor and mounted in an approved location near the noise protection station.

- B. Service Factors: Service factors shall be applied in the selection or design of mechanical power transmission components. Unless otherwise indicated, the following load classifications shall apply in determining service factors:

Type of Equipment	Load Classification
Blower:	
Centrifugal or vane	Uniform
Lobe	Moderate Shock
Reciprocating Air Compressor:	
Multi-Cylinder	Moderate Shock
Single-Cylinder	Heavy Shock
Pump:	
Centrifugal or Rotary	Uniform
Reciprocating	Moderate Shock
Mixer:	
Constant Density	Uniform
Variable Density	Moderate Shock
Crane or Hoist	Moderate Shock

- C. For service factors of electric motors, see Section 26 19 00 – Medium-Voltage Induction Motors. Where load classifications are not indicated, best modern practice shall be used.
- D. Welding: Unless otherwise indicated, all welding shall conform to the following:
1. Latest revision of ANSI/AWWA D100.
 2. Latest revision of AWWA C206.
 3. All composite fabricated steel assemblies which are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent entrance of air or moisture.
- E. All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.
- F. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All

sharp corners of material which is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

- G. Protective Coating: All equipment shall be painted or coated in accordance with Section 09 90 00 – Painting, unless otherwise indicated. Nonferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.
- H. Protection of Equipment: All equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage by methods recommended by the manufacturer. All equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weathertight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers should be avoided, to prevent accumulation of condensate in gears and bearings.
- I. Identification of Equipment Items: Each item of equipment shipped shall have a legible identifying mark corresponding to the equipment number indicated for the particular item.
- J. Vibration Level: All equipment subject to vibration shall be provided with restrained spring-type vibration isolators or pads per manufacturer's written recommendations.
- K. Shop Fabrication: Shop fabrication shall be performed in accordance with the Contract Documents and the Engineer-approved shop drawings.

2.2 EQUIPMENT SUPPORTS AND FOUNDATIONS

- A. Equipment Supports: All equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. The design horizontal seismic force shall be the greater of: that noted in the general structural notes or as required by the governing building code, or 10 percent of gravity. Submitted design calculations for equipment supports must bear the signature and seal of an Engineer registered in Utah.
- B. Equipment Foundations: Equipment foundations shall be as per manufacturer's written recommendations. All mechanical equipment, tanks, and control cabinets shall be mounted on concrete bases as shown on standard structural details.
- C. Shop Drawings: Shop drawings shall be submitted to the Engineer for review in accordance with the requirements of Section 01 33 20 – Contractor Submittals. Shop drawings will be considered incomplete unless clear, concise calculations are presented showing equipment anchorage forces and the capacities of the anchorage elements provided by the Contractor.

2.3 PIPE HANGERS, SUPPORTS, AND GUIDES

- A. All pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment. Supports and hangers shall be in accordance with the requirements of Section 40 00 01 - Pipe Supports.

2.4 FLANGES AND PIPE THREADS

- A. All flanges on equipment and appurtenances provided under this Section shall conform to ANSI B16.1, Class 125; or B16.5, Class 150, unless otherwise indicated. All pipe threads shall be in accordance with ANSI/ASME B1.20.1, and with requirements of Section 40 05 00 - Piping, General.

2.5 COUPLINGS

- A. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads. Where required for vertical shafts, 3-piece spacer couplings or universal type couplings for extended shafts shall be installed.
- B. The CONTRACTOR shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.
- C. Taper-lock bushings may be used to provide for easy installation and removal on shafts of various diameters.
- D. Where universal type couplings are shown, they shall be of the needle bearing type construction, equipped with commercial type grease fittings.

2.6 SHAFTING

- A. General: All shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. All shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.
- B. Materials: Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as indicated unless furnished as part of an equipment assembly.
 - 1. Low carbon cold-rolled steel shafting shall conform to ASTM A 108, Grade 1018.
 - 2. Medium carbon cold-rolled shafting shall conform to ASTM A 108, Grade 1045.
 - 3. Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.
- C. Differential Settlement: Where differential settlement between the driver and the driven equipment may be expected, a shaft of sufficient length with two sets of universal type couplings shall be provided.

2.7 BEARINGS

- A. General: Bearings shall conform to the standards of the AFBMA.

- B. To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and other important factors shall be considered in bearing selection.
- C. All re-lubricatable type bearings shall be equipped with a hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.
- D. All lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.
- E. Bearing Life: Except where otherwise indicated, all bearings shall have a minimum L-10 life expectancy of 5 years or 20,000 hours, whichever occurs first. Where indicated, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	Design Life (years)*	L-10 Design Life (hours)*
8-hour shift	10	20,000
16-hour shift	10	40,000
Continuous	10	60,000
* = Design Life in years or L-10 Design Life in hours, whichever occurs first		

- F. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as indicated, or as recommended in the published standards of the manufacturer if not indicated. Split-type housings may be used to facilitate installation, inspection, and disassembly.
- G. Sleeve-type bearings shall have a Babbitt or bronze liner.

2.8 GEARS AND GEAR DRIVES

- A. Unless otherwise indicated, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.7, a minimum L-10 bearing life of 60,000 hours and a minimum efficiency of 94 percent. Worm gears shall not be used, unless specifically approved by the Engineer.
- B. All gear speed reducers or increases shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, arranged for easy reading.
- C. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.
- D. Material selections shall be left to the discretion of the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have two positive seals to prevent oil leakage.

- E. Oil level and drain location relative to the mounting arrangement shall be easily accessible. Oil coolers or heat exchangers with all required appurtenances shall be furnished when necessary.
- F. Where gear drive input or output shafts have to connect to couplings or sprockets supplied by others, the Contractor shall have the gear drive manufacturer supply matching key taped to the shaft for shipment.

2.9 DRIVE CHAINS

- A. Power drive chains shall be commercial type roller chains and meet ANSI Standards.
- B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.
- C. A minimum of one connecting or coupler link shall be provided with each length of roller chain.
- D. Chain and attachments shall be of the manufacturer's best standard material and suitable for the process fluid.

2.10 SPROCKETS

- A. General: Sprockets shall be used in conjunction with all chain drives and chain-type material handling equipment.
- B. Materials: Unless otherwise indicated, materials shall be as follows:
 - 1. Sprockets with 25 teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.
 - 2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.
 - 3. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A 48, Class 30.
- C. All sprockets shall be accurately machined to ANSI Standards. Sprockets shall have deep hardness penetration in tooth sections.
- D. Finish bored sprockets shall be furnished complete with keyseat and set screws.
- E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with taper-lock bushings as required.
- F. Idler sprockets shall be furnished with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving. Steel collars with set screws may be provided in both sides of the hub.

2.11 V-BELT DRIVES

- A. V-belts and sheaves shall be of the best commercial grade and shall conform to ANSI, MPTA, and RMA Standards.

- B. Unless otherwise indicated, sheaves shall be machined from the finest quality gray cast iron.
- C. All sheaves shall be statically balanced. In some applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm may be required to be of special materials and construction.
- D. To facilitate installation and disassembly, sheaves shall be furnished complete with taper-lock or QD bushings as required.
- E. Finish bored sheaves shall be furnished complete with keyseat and set screws.
- F. Sliding motor bases shall be provided to adjust the tension of V-belts.

2.12 DRIVE GUARDS

- A. All power transmission, prime movers, machines, shaft extensions, and moving machine parts shall be guarded to conform with the OSHA Safety and Health Standards (29CFR1910). The guards shall be constructed of minimum 10 gauge expanded, flattened steel with smooth edges and corners, galvanized after fabrication and securely fastened. Where required for lubrication or maintenance, guards shall have hinged and latched access doors.

2.13 FLEXIBLE CONNECTORS

- A. General: Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems in accordance with Section 40 05 00 - Piping, General.

2.14 INSULATING CONNECTIONS

- A. General: Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used in accordance with the requirements of the Section 40 05 00 - Piping, General.

2.15 GASKETS AND PACKINGS

- A. Gaskets shall be in accordance with the requirements of Section 40 05 00 - Piping, General.
- B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane "Everseal," or equal.
- C. Packing around rotating shafts (other than valve stems) shall be "O"-rings, stuffing boxes, or mechanical seals, as recommended by the manufacturer and approved by the ENGINEER, in accordance with Section 43 20 10 - Pumps, General.

2.16 NAMEPLATES

- A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.17 SAFETY REQUIREMENTS

- A. Where Work areas are located within a flammable or toxic gas environment, suitable gas detection, ventilating, and oxygen deficiency equipment shall be provided. Workers shall be equipped with approved breathing apparatus.

2.18 OVERLOAD PROTECTION

- A. General: Unless otherwise indicated in individual equipment Sections, all equipment drives incorporating overload protection shall be provided with an overload protection device.
- B. Mechanical Torque Monitoring System: The overload protection shall be a mechanical device to provide for reliable protection in the event of excessive overload. It shall be a ball detent type designed for long term repeatability and life. It shall be infinitely adjustable by a single adjusting nut. Once set it shall be tamperproof, and incorporate a torque monitoring and control system. It shall activate an alarm set for 85 percent, and a motor cutout switch set for 100 percent of maximum continuous running torque. A visual torque indication shall be provided and oriented so that it may be read from the walkway. The dial shall be calibrated from 0 to 100 percent of maximum continuous running torque. The design of the torque limiter should initiate the mechanical disengagement of the drive upon overload. Each unit shall be suitable for outdoor/corrosive environments with a protective finish, corrosion inhibiting lubricants and a stainless steel cover.
- C. Electronic Torque Monitoring System:
 - 1. As an alternative to the mechanical system, the overload protection may be an Electronic Torque Monitoring Control System capable of displaying torque, rpm's, one level of overload, and two levels of overload of the drive system. It shall incorporate a time-delay for start-up and a voltage monitoring and compensation circuit for up to ± 15 percent variation.
 - 2. The overload device shall be housed in an enclosure with NEMA rating in accordance with the area designations of Section 26 00 10 - Electrical General Requirements. A visual torque dial shall be provided and oriented so that it can be easily read from the walkway.
 - 3. The torque monitoring system shall be calibrated to: alarm and shut down the system in the event the torque drops to 50 percent of normal running; alarm at 85 percent of maximum continuous running torque and shut down the motor at maximum continuous running torque of the equipment. The system shall be calibrated at the factory of the equipment manufacturer and it shall be capable of monitoring twice the maximum continuous running torque of the equipment.
- D. Manufacturers, or Equal
 - 1. American Autogard Corporation;
 - 2. Ferguson Machine Company.

PART 3 - EXECUTION

3.1 COUPLINGS

- A. The Contractor shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application; installation shall be per equipment manufacturer's printed recommendations.

3.2 INSULATING CONNECTIONS

- A. All insulating connections shall be installed in accordance with the manufacturer's printed instructions.

3.3 PIPE HANGERS, SUPPORTS, AND GUIDES

- A. Hangers, supports, seismic bracing and guides shall be spaced in accordance with ANSI/ASME B.31.1 standard.

3.4 PACKAGED EQUIPMENT

- A. When any system is furnished as pre-packaged equipment, the Contractor shall coordinate with subcontractors all necessary space and structural requirements, clearances, utility connections, signals, and outputs.
- B. If the packaged system has any additional features (for example, safety interlocks), other than indicated, the Contractor shall coordinate such features with the Engineer and furnish all material and labor necessary for a complete installation as required by the manufacturer, at no additional cost to the Owner.

END OF SECTION

DIVISION 22
PLUMBING

SECTION 22 11 16
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes domestic water piping inside the building plumbing.

1.3 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
 - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
 - 4. Copper Press Seal-Fittings: Shall conform to the material requirements of ASME B16.22 copper and ASME B22.18 Bronze and the performance requirements of IAPMO PS117.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Elkhart Products Corporation.
 - 2) NIBCO, Inc.
 - 3) Tyco GRINNELL.
 - 4) Viega.
 - b. Fittings for NPS 2 and Smaller: Wrought-copper or lead-free bronze fitting with EPDM sealing element in each end and un-pressed fitting leak identification feature.
- B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping
 - 3. Copper Unions. MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
 - 4. Copper Press-Seal Fittings: Shall conform to the material requirements of ASME B16.18 bronze and ASME B16.22 copper, and the performance requirements of IAPMO PS117.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Elkhart Products Corporation.
 - 2) NIBCO, Inc.
 - 3) Tyco GRINNELL.
 - 4) Viega.
 - b. Fittings for NPS 2 and Smaller: Wrought-copper or lead-free bronze fitting with EPDM sealing element in each end.

PART 3 - EXECUTION

3.1 PIPE AND FITTING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

- B. Flanges may be used on aboveground piping, unless otherwise indicated.
- C. Under Building slab, Domestic Water piping to 5feet outside of building, NPS 2 and smaller. Soft copper tube, Type K; copper pressure fittings; and brazed joints.
- D. Aboveground Domestic Water Piping: Use the following piping materials:
 - 1. NPS 6 and Smaller: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 - 2. NPS 1/2 to NPS 4: Hard copper tube, Type L; copper or lead-free bronze press-seal-fittings.

3.2 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use bronze ball valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Drain Duty: Hose-end drain valves.
 - 4. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 and smaller. Use butterfly valves for piping NPS 2-1/2 and larger.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
 - 1. Install hose-end drain valves at low points in water mains, risers, and branches.
 - 2. Install stop-and-waste drain valves where indicated.
- D. Shutoff Duty: Use bronze press-seal ball valves for NPS 2 and smaller type L copper tube.
- E. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow.

3.3 PIPING INSTALLATION

- A. Install under-building-slab copper tubing according to CDA's "Copper Tube Handbook."
- B. Install sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance.
- D. Install water-pressure regulators downstream from shutoff valves.

- E. Install domestic water piping level without pitch and plumb.

3.4 JOINT CONSTRUCTION

- A. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- B. Press Seal Joints: Shall be installed using the most current edition of the manufacturer's installation guidelines. The factory trained representative shall periodically visit the jobsite, review the product installation and provide additional training if new manpower has been assigned to pressure-sealed-joint piping installation. Contractor shall remove and replace any improperly installed products.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
- B. Install supports for vertical copper tubing every 10 feet.
- C. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.
- D. Fire stopping shall be provided to both be compatible with the piping and meet the requirements of ASTM E 814 or ULC S115, "Fire Tests of Through-Penetration Firestops." Pipe insulations or fire resistive coating shall be removed where the pipe passes through a fire stop and, if required by the firestop manufacturer, for 3 inches beyond the firestop outside of the fire barrier.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve, and extend and connect to the following:
 - 1. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code.
 - 3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.7 FIELD QUALITY CONTROL

- A. Inspect domestic water piping as follows:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test domestic water piping as follows:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.

3.8 ADJUSTING

- A. Perform the following adjustments before operation:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
 - 5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - 7. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.9 CLEANING

- A. Clean and disinfect potable and non-potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION

SECTION 22 11 19
DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:
 - 1. Strainers.
 - 2. Drain valves.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Compliance:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
 - 2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Ames Co.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Flomatic Corporation.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1013. See Plumbing Fixture Schedule on Drawings.

2.2 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cash Acme.
 - b. Conbraco Industries, Inc.
 - c. Honeywell Water Controls.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Body: Bronze with chrome-plated finish for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.3 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Drain: Factory-installed, hose-end drain valve.

2.4 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves. See Plumbing Fixture Schedule on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Section 230500 "Common Work Results for Plumbing and HVAC" for piping joining material, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 - 3. Do not install bypass piping around backflow preventers.
- C. Install water control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- D. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- E. Install balancing valves in locations where they can easily be adjusted.
- F. Install Y pattern strainers for water on supply side of each water pressure reducing valve.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

SECTION 22 13 16
PLUMBING DRAIN, WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 80 pipe.
- C. Adhesive Primer: ASTM F 656.
 - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Solvent Cement: ASTM D 2564.
 - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers"

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be

used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

- K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- M. Plumbing Specialties:
 - 1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."
- N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- O. Install sleeves, sleeve seals and escutcheons for piping penetrations of walls, ceilings, and floors.
- P. Install underground PVC piping according to ASTM D 2321.

3.2 JOINT CONSTRUCTION

- A. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.3 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.
 - 2. In Drainage Piping: Unshielded or Shielded, nonpressure transition couplings.
- B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or nipples.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- D. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
- E. Install supports for vertical PVC piping every 48 inches.
- F. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 5. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg . Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.

3.8 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.9 PIPING SCHEDULE

- A. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
 - 1. Hubless, cast-iron soil pipe and fittings heavy-duty hubless-piping couplings; and coupled joints.
- B. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
- C. Aboveground drain piping NPS 4 and smaller shall be any of the following:
 - 1. PVC pipe, PVC socket fittings, and solvent cemented joints.
- D. Underground, soil, waste, and vent piping NPS 6 and smaller shall be any of the following:
 - 1. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; and coupled joints.
 - 2. Solid wall PVC pipe: PVC socket fittings: and solvent cemented joints.

END OF SECTION 22 13 16

SECTION 22 45 00
EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following emergency plumbing fixtures:
 - 1. Combination units, eyewash and drench shower.

1.3 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. PVC: Polyvinyl chloride plastic.
- D. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.
- E. Tepid: Approximately 85 deg F temperature.
 - 1. Allowable Variation: Plus or minus 5 deg F.

1.4 SUBMITTALS

- A. Product Data: Include flow rates and capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each product indicated.
- B. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- D. Maintenance Data: For emergency plumbing fixtures to include in maintenance manuals specified in Division 01 33 20.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; about plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about plumbing fixtures for people with disabilities.
- E. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

1.6 COORDINATION

- A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. For fixture descriptions in other Part 2 articles where the subparagraph titles "Available Products" and "Products" introduce a list of manufacturers and their products, the following requirements apply for product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified in other Part 2 articles.

2.2 COMBINATION UNITS

- A. Combination Units: Plumbed, frost proof type with emergency drench shower and eye/face wash equipment.
 - 1. Available Products:
 - a. Bradley Corporation.
 - b. Chicago Faucet Co.
 - c. Encon Safety Products.
 - d. Guardian Equipment Co.
 - e. Haws Corporation.
 - f. Lab Safety Supply, Inc.
 - g. Murdock, Inc.
 - h. Speakman Co.
 - i. WaterSaver Faucet Co.
 - j. Western Emergency Equipment.

2. See Plumbing Fixture schedule on drawings.

2.3 SOURCE QUALITY CONTROL

- A. Certify performance of plumbed emergency plumbing fixtures by independent testing agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components according to manufacturer's written instructions.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Refer to Section 230523 "General-Duty Valves for Plumbing Piping" for general-duty shutoff valves.
 - 1. Exception: Omit shutoff valves on supplies to emergency equipment if prohibited by authorities having jurisdiction.
- E. Install shutoff valve and strainer in steam piping and shutoff valve in condensate return piping.
- F. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Refer to Section 230500 "Common Work Results for Plumbing and HVAC" for dielectric fittings.
- G. Install trap and waste to wall on drain outlet of fixture receptors that are indicated to be directly connected to drainage system.
- H. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Refer to Section 230500 "Common Work Results for Plumbing and HVAC" for escutcheons.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other related Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Connect tempered-water-supply piping to emergency fixture equipment per manufacturers installation instruction. Connect tempered water supply to tankless water heater.

3.4 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
- C. Report test results in writing.

3.5 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION

DIVISION 23
HVAC

SECTION 23 05 00
COMMON WORK RESULTS FOR PLUMBING AND HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Record Documents, Maintenance Manuals, and General Provisions for Plumbing and HVAC work.
 - 2. Piping materials and installation instructions common to most piping systems.
 - 3. Transition fittings.
 - 4. Dielectric fittings.
 - 5. Mechanical sleeve seals.
 - 6. Sleeves.
 - 7. Escutcheons.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Painting and finishing.
 - 10. Supports and anchorages.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Dielectric fittings.
 - 2. Mechanical sleeve seals.
 - 3. Escutcheons.

- B. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing by the engineer and connecting electrical services, circuit breakers, and conduit

sizes are appropriately modified without added cost to Project. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.5 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

1.6 FEES AND PERMITS

- A. Contractor shall apply and pay for all permits, inspections, reviews, etc. required by the authorities having jurisdiction.
 - 1. This shall include the cost of extending the natural gas service from the utility company main line to the building meter, setting the meter and regulator and all related utility company costs.
 - 2. The Contractor shall include in his/her Bid all system development or similarly named fee imposed by the serving utility company or governing entity (City, County, etc.).

1.7 RECORD DOCUMENTS

- A. Prepare Record Documents in accordance with the requirements in Division 01 Section "Closeout Procedures." In addition to the requirements specified in Division 01, indicate the following installed conditions:
 - 1. Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.
 - 2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (ie. traps, strainers, tanks, etc.). Refer to Section 230553 "Identification for Plumbing and HVAC Piping and Equipment". Indicate actual inverts and horizontal locations of underground piping.
 - 3. Equipment locations (exposed and concealed) dimensioned from prominent building lines.
 - 4. Approved substitutions, Contract Modifications, and actual equipment and materials installed. Revise equipment schedules.
 - 5. Contract Modifications, actual equipment and materials installed.

1.8 MAINTENANCE MANUALS

- A. Prepare maintenance manuals in accordance with Division 01 Section "Closeout Procedures." In addition to the requirements specified in Division 01. Assemble O & M Manuals as follows:

1. Compile three copies of Operating and Maintenance Manuals for the mechanical systems and equipment. The manuals shall be provided to the Architect for approval complete and at one time, prior to requesting final payment. Partial or separate data will be returned for completion.
2. Manuals shall be assembled in three-ring binders. Binders shall be 3 inches thick or less and more than one binder shall be used for each set of data if required to prevent overfilling of one binder. Binders shall have plastic coating with correct name of the Project permanently attached to the spine. All information shall be arranged in sections and each section shall have a blank buff colored, heavy paper divider with a protruding tab clearly labeled. Sections shall be arranged in the same order that the equipment is listed in the Specification and each Specification Section shall have a separate tab. Shop Drawings which are larger than 8-1/2 inches x 11 inches shall be individually folded so they are 8-1/2 inches x 11 inches or less and inserted behind the appropriate tab.
3. Tabs shall be labeled and arranged as follows:
 - a. Index: Furnish under the first tab an index of sections listing name of Section and Specification numbers.
 - b. Equipment Manufacturers: Furnish under the second tab a complete typed list of equipment suppliers and manufacturers representative including type of equipment, name, address and phone number. The company listed here should be the one which could furnish replacement parts and offer technical information about the equipment.
 - c. Valve Directory: Furnish under this tab a typed copy of the valve chart required.
 - d. Product Literature: Each tab, starting with the fourth shall contain the name of a Specification Section. Behind each tab shall be the previously submitted and approved Shop Drawing, factory published operation and maintenance instructions and parts lists.
4. Upon completion and approval of the booklets, one copy shall be given to the Architect, and two to the Owner.
5. Electronic Format: Provide all O&M information in a searchable electronic PDF format on CD for submission to the Owner with the hard copies.

1.9 MECHANICAL EQUIPMENT TRAINING

- A. The mechanical contractor shall schedule training with the Owner. Using the O & M Manuals, the mechanical contractor shall explain in detail and instruct the Owner's maintenance personnel in the correct operation and maintenance of the equipment.
 1. The mechanical contractor shall develop and create an agenda to be used during Training.
 2. The mechanical contractor shall provide a sign in sheet to verify dates and types of training and who attended.
- B. Refer to specific training and demonstration, Section 01 91 14 requirements in the individual specifications.

1.10 GENERAL PROVISIONS FOR MECHANICAL WORK

- A. Interferences: Project design took into account potential interferences between trades (e.g. mechanical ductwork with piping or with electrical light fixtures), however, not every interference has been eliminated. It shall be the responsibility of the Bidder and potential Contractor to field verify all mechanical piping and duct routing, making allowances for existing beams, pipes, ducts, hangers, and other obstructions. Provide HVAC duct offsets and transitions as required maintaining duct aspect ratios within 10 percent of design and piping offsets as required. The cost associated with interferences shall be included in the Base Bid.
- B. Examination of Project Drawings:
1. The Drawings (Plans, elevations, flow schematics, etc.) for the mechanical work are intended to convey Scope of Work and to indicate the general arrangements and locations of end-use equipment, systems, etc., and the approximate sizes thereof.
 2. The Contractor shall determine the exact location and mounting heights of equipment, rough-ins, and the exact routing and positioning of piping/ductwork equipment so as to best fit the layout of the job. Scaling of the Drawings will not be sufficient for determining these locations. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made, by the Contractor, at no additional cost to the Client.
 3. Because of the scale of the Drawings, certain basic items/materials and quantities thereof, (e.g. fittings, connectors, flanges, unions, pipe wells, couplings, hangers, sleeves, clamps, screws, hooks, inserts, pipe/duct mounted - meters, gauges, sensors, etc.) may not be shown, but where such items are required by other sections of the Specifications or where they are required for proper installation of the Work, such items shall be furnished and installed and the cost thereof, reflected in the Base Bid.
 4. The determination of quantities of HVAC and plumbing end-use systems and equipment required shall be made by the Contractor from the Drawings. Interferences and quantities and locations of basic items/materials may not be indicated on the Drawings and will require field verification and determination by the Contractor.
 5. The Contractor shall coordinate the location and method of support of the piping/duct systems with that of all installations under other Divisions and Sections of the Specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 and 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 22 and 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8-inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BcuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Solvent Cements for Joining Plastic Piping:
 - 1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 2. PVC to ABS Piping Transition: ASTM D 3138.

2.4 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Available Manufacturers:
 - a. Eslon Thermoplastics.
- B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Available Manufacturers:
 - a. Thompson Plastics, Inc.

- C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - 1. Available Manufacturers:
 - a. NIBCO INC.
 - b. NIBCO, Inc.; Chemtrol Div.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250 psig minimum working pressure at 180 deg F.
 - 1. Available Manufacturers:
 - a. Central Plastics Company.
 - b. Epco Sales, Inc.
 - c. Hart Industries, International, Inc.
 - d. Watts Industries, Inc., Water Products Div.
 - e. Zurn Industries, Inc., Wilkins Div.
- D. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300 psig minimum working pressure at 225 deg F.
 - 1. Available Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300 psig minimum working pressure at 225 deg F.
 - 1. Available Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Available Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Plastic or carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
 1. One-Piece, Cast-Brass Type: With set screw and polished chrome-plated.
- C. Split-Plate, Cast-Brass or Stamped-Steel Type: With concealed hinge, spring clips and chrome-plated finish.
- D. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Drawing Plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.

- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast-brass type with polished chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: Split plate, cast-brass or stamped steel type with polished chrome-plated finish.
- L. Sleeves are not required for core-drilled holes.
- M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

END OF SECTION

SECTION 23 05 29
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Equipment supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For multiple piping supports and trapeze hangers, show fabrication and installation details and include calculations. Details shall indicate connections to equipment, piping and structure.
- C. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Thermal-Hanger shield inserts shall be installed at the time of hanger installation.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Copper Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut Corporation; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
 - 3. Standard: MFMA-4.
 - 4. Channels: Continuous slotted steel channel with inturned lips.
 - 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
 - 7. Metallic Coating: Electroplated zinc.
 - 8. Paint Coating: Acrylic.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO International Corporation.
 - 3. Mechanical Pipe Shields "SNAP-ITZ."
 - 4. National Pipe Hanger Corporation.
 - 5. PHS Industries, Inc.
 - 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 - 7. Piping Technology & Products, Inc.
 - 8. Rilco Manufacturing Co., Inc.
 - 9. TOLCO a brand of Nibco.
 - 10. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig or water-repellent treated, ASTM C 533, Type I calcium silicate, minimum compressive strength and vapor barrier.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Installed by Mechanical Contractor at time of hanger installation. Inserts are required on all cold piping 2 inch (50 mm) and larger.
- E. Fastener System Installation:
 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before

concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert for pipes 2 inches and larger. Run insulation continuously through hanger and install a galvanized Type 40 insulation shield between hanger and insulation for pipes smaller than 2 inches .
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Where indicated, install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier smaller than 2 inches. Shields shall span an arc of 180 degrees.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods.

3.5 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for cold insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

Pipe Size	Pipe Material	MSS Hanger Type	Manufacturer/Model	Notes
1/2" - 4"	Bare Steel	Type 1	ANVIL Fig. 65	
5" - 14"	Bare Steel	Type 1	ANVIL Fig. 260	

1/2" - 4"	Bare Copper	Type 9	ANVIL Fig. CT-99 or CT-65	
1/2" - 4"	Insulated Copper (Hot)	Type 9	ANVIL Fig. CT-99 or CT-65	
1/2" - 12"	Insulated Steel (Hot)	Type 1	ANVIL Fig. 300	Hanger may contact pipe.
1/2" - 1-1-2"	Insulated Copper and Steel (Cold)	Type 1	ANVIL Fig. 300 with shield	No pipe contact allowed.
2" - 12"	Insulated Copper and Steel (Cold)	Type 1	ANVIL Fig. 300 with shield and insert	No pipe contact allowed.
2" - 8"	Cast Iron Sewer	Type 1	ANVIL Fig. 260	
1/2" - 4"	Bare PVC	Type 1	ANVIL Fig. 65 Epoxy Coated	
5" - 18"	Bare PVC	Type 1	ANVIL Fib. 260 (Epoxy Coated)	

- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 14. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR PLUMBING AND HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation:
 - 1. Equipment markers.
 - 2. Pipe markers.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
 - 1. Terminology: Match schedules as closely as possible.
 - 2. Data:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

2.2 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
 1. Colors: Comply with ASME A13.1, unless otherwise indicated.
 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 3. Pipes with OD, Including Insulation, Less Than 6 inches: Full-band pipe markers extending 360 degrees around pipe at each location.
 4. Pipes with OD, Including Insulation, 6 inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
 5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.
- C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.
- D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.
- E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 inches: 3/4-inch minimum.
 2. Width for Markers on Pipes with OD, Including Insulation, 6 inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other related Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment.
 1. Letter Size: Minimum 1/4-inch for name of units if viewing distance is less than 24 inches, 1/2-inch for viewing distances up to 72 inches, and proportionately larger

- lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. Fire department hose valves and hose stations.
 - b. Fuel-burning units, including boilers, furnaces, heaters, and rooftop units.
 - c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
 - d. Heat exchangers, cooling towers, heat recovery units, and similar equipment.
 - e. Fans, blowers, mixing boxes and VAV boxes.
 - f. Packaged HVAC central-station air handling units.
 - g. Tanks and pressure vessels.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
 1. Pipes with OD, Including Insulation, Less Than 6 inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4-inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
 2. Pipes with OD, Including Insulation, 6 inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- B. Locate pipe markers where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; exterior nonconcealed locations and concealed ceiling spaces as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings at intervals of 50 feet.

3.4 CLEANING

- A. Clean faces of mechanical identification devices.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes TAB to produce design objectives for all air systems.

1.3 SUBMITTALS

- A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 45 days from Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3.
- C. Sample Report Forms: Submit two sets of sample TAB report forms.

1.4 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.
- B. The Test and Balance Contractor shall be an independent consultant. The firm shall be independent of all Contractors including the Mechanical and Temperature Controls Contractor.
- C. TAB Conference: Meet with Owner's and Engineer's representatives to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items: Include at least the following:
 - a. Submittal distribution requirements.
 - b. The Contract Documents examination report.
 - c. TAB plan.
 - d. Work schedule and Project-site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.
 - f. Coordination of documentation and communication flow.
- D. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- E. TAB Report Forms: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." Or from SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing."
- F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.
- 1.5 COORDINATION
- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

PART 2 - EXECUTION

2.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- C. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- D. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

- E. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- F. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- G. Examine heating water system pumps to ensure absence of entrained air in the suction piping.
- H. Examine equipment for installation and for properly operating safety interlocks and controls.
- I. Examine operating safety interlocks and controls on HVAC equipment.
- J. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

2.2 PREPARATION

- A. Complete system readiness checks and submit a system readiness report to the Project Engineer. Verify the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Clean filters are installed.
 - 5. Balance, smoke, and fire dampers are open.
 - 6. Isolating and balancing valves are open and control valves are operational.
 - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 8. Windows and doors are installed and can be closed so indicated conditions for system operations can be met.
 - 9. Verify leakage and pressure tests on heating water distribution systems have been satisfactorily completed.

2.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

2.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- C. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- D. Verify that motor starters are equipped with properly sized thermal protection.
- E. Check dampers for proper position to achieve desired airflow path.
- F. Check for airflow blockages.
- G. Check condensate drains for proper connections and functioning.
- H. Check for proper sealing of air-handling unit components.
- I. Check for proper sealing of air duct system.

2.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Obtain approval from Construction Manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure inlets and outlets airflow.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 6. Measure and record all operating data.
 7. Record final fan-performance data.

2.6 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
 2. Air Outlets and Inlets: 0 to minus 5 percent.

2.7 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

- B. Include a certification sheet in front of binder signed by the testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page.
 - 2. Name and address of TAB firm.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's/Engineer's name and address.
 - 6. Contractor's name and address.
 - 7. Report date.
 - 8. Signature of TAB firm who certifies the report.
 - 9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 10. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 11. Notes to explain why certain final data in the body of reports varies from indicated values.
 - 12. Test conditions for fans performance forms including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Fan drive settings including settings and percentage of maximum pitch diameter.
 - e. Other system operating conditions that affect performance.

2.8 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 07 00
PLUMBING AND HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes pipe, duct, and equipment insulation.

1.2 SUBMITTALS

- A. Product data for each type of mechanical insulation identifying k-value, thickness, jackets (factory and field applied) and accessories.

1.3 QUALITY ASSURANCE

- A. Fire Performance Characteristics: Conform to the following characteristics for insulation including facings, cements, and adhesives, when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.
 - 1. Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.
 - 2. Exterior Insulation: Flame spread rating of 75 or less and a smoke developed rating of 150 or less.

1.4 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for Plumbing and HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct installation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation.

1.5 SEQUENCING AND SCHEDULING

- A. Schedule insulation application after pressure testing of piping and duct systems.
- B. Thermal-hanger shield inserts are specified in "Hangers and Supports." Inserts shall be installed at the time of hanger installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. Glass Fiber:
 - a. CertainTeed Corporation.
 - b. Knauf Fiberglass.
 - c. Manville/Schuller.
 - d. Owens-Corning Fiberglas Corporation.
 - e. E-Insulation.
 - 2. Flexible Elastomeric Cellular:
 - a. Armacell LLC.
 - b. IMCOA Corporation.
 - c. Rubatex Corporation.

2.2 GLASS FIBER

- A. Material: Inorganic glass fibers, bonded with a thermosetting resin.
- B. Jacket: All-service, factory-applied, laminated glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil skrim backing having pressure sensitive self-sealing lap.
- C. Board: ASTM C 612, Class 2, semi-rigid jacketed board.
 - 1. Thermal Conductivity: 0.23 average maximum, at 75 deg F mean temperature.
 - 2. Density: 3.0 pcf average maximum.
- D. Blanket: ASTM C 553, Type I, Class B-2, jacketed flexible blankets.
 - 1. Thermal Conductivity: 0.27 at compressed thickness, at 75 deg F mean temperature.
 - 2. Density: 0.75lb/cu. ft.
- E. Preformed Pipe Insulation: ASTM C 547, Class 1, rigid pipe insulation, factory applied all-service jacket with self seal lap.
 - 1. Thermal Conductivity: 0.26 average maximum at 75 deg F mean temperature.
 - 2. Density: 5 lb/cu. ft average maximum.
- F. Vapor Barrier Coating: Waterproof coating recommended by insulation manufacturer for outside service.

2.3 FLEXIBLE ELASTOMERIC CELLULAR

- A. Material: Flexible expanded closed-cell structure with smooth skin on both sides.
 - 1. Tubular Materials: ASTM C 534, Type I.
 - 2. Sheet Materials: ASTM C 534, Type II.
- B. Thermal Conductivity: 0.25 average maximum at 75 deg F.
- C. Coating: Water based latex enamel coating recommended by insulation manufacturer.

2.4 ADHESIVES

- A. Flexible Elastomeric Cellular Insulation Adhesive: Solvent-based, contact adhesive recommended by insulation manufacturer. Comply with MIL-A-24179A, Type II, Class 1.

2.5 FIELD APPLIED JACKETS

- A. PVC Jacketing: High-impact, ultra-violet-resistant PVC, 30-mils thick, roll stock ready for shop or field cutting and forming to indicated sizes.
 - 1. Mastic/Adhesive: As recommended by insulation manufacturer.
- B. PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 30-mil-thick, high-impact, ultra-violet-resistant PVC.
 - 1. Mastic around fitting to pipe insulation.
- C. Aluminum Jacket: ASTM B 209, 3003 Alloy, H-14 temper, roll stock ready for shop or field cutting and forming to indicated sizes.
 - 1. Finish and Thickness: Smooth finish, 0.016-inch thick for interior applications and 0.020-inch (0.51mm) thick for exterior applications.
 - 2. Moisture Barrier for Indoor Applications: 1 mil thick, heat-bonded polyethylene and kraft paper.
 - 3. Moisture Barrier for Outdoor Applications: 3 mil thick, heat-bonded polyethylene and kraft paper.
 - 4. Elbows: Preformed 45-degree and 90-degree, short- and long-radius elbows, same material, finish, and thickness as jacket.

2.6 ACCESSORIES AND ATTACHMENTS

- A. Bands: 3/4-inch wide, in one of the following materials compatible with jacket:
 - 1. Aluminum: 0.007-inch thick.
 - 2. 1/8-inch by 1/8-inch Rapid Penetrating point screws for non vapor barrier application.
- B. Wire: 14 gauge nickel copper alloy, 16 gauge, soft-annealed stainless steel, or 160 gauge, soft-annealed galvanized steel.
- C. Cupped Head Weld Pins- 1-1/2 inch diameter cupped head, mild, annealed steel with zinc plating.
- D. Corner Angles: 28 gauge, 1 inch by 1 inch aluminum, adhered to 2 inch by 2 inch kraft paper.
- E. Anchor Pins: Capable of supporting 20 pounds each. Provide anchor pins and speed washers of sizes and diameters as recommended by the manufacturer for insulation type and thickness.
- F. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.

5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- G. Foil/Skrim/Kraft Tape: Vapor barrier tape with rubber adhesive and UL listed and 25/20 rated.
1. Width: 2 inches.
 2. Thickness: 3.7 mils.
 3. Adhesion: 85 ounces force/inch in width.
 4. Elongation: 5 percent.
 5. Tensile Strength: 45 lbf/inch in width.

2.7 SEALING COMPOUNDS-MASTIC

- A. Vapor Barrier Compound: Water-based, fire-resistive composition.
1. Water Vapor Permeance: 0.08 perm maximum.
 2. Temperature Range: Minus 20 to 180 deg F.
- B. Weatherproof Sealant: Flexible-elastomer-based, vapor-barrier sealant designed to seal metal joints.
1. Water Vapor Permeance: 0.02 perm maximum.
 2. Temperature Range: Minus 50 to 250 deg F.
 3. Color: Aluminum.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean, dry, and remove foreign materials such as rust, scale, and dirt.

3.2 INSTALLATION, GENERAL

- A. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each mechanical system.
- B. Select accessories compatible with materials suitable for the service. Select accessories that do not corrode, soften, or otherwise attack the insulation or jacket in either the wet or dry state.
- C. Install vapor barriers on insulated pipes, ducts, and equipment where indicated and defined in insulation service chart.
- D. Apply insulation material, accessories, and finishes according to the manufacturer's printed instructions.
- E. Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.
- F. Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.

- G. Keep insulation materials dry during application and finishing.
- H. Items Not Insulated: Unless otherwise indicated do not apply insulation to the following systems, materials, and equipment:
 - 1. Metal ducts with duct liner.
 - 2. Flexible connectors for ducts and pipes.
 - 3. Testing laboratory labels and stamps.
 - 4. Nameplates and data plates.
 - 5. Access panels and doors in air distribution systems.
 - 6. Chrome-plated pipes and fittings, except for plumbing fixtures for the disabled.
 - 7. Backflow prevention device.

3.3 PIPE INSULATION INSTALLATION, GENERAL

- A. Tightly butt longitudinal seams and end joints.
- B. Apply insulation continuously over fittings, valves, and specialties.
- C. Apply insulation with a minimum number of joints.
- D. Apply insulation with all service jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Cover circumferential joints with butt strips, at least 3 inches wide, and of same material as insulation jacket.
 - 3. Longitudinal Seams: Overlap seams at least 1-1/2-inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap.
 - 4. At penetrations in jackets for thermometers and pressure gauges, fill and seal voids with mastic.
 - 5. Repair damaged insulation jackets, except metal jackets, by applying jacket material around damaged jacket. Extend patch at least 2 inches in both directions beyond damaged insulation jacket and around the entire circumference of the pipe.
- E. Roof Penetrations: Apply insulation for interior applications to a point even with the top of the roof flashing. Seal with vapor barrier coating. Apply insulation for exterior applications butted tightly to interior insulation ends. Extend metal jacket for exterior insulation outside roof flashing at least 2 inches below top of roof flashing. Seal metal jacket to roof flashing with vapor barrier coating.
- F. Exterior Wall Penetrations: For penetrations of below grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor barrier coating.
- G. Interior Walls and Partitions Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.
- H. Fire-Rated Walls and Partitions Penetrations: Terminate insulation at penetrations through fire-rated walls and partitions. Seal insulation ends with vapor barrier coating. Seal around penetration with firestopping or fire-resistant joint sealer.

- I. Floor Penetrations: Terminate insulation underside of floor assembly and at floor support at top of floor.
- J. Flanges, Fittings, and Valves - Interior Exposed and Concealed: Coat pipe insulation ends with mastic. Apply premolded, precut, or field-fabricated segments of insulation around flanges, unions, valves, and fittings. Make joints tight.
 - 1. Use same material and thickness as adjacent pipe insulation.
 - 2. Overlap nesting insulation by 2 inches or 1-pipe diameter, whichever is greater.
 - 3. Insulate elbows with blanket insulation inserts.
 - 4. Cover insulation, except for metal jacketed insulation, with PVC fitting covers and seal circumferential joints with butt strips.
- K. Hangers and Anchors: Apply insulation continuously through hangers and around anchor attachments. For vapor barrier application piping, extend insulation on anchor legs a minimum of 12 inches and taper and seal insulation ends.
 - 1. Install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer. Refer to "Hangers and Supports" for thermal-hanger shield inserts.
 - 2. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

3.4 GLASS FIBER PIPE INSULATION INSTALLATION

- A. Seal exposed seams and joint ends, with mastic.

3.5 FLEXIBLE ELASTOMERIC PIPE INSULATION INSTALLATION

- A. Slip insulation on the pipe before making connections wherever possible. Seal joints with adhesive. Where the slip-on technique is not possible, use longitudinally precut insulation and apply to the pipe. Seal seams and joints with adhesive.
- B. Valves, Fittings, and Flanges: Cut insulation segments from pipe or sheet insulation. Bond to valve, fitting, and flange and seal joints with adhesive. Use prefabricated fittings if available.
 - 1. Miter cut materials to cover soldered elbows and tees.
 - 2. Fabricate sleeve fitting covers from flexible elastomeric cellular insulation for screwed valves, fittings, and specialties. Miter cut materials. Overlap adjoining pipe insulation.

3.6 EQUIPMENT INSULATION INSTALLATION, GENERAL

- A. Install board materials with a minimum number of joints.
- B. Ensure insulation materials to fit as closely as possible to the equipment and to fit contours of equipment. Stagger end joints.
- C. Insulation Thicknesses Greater than 2 inches: Install insulation in multiple layers with staggered joints.

- D. Secure sections of insulation in place with bands spaced at 12 inch centers, except for flexible elastomeric cellular insulation.
- E. Protect exposed corners with corner angles under bands.
- F. Manholes, Handholes, and Information Plates: Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
- G. Removable Insulation: Install insulation on components that require periodic inspecting, cleaning, and repairing for easy removal and replacement without damage to adjacent insulation.
- H. Finishing: Except for flexible elastomeric cellular insulation, see Insulation schedule for jacketing.

3.7 GLASS FIBER EQUIPMENT INSULATION INSTALLATION

- A. Secure insulation with anchor pins and speed washers.
- B. Space anchors at maximum intervals of 18 inches in both directions and not more than 3 inches from edges and joints.

3.8 FLEXIBLE ELASTOMERIC EQUIPMENT INSULATION INSTALLATION

- A. Install sheets of the largest manageable size.
- B. Apply full coverage of adhesive to the surfaces of the equipment and to the insulation.
- C. Butt insulation joints firmly together and apply adhesive to insulation edges at joints.
- D. Coat exterior installations with manufacturer's coating and install by manufacturer's installation instructions.

3.9 FIELD APPLIED JACKETS

- A. Install metal jacket with 2 inch overlap at longitudinal and butt joints. Overlap longitudinal joints to shed water. Seal butt joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel draw bands 12 inches on center and at butt joints.
- B. Install the PVC jacket with 1 inch overlap at longitudinal and butt joints and seal with adhesive.

3.10 FINISHES

- A. Flexible Elastomeric Cellular Insulation: After adhesive has fully cured, apply 2 coats of manufacturer's recommended protective coating to exposed insulation.
- B. Exterior insulated ductwork and equipment shall have a weatherproof coating applied over the insulation.

3.11 INSULATION SCHEDULES

A. General: Abbreviations used in the following schedules include:

1. Field-Applied Jackets: PVC - PVC, A - Aluminum, SS - Stainless Steel, Glass Cloth.
2. Pipe Sizes: NPS - Nominal Pipe Size.
3. Materials: GF - Glass Fiber, FE - Flexible Elastomeric.

B. Pipe Insulation:

APPLICATION	TEMP (°F)	NOM. PIPE SIZE (IN.)	INSUL. MAT.	THICK NESS (IN.)	INSERTS OR SHIELDS NOTE 1	VAPOR BARRIER	FIELD APP. JKT.
DOMESTIC COLD WATER	ALL	ALL	GF OR FE	1	NO	YES	NONE
DOMESTIC HOT WATER	ALL	1/2 TO 1 1/4 1 1/2 TO 4	GF OR FE	1 1.5	NO	NO	NONE
EVAP COOLER MAKEUP WATER, RECIRC PUMP AND PIPING, CHEMICAL FEED LINES, BELOW DOWN AND DRAIN PIPING	ALL	ALL	GF or FE	1	YES	PVC OR A	PVC OR A
PLUMBING VENTS WITHIN 6 FT OF ROOF OUTLET	ALL	ALL	GF	1	NO	NO	NONE
REFRIGERANT SUCTION AND HOT GAS	ALL	BELOW 1 1 AND UP	FE FE	1/2 1	NO	NO	NONE
RAIN WATER AND OVERFLOW	ALL	ALL	GF OR FE	1	NO	NO	NONE

DOMESTIC HOT WATER AND HW RECIRC	ALL	< 1-1/2	GF OR FE	1	NO	NO	NONE
--	-----	---------	-------------	---	----	----	------

NOTE 1: INSERTS AND SHIELDS ARE IN SECTION 230529 - HANGERS AND SUPPORTS FOR PLUMBING AND HVAC PIPING AND EQUIPMENT AND SHALL BE PROVIDED BY THE INSULATION CONTRACTOR.

NOTE 2: ALL PIPING INSTALLED OUTDOORS OR EXPOSED TO WEATHER SHALL HAVE FIELD APPLIED JACKET, EVEN IF A JACKET IS NOT EXPLICITLY CALLED OUT IN TABLE.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

SECTION 23 31 13 METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Rectangular ducts and fittings.
 - 2. Single-wall round ducts and fittings.

1.3 DEFINITIONS

- A. NUSIG: National Uniform Seismic Installation Guidelines.

1.4 WORK INCLUDED

- A. Provide an installed duct system which will supply the air quantities indicated by the Drawings and have the lowest possible friction loss with the least possible leakage loss. System static pressure loss for each system shall not exceed that which is indicated in the equipment schedule as external static pressure or in the fan schedule as static pressure and shall include the losses of all accessories. Friction losses shall be minimized by reduction in the number of offsets and elbows by pre-planning the duct system installation and coordination with other trades to prevent interferences. Maintain access to accessories requiring maintenance, service, and inspection. Radius elbows are preferred for turns to minimize friction, noise, and vibrations, and especially for sections having large volume or higher velocities and sections which may have turbulence.
- B. Provide and/or construct materials, ductwork, joints, transformations, splitters, dampers, and access doors as specified herein for the sheet metal ductwork as shown on Drawings.

1.5 SUBMITTALS

- A. Shop Drawings:
 - 1. Ductwork fabrication shop standards.
 - 2. Fittings.
 - 3. Reinforcement and spacing.
 - 4. Seam and joint construction.
 - 5. Penetrations through fire-rated and other partitions.
 - 6. Equipment installation based on equipment being used on Project.
 - 7. Duct accessories, including access doors and panels.
 - 8. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.

- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. NFPA Compliance:
 - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 - 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 SEALANT MATERIALS

- A. Joint and Seam Sealants, General: The term "sealant is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
- B. Joint and Seam Tape: Not acceptable.
- C. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
- D. Water-Based Joint and Seam Sealant: One-part flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

- E. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.
- F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.4 HANGERS AND SUPPORTS

- A. Hanger Materials: Galvanized sheet steel or threaded steel rod.
 - 1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 - 2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
 - 3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
- B. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- C. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.5 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
 - 1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 - 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
 - 1. Available Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Nexus Inc.
 - c. Ward Industries, Inc.
- C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
 - 1. Available Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Lockformer.

2. Duct Size: Maximum 30 inches wide and up to 2 inch wg pressure class.
 3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant (only on all medium and high pressure ductwork).
- D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 12 inches and larger and 20 gage or less, with more than 10 sq. ft. of nonbraced panel area.
- E. Transitions:
1. Do not exceed 1 inch in 7 inches of slope for increase-in-area transitions.
 2. Do not exceed 1 inch in 4 inches of slope for decrease-in-area transitions, 1 inch in 7 inches is preferable.
 3. Do not exceed 45 degrees on the entering or leaving side for angle of transitions at connections to equipment without the use of approved vanes.
- F. Elbows:
1. Fabricate elbows using one of the following Specifications: The fabrication methods are listed in order of preference. Use radius elbows wherever possible. Use square elbows only when available space prevents the use of radius elbows.
 - a. Unvaned, long radius elbow with the throat radius equal to 3/4 of the width of the duct and with a full heel radius.
 - b. Six inch throat radius with full radius, single thickness vanes and full heel radius.
 - c. Square elbows with airfoil, double thickness turning vanes.
 - d. Maximum unsupported length of vanes shall be 36 inches. Securely fasten vanes to runners. Secure vanes in stable position. Construct vane edges to project tangents parallel to duct sides.
 2. Turning Vanes:
 - a. True airfoil design; smoothly-rounded entry nose with extended trailing edge. Generated sound power level shall not exceed 54 decibels in band 4 at 2000 FPM in a 24 inch x 24 inch duct.
 - b. Manufacturer: Equal to Aero/Dyne Co., High Efficiency Profile, HEP. Contact Aero/Dyne Co. at 1215 High Street, Suite 103, Auburn, CA 95603. (Telephone #800-522-2423).
 - c. Fabricate assemblies with side rails; install vanes on design centers of 2.4 inches across the full diagonal dimension of the elbow.
 - d. Submit manufacturer's product data for review.
- G. Branch Connections:
1. Pressure Classification 2 Inches and Less:
 - a. Rectangular branch from rectangular main: 45 degree entry with all corners closed as shown in Figure 4-6.
 - b. Round branches: High-efficiency take-offs.
 - c. Parallel flow branches: See Figure 4-5.
 - d. Space duct joints to avoid cutting them for branch take offs and outlet collars.

2.6 ROUND DUCT AND FITTING FABRICATION

- A. Round and Flat-Oval, Spiral Lock Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
 - 1. Available Manufacturers:
 - a. Accu-Duct.
 - b. McGill AirFlow Corporation.
 - c. Norlock.
 - d. Omniduct.
 - e. SEMCO Incorporated.
 - f. Team Mechanical Inc.
 - g. Ventline.
 - h. Sheet Metal Contractors, Inc.
- B. Duct Joints:
 - 1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
- C. 90 Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts. Tees shall be conical. Saddle taps or straight tees shall not be used.
- D. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- E. Two piece mitered elbows shall not be used.
- F. The leading edge of all vanes in ducts over 20 inch diameter is to be hemmed with 1/2 inch foldback. Turning vanes in ducts over 24 inches are to be reinforced by stays or sectional construction to limit unsupported length to 24 inches. Vanes shall be minimum of 20 gauge.
- G. Reduction of divided flow fittings to conical span section in the 36 common reductions in sizes 4 inch through 22 inch.
- H. Galvanized areas damaged by welding to be coated with corrosion resistant aluminum paint.
- I. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
 - 1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
 - 2. 90 Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
 - 3. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45 and 90 degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only.

- Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
4. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
 5. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
 6. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 20 gage thick with 2-piece welded construction.
 7. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

- A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
 1. Supply Ducts: 2 inch wg.
 2. Return and Exhaust Ducts (Negative Pressure): 2 inch wg.
- B. All ducts shall be galvanized steel.

3.2 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections. Secure fittings with screws. Install screws at intervals of 10 inches, with a minimum of (3) screws per fitting. Seal all joints and seams.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Protect duct interiors with sheet metal or plastic sheet covers from moisture, construction debris and dust, and other foreign materials until system is energized. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines," Intermediate Level.
- L. Intermediate duct reinforcement to be same as duct material.
- M. Do not exceed 45 degrees for easement transition angle.
- N. Insulation: Where Drawings and Specifications require ducts to be insulated, make provisions for neat insulation finish around damper operating quadrants, splitter adjusting clamps, access doors, and similar operating devices. Metal collar equivalent in depth to insulation thickness and of suitable size to which insulation may be finished used for this purpose shall be attached to the duct. Linings in air ducts shall meet the Erosion Test Method described in UL Publication no. 181.
- O. Counterflashing: Counterflash ductwork penetrating roof.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, anchors, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Powder-actuated fasteners not acceptable for ductwork installation.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

- G. Support round ducts from building structure with galvanized steel hangers as recommended in SMACNA manual. Secure hangers to masonry portion of building by means of inserts or other acceptable anchors.

3.4 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes.
 - 1. Space lateral supports a maximum of 40 feet o.c. and longitudinal supports a maximum of 80 feet o.c.
 - 2. Brace a change of direction longer than 12 feet.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 AIR TEST AND BALANCE

- A. Prepare the system for tests as specified in Section 230593 and correct deficiencies found by the Test and Balance firm.
- B. Duct dimensions shown on Drawings indicate inside clear dimensions. Make allowances for duct requiring internal sound lining, or insulation to provide "inside clear"(IC) dimensions.
- C. In addition to the requirements above, add supplemental bracing as necessary to prevent sagging and drumming, and/or vibration.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

SECTION 23 34 23
HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Centrifugal UpBlast roof ventilators.
 - 2. Inline Ventilators.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 INLINE VENTILATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. ACME Engineering and Manufacturing Company.
 - 2. Carnes Company HVAC.
 - 3. Loren Cook Company.
 - 4. Greenheck Fan Corp.
- B. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.
- C. Housing: Steel, lined with acoustical insulation.
- D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- E. Grille: Steel, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- G. Accessories:
 - 1. Isolation: Rubber-in-shear vibration isolators.
 - 2. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.2 UPBLAST CENTRIFUGAL ROOF VENTILATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Acme Engineering and Manufacturing Company.
 - 2. Carnes Company HVAC.
 - 3. Loren Cook Company.
 - 4. New York Blower Company (The).
 - 5. Penn Ventilation.
 - 6. Greenheck Fan Corp.
- B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and, drive assembly, curb base, and accessories.
- C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
 - 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
 - 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 4. Fan and motor isolated from exhaust airstream.
- F. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 - 3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
- G. Roof Curbs: Provide curb adapter for fan to sit on existing concrete curb. Coordinate existing size for exhaust fan.

2.3 MOTORS

- A. Enclosure Type: Totally enclosed, fan cooled.

2.4 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Section 230553 "Identification for Plumbing and HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other related Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment and connect wiring according to Electrical Specification.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 10. Shut unit down and reconnect automatic temperature-control operators.
 - 11. Remove and replace malfunctioning units and retest as specified above.

- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

SECTION 23 55 33 UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes electric unit heaters.

1.3 SUBMITTALS

- A. Product Data: For each type of electric unit heater indicated. Include rated capacities, operating characteristics, and accessories.
- B. Operation and Maintenance Data: For electric unit heaters to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

PART 2 - PRODUCTS

2.1 GAS-FIRED UNIT HEATERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Lennox Industries, Inc.
 - 2. Modine Manufacturing Company.
 - 3. Reznor/Thomas & Betts Corporation.
 - 4. Sterling HVAC Products; Div. of Mestek Technology Inc.
 - 5. Trane Company (The).
- B. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.
 - 1. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

2. AGA Approval: Designed and certified by and bearing label of American Gas Association.
- C. Type of Venting: outdoor, separated combustion, power vented.
- D. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.
 1. External Casings and Cabinets: Powder coating over corrosion-resistant-treated surface.
 2. Finish: Manufacturer's standard paint applied to factory-assembled and tested, fuel-fired unit heater before shipping.
- E. Heat Exchanger: Aluminized steel.
- F. Burner Material: Aluminized steel with stainless-steel inserts.
- G. Unit Fan: Formed-steel propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.
 1. Fan-Blade Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
 2. Motors: Totally enclosed with internal thermal-overload protection and complying with Division 23 Section "Common Motor Requirements for HVAC Equipment."
 3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 4. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
- H. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
 1. Gas Control Valve: Two stage
 2. Ignition: Electronically controlled electric spark with flame sensor.
 3. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
 4. Control transformer.
 5. High Limit: Thermal switch or fuse to stop burner.
 6. Thermostat: 2-stage, wall-mounting type with 50 to 90 deg F operating range and fan on switch.
- I. Discharge Louvers: Independently adjustable horizontal blades.
- J. Accessories:
 1. Four-point suspension kit.
 2. Concentric, Terminal Vent Assembly: Combined combustion-air inlet and power-vent outlet with wall or roof caps. Include adapter assembly for connection to inlet and outlet pipes, and flashing for wall or roof penetration.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and connect gas-fired unit heaters and associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.
- B. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.
 - 1. Restrain the unit to resist code-required horizontal acceleration.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to fuel-fired unit heater to allow service and maintenance.
- C. Gas Piping: Comply with applicable Division 23 Section for fuel gas piping requirements. Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.
- D. Electrical Connections: Comply with applicable requirements in Division 26 Sections.
 - 1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 2. Verify bearing lubrication.
 - 3. Verify proper motor rotation.
 - 4. Test Reports: Prepare a written report to record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- C. Remove and replace malfunctioning units and retest as specified above.

3.4 ADJUSTING

- A. Adjust initial temperature set points.

- B. Adjust burner and other unit components for optimum heating performance and efficiency.

END OF SECTION

DIVISION 26
ELECTRICAL

SECTION 26 00 10**GENERAL ELECTRICAL REQUIREMENTS****PART 1: GENERAL****1.01 SCOPE OF WORK**

- A. Contractor shall provide all labor, materials, equipment, machinery and tools necessary to put into satisfactory operation all electrical equipment specified and as shown on the Drawings. Contractor shall connect the various items or sections of the Work to form a complete and properly operating entity. All items not specified in detail or shown on Drawings but necessary for complete installation and proper operation of work described or implied, shall be furnished and installed.
- B. Test all electrical conductors after completion of installation of wiring and apparatus to insure continuity, proper splicing, freedom from grounds, except "made grounds" and those required for protection and insulation resistance. Use testing instruments, i.e. megger. Activation of each circuit will be required as final test. Testing shall be done at no additional expense to AW.
- C. Drawings are indicative of work to be installed but do not indicate all bends, fittings, boxes, etc. that will be required in this Contract. The structural and finished conditions of the project shall be investigated prior to construction.
- D. Coordinate work with other trades to avoid interference between piping, ducts, equipment, architectural or structural features. In case of interference, the AW Project Manager decides which work is to be relocated, regardless of which is first installed.
- E. All equipment pads located in areas receiving a floor finish (i.e.: tile, paint) shall be painted. Type of paint shall be approved for concrete application. The color is to be selected by the AW Project Manager.

1.02 STANDARDS, CODES AND PERMITS

- A. All work shall be performed in strict compliance with all applicable Local and State codes. In addition, all practices shall be in accordance with the latest editions of the NEC of the NFPA, the National Electrical Safety Code, and OSHA.
- B. All material and equipment shall comply with Local and State electrical codes, the latest requirements of the National Electrical Code, OSHA and the applicable standards of the NEMA, UL, ASTM, IEEE, ANSI, ICEA.
- C. Local codes shall have precedence over the standards setting organizations and OSHA shall have precedence over local codes. Contractor shall furnish any and

all labor or material, in addition to that described herein or shown on the Drawings, necessary to comply with the previously mentioned codes and standards.

1.03 DESIGN REQUIREMENTS

- A. All electrical installations must comply with all Federal and State, and local base rules and/or regulations.
- B. Electrical inspections by the required authorities may be made for verifying that the installations associated with this Project are in compliance with the NEC and other Regulatory Agencies governing electrical work. Original final wiring certificates shall be submitted to the AW Project Manager for review, at no additional cost to AW.
- C. Where possible, all electrical equipment and its components and materials shall meet all applicable UL criteria and bear the appropriate label of the UL. Where UL is not applicable or available, electrical equipment, cabling and components shall be listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) as outlined in the NEC.
- D. All control panels, MCC, VFD assemblies, and related electrical equipment assemblies shall bear the UL 508A, UL 845, UL 508C respectively listing from the manufacturer or assembler/supplier; individual serial listing/labeling is not otherwise required. In addition, these assemblies shall be constructed and labeled in accordance with Article 409 of the NEC and shall include appropriate safety labeling with respect to short-circuit rating, arc-flash hazard and other governing criteria as outlined in the Code. As stated, all completed assemblies shall be NRTL listed and labeled; UL or other NRT Laboratory.
- E. All new and rehabilitated electrical equipment including control panels, switchboards, panel boards, meter socket enclosures, MCC, VFD assemblies, etc., must have an Arc-Flash Hazard Analysis conducted, and shall be field marked to warn qualified personnel of potential electric arc flash hazards. Warning labels shall be clearly visible and shall be provided in compliance with NEC 110.16 and NFPA 70E.
- F. All electrical equipment or apparatus of any one system shall be of the same quality as produced by one or more manufacturers, suitable for use in a unified system. The term "manufacturer" shall be understood as applying to a reputable firm or supplier/assembler who shall assume full responsibility for those products provided on this project.

1.04 ARC FLASH WARNING LABEL REQUIREMENTS

- A. All new and rehabilitated electrical equipment including control panels, switchboards, panel boards, meter socket enclosures, MCC, VFD assemblies, etc., must have an Arc-Flash Hazard Analysis (AFHA) conducted, and shall be field marked to warn qualified personnel of potential electric arc flash hazards.

Warning labels shall be clearly visible and shall be provided in compliance with NEC 110.16 and NFPA 70E.

- B. All work shall be performed in strict compliance with all applicable local and state codes. In addition, all practices shall be in accordance with the latest editions of the National Electric Code (NEC) of the NFPA, the National Electrical Safety Code, and OSHA.
- C. Provide an ANSI Z535.4 compliant (size 4 in. x 6 in.) thermal transfer or equivalent type two color die-cut arc flash label as provided by DuraLabel or Brady for each work location analyzed and included in this project. Material type to be suitable for the locations; IE indoor, outdoor, chemical resistively, etc.
- D. If the equipment will be energized prior to the application of the final labels, provide temporary labels until the final labels are applied. Temporary labels do not need to be of the materials specified above. Temporary labels shall be suitable for the environment (example 110 pound paper or 30 pound paper in a plastic "page protector"). [Note: label information to meet required criteria outlined herein for permanent labeling. Once final labels are available, remove temporary labeling and provide permanent labels as indicated.]
- E. The label shall have either an orange header with black lettering and the wording, "**WARNING, ARC FLASH HAZARD**", or a red header with white lettering and the wording, "**DANGER, ARC FLASH HAZARD**". Include the ANSI Safety Symbol in the header as recommended. The Danger signal wording shall be provided for all incident energy values calculated greater than 40 Cal/cm²; Warning to be used for all values calculated below 40 Cal/cm². These labels shall include the following information:
 - 1. Location designation
 - 2. Shock Hazard Information including; Nominal voltage, Limited Approach, Restricted Approach, and Prohibited Approach
 - 3. Flash protection boundary
 - 4. Hazard/Risk category (HRC) including PPE Category
 - 5. Incident energy
 - 6. Working distance
 - 7. Reference actual listing of clothing and glove requirements.
- F. Labels shall be machine printed, with no field markings. The size of the lettering is to be in accordance with ANSI-Z535.4 recommendations for a safe viewing distance of 3' minimum based on favorable viewing conditions and information to be included.
- G. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended over-current device settings. Coordinate the data provided with the Arc Flash Study results and the ANSI labeling requirements.

Quantities outlined below are considered minimum quantities necessary; provide additional labeling as may be required by Regulatory or Inspection Agencies at no additional cost to the project.

1. For each transformer, 480 and applicable 240 and/or 208 volt panelboard, individually-mounted circuit breaker and safety disconnect device, one arc flash label shall be provided
2. For each motor control center, one arc flash label shall be provided at the top of each vertical section (*see footnote below*).
3. For each low voltage switchboard, one arc flash label shall be provided at the top of each vertical section (*see footnote below*).
4. For each low or medium voltage switchgear, one arc flash label shall be provided at the top of each vertical section (*see footnote below*).
5. For medium voltage switches one arc flash label shall be provided at the top of each vertical section (*see footnote below*).
6. For each motor power terminal box, 25 horsepower and larger, one arc flash label shall be provided
7. Additional arc flash labels to address installations and specific equipment requirements to be provided based on an individual evaluation basis.
8. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.

(Footnote – where control center, switchboard, or switchgear assemblies are dual-fed, provide on arc flash label at each main entrance device or section as well as at any “Tie” device location. For equipment that is front and rear accessible, provide the same labeling on the rear sections as outlined above.)

- H. Refer to the attachment for examples of required labels.
- I. Labels shall be field installed by the (Contractor or Engineer) at the conclusion of the project after acceptance by AW.
- J. Provide written maintenance procedures and guidelines in accordance with NFPA-70E; Latest Edition.
- K. At a minimum, provide a written report with the following:
 1. Equipment ID
 2. Available fault current
 3. Method and software used for calculations
 4. Any other relevant data used to support the calculations
 5. One-line diagram

6. State licensed Professional Engineer's contact information and final report issue date

Following is an "Arc Flash Warning Label" Example



All values shown on the example label shall be the calculated values for the equipment that the label is to be placed.

1.05 MATERIAL AND INSTALLATION WORK

- A. All material and equipment shall be new without defects, and shall bear the inspection labels of the UL, if the material is of a class inspected by the said laboratories.
- B. Contractor shall install and/or wire all electrical equipment as per the manufacturer's recommendations.

- C. Installation shall be periodically inspected by the AW Project Manager. Any defects shall be corrected at the Contractor's expense.

1.06 SUPERVISION

- A. Contractor shall provide competent supervision of all phases of the electrical installations.

1.07 SUBMITTALS

- A. Shall conform to the requirements of Specification Section 01 33 00 – Submittals.
- B. Contractor shall furnish to the AW Project Manager for review detailed shop drawings, including elementary, connection and interconnection wiring diagrams. These diagrams shall show the interconnection of all equipment requiring electrical connections.

1.08 TESTING

- A. The Contractor shall demonstrate to the AW Project Manager operation of all equipment and systems. All tests shall be completed to the satisfaction of the AW Project Manager and AW. Each test shall be performed as indicated in the individual specification section. Such tests shall demonstrate the proper functioning of all equipment and wiring and the adequacy of the entire electrical system. Any equipment or material, which fails to perform satisfactorily, shall be repaired or replaced and then retested until satisfactory results are obtained. All testing and retesting shall be at the Contractor's expense.

1.09 QUALITY ASSURANCE

- A. All Work shall be provided in conformance with the latest Standards as well as the requirements associated with products and systems outlined within these Contract Documents including the manufacturer's criteria, code compliance and the industry standards indicated.

1.10 ACCEPTANCE

- A. The operation by AW of the equipment and/or the electrical installations does not constitute an acceptance of the Work. Final acceptance of equipment and/or the electrical installation shall be made only after the Contractor has demonstrated that the electrical installation fulfills the requirements of the Contract Documents, and has furnished all the required certificates, "as built" Drawings and a satisfactory operations and maintenance manual.

1.11 GUARANTEE

- A. Contractor assumes full responsibility for the proper functioning and quality of the entire electrical installation. Any breakdowns, deficiencies or deteriorations caused by poor workmanship, materials, method of installation or inferior

equipment furnished by this Contract shall be promptly remedied, replaced or repaired by the Contractor.

- B. The Contractor shall guarantee that all materials, equipment and workmanship shall be free from defects for a period of one year from the date of acceptance of the work and shall replace any defective Work or equipment at no cost to AW.

1.12 DELIVERY, STORAGE AND HANDLING

- A. Contractor shall make all necessary arrangements and provisions for the receiving, storage and protection of materials and equipment to be used in executing this Contract.

PART 2: PRODUCTS

2.01 U.L. LISTING

- A. All products shall be U.L. listed where a U.L. listing exists for a similar product. If any non U.L. listed products are found in the installation they shall be removed and replaced with U.L. listed products at no additional expense to AW.

2.02 ONLY NEW PRODUCTS SHALL BE ALLOWED

- A. All products used on this project shall be new, without defects and covered by the manufacturer's full U.S. warranty. Only specific items or equipments noted or specified by the AW Project Manager will be allowed to be reused.

2.03 INDUSTRIAL GRADE PRODUCTS REQUIRED

- A. All products shall be of industrial grade and shall be compatible with the required use. All electrical components shall be rated for continuous 24 hour/day, 7 day/week operation. Components shall not overheat nor fail prematurely when used continuously. All equipment shall be adequately protected from corrosion and shall not rust or deteriorate.

PART 3: EXECUTION

3.01 INSTALLATION

- A. All equipment shall be installed as per the manufacturer's recommendations and in accordance with accepted construction practices.
- B. Protection of Installation:
 - 1. All equipment shall be protected during construction.
 - 2. All damaged equipment caused by noncompliance with this requirement shall be repaired at no additional expense to AW.

- C. Openings and Chases:
1. Determine locations of chases and openings prior to construction so that same may be provided where required.
 2. If openings or chases are made after building construction is accomplished, such cutting and repairing of the building shall be made by the Contractor in complete coordination with other trades on the job site to match original conditions in quality, color and type of materials used, and at no additional expense to AW.
- D. Position of Outlets and Equipment: The AW Project Manager shall determine the position of all outlets and equipment if the required location differs from that indicated on the Drawings. The Contractor shall coordinate and confirm the position of outlets and equipment prior to the rough-in work for such equipment and associated finish materials associated with the space.
- E. Moving Outlets and Equipment: AW reserves the right to move any outlet or rough-in termination for a device, item, or equipment a distance of ten (10) feet prior to roughing in by the Contractor at no additional expense to the Project. Contractor shall coordinate all outlet and equipment termination requirements with the approved shop drawing submittals and other disciplines performing work in the area. Outlets located in brick, tile or block walls, as well as those devices associated with special finished areas of the building shall be coordinated with the special finish and the AW Project Manager in advance of roughing in. Provide coordination drawings where outlined in these Documents.
- F. Methods and Materials:
1. All work shall be installed in a first-class, neat and workmanlike manner as defined in the NEC, Article 110.12 (and other locations throughout the Code) by skilled mechanics trained in the application of the materials being provided. Proof of adequate training of personnel performing the Work associated with this Project from the Manufacturer or Supplier shall be provided by the Contractor upon request from the AW Project Manager.
 2. All materials shall be new unless otherwise indicated or specified.
 3. Firmly support all materials and equipment.
 4. Any materials and/or workmanship found to be of inferior quality, damaged, improperly installed, or having been exposed to harmful substances or conditions at any time during the construction work, shall be immediately replaced upon notification from AW to the Contractor. Contractor shall at all times provide protective equipment meeting all Regulatory Agency requirements as may become necessary to protect all

parts of the Work from damage or exposure to harmful conditions or contaminating substances.

5. Where equipment is indicated to be relocated/reinstalled, the Contractor shall first conduct an inspection of such, prior to removal and report (document in writing) any component noted as defective or inoperable. Removal of the equipment constitutes acceptance of the equipment; indicating operable equipment is now the responsibility of the Contractor for storage, reinstallation and proper operation (based on original) after the Work is completed. In relocating and/or reinstalling any existing equipment, the Contractor shall clean and inspect the equipment as part of the Work; performing routine maintenance to the affected equipment prior to reinstallation. Any component found to be defective shall be brought to the AW Project Manager's attention in writing requesting direction.

G. Cutting, Repairing and Finishing:

1. All cutting, repairing, finishing and painting required for the installation of work under this Contract shall be performed under this Contract.
2. All disturbed surfaces shall be repaired and finished to match adjacent surfaces by skilled mechanics working in their respective fields.

H. Excavation, Backfilling and Blasting: Excavation, backfilling and blasting work shall be in accordance with the requirements of AW Standard Specifications and as required to complete the work according to details on Drawings.

I. Concrete: Concrete work shall be in accordance with the requirements of AW Standard Specifications and as required to complete the Work according to details on the Drawings.

J. Cutting and Patching of Asphalt Paving and Concrete Areas:

1. Openings in concrete or asphalt paving required for electrical construction shall be made by taking extreme precautions to prevent excessive damage to existing facilities.
2. Prior to completion, all disturbed areas shall be closed, restored to normal and finished to match surrounding areas.

K. Access: Install all conduit, wire, cable, wiring devices and equipment to preserve access to all equipment and required areas. Where necessary, provide access panels in walls or ceiling, coordinated with the finish materials and type applicable to the area, to gain working access to the work installed. Minimum size of access panels shall be 18-inch by 18-inch unless otherwise approved by the AW Project Manager.

L. Layout of Wiring and Work:

1. The layout of wiring and work as shown on the Drawings shall not be considered as absolute; it shall be subject to changes where necessary to overcome obstacles in construction.
 2. Where a major deviation from the Drawings is indicated by practical consideration, shop drawings shall be submitted showing all deviations in detail to clearly indicate the necessity or desirability for the change and the resulting new layout for acceptance by the AW Project Manager.
- M. Furnish and install all necessary structural steel supports (i.e. angles, beams, channels), hanger rods or other required support/bracing needed for equipment and raceways furnished under this Contract requiring support or suspension from building structure, except building support steel where otherwise noted on the plans.
- N. Continuity of Service:
1. Uninterrupted electrical and telephone service shall be maintained during the entire time required for complete installation of the Work required under these Specifications and Drawings.
 2. Temporary equipment, cable and additional materials and/or provisions as necessary shall be provided by the Contractor to maintain electrical, special systems and telephone services. Temporary service facilities, if required at any time, shall not be disconnected or removed until new services are placed in proper operation.
 3. If any service or system must be interrupted, the Contractor shall request permission in writing stating the date, time, etc. the service that will be interrupted and the areas affected. This request shall be made in sufficient time (approximately 3 weeks in advance) for proper arrangements to be made. Written permission shall be obtained from the AW and appropriate regulatory agencies before interrupting electrical, special systems and telephone/communications systems.
- O. Clean Up:
1. Upon completion of all work under electrical specifications, furnish labor, materials, and equipments to accomplish the following: remove all dirt, foreign materials, stains, fingerprints, etc. from all lighting fixtures, glassware, panel boards, MCC's, switchboards, VFD's, wall plates, system equipment, floors, walls and ceilings adjacent to the above equipment and leave the electrical work in such a condition that no cleaning will be required by AW.
 2. The complete system shall be subject to inspection and approval by the AW Project Manager.

P. Start-up and Acceptance Testing:

1. Provide the services of a manufacturer's representative to start-up, adjust and test each piece of equipment.
2. All start-up and testing shall be performed in the presence of the AW Project Manager. All startup data and controls configuration and programming shall be recorded at startup or training on approved data recording sheets and verified. Completed data sheets shall accompany the O&M manuals provided for use in training. Scheduling and coordination arrangements are to be made a minimum of two weeks in advance, and approved by AW.

Q. Training – General Requirements:

1. Contractor shall provide training sessions for the individual equipment and systems. Training shall include theory of operation, maintenance, startup, and troubleshooting procedures. Training shall include control and monitoring/metering systems with specific emphasis on use and performance of these systems in concert with the customer's framework of controls and reporting systems.
2. All training shall be performed by qualified and manufacturer-certified representatives.
3. O&M manuals shall be submitted prior to scheduling of training. Scheduling and commencement of training shall be contingent on the approved status of the O&M manuals.

3.02 TESTING AND VERIFICATION

- A. All electrical connections shall be verified before circuits are energized. Any equipment damaged due to a failure to check for short circuits or miswiring shall be corrected by the Contractor at no additional expense to the AW.

3.03 SAFETY DURING CONSTRUCTION

- A. All electrical equipment shall be maintained in a safe manner during construction. No exposed live circuits shall be accessible to other than qualified personnel. Contractor shall perform proper lockout and tagout procedures per OSHA requirements to prevent accidental starting of equipment. The work area shall at all times be kept neat and free from hazards.

END OF SECTION 26 00 10

SECTION 26 00 20**ELECTRICAL MATERIALS AND METHODS****PART 1: GENERAL****1.01 WORK INCLUDED**

- A. Furnish and install all conduit, conduit fittings and boxes to complete the installation of all electrically operated equipment as specified herein, in other AW Specifications and as required.
- B. Furnish and install all wires and cables for power, lighting, instrumentation and control as required to complete the electrical installation.
- C. Furnish and install lighting switches and receptacles as shown on the Drawings.

1.02 EQUIPMENT LOCATION

- A. Contractor shall install conduits and appurtenances in such a manner as to avoid all interferences.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Protect conduit and accessories from corrosion and entrance of debris by storing above grade. Provide appropriate covering. Protect PVC conduit and fittings from sunlight.

PART 2: PRODUCTS**2.01 CONDUIT**

- A. Conform to requirements of ANSI/NFPA 70, National Electric Code (NEC).
- B. General - The minimum size conduit permitted is $\frac{3}{4}$ -inch unless otherwise specified or indicated on the Drawing. Minimum size conduit permitted is $\frac{1}{2}$ -inch for lighting circuit applications only. Conduits smaller than $\frac{1}{2}$ -inch are not permitted.
- C. Rigid nonmetallic conduit may be used for underground service entrance, underground feeders, and underground branch circuits with the following specific requirements:
 - 1. Conduit shall be Schedule 80 PVC
 - 2. The conduit shall be embedded in soil below the aggregate and shall be at least 12-inches below floor surface. External to structures, such conduits shall be minimum of 24-inch below finished grade.

3. PVC conduits shall not be used in suspended floor slabs.
 4. All conduit bends subjected to physical damage and turning up through the floor shall be galvanized rigid steel.
- D. Outdoor and Process Building Locations: Use rigid galvanized steel conduit. These areas also include interior below-grade locations and wall locations which are water bearing or noted as "wet and corrosive". It shall also be used in exterior and interior above-grade locations.
- E. In wet and corrosive locations, all seals and all fittings shall be liquid tight, non-metallic.
- F. Conduits shall be installed as shown below:
1. Rigid Conduit ----- Article 344, NEC or latest edition.
 2. Rigid Nonmetallic ----- Article 3527, NEC or latest edition.
- G. A grounding conductor shall be installed in each conduit. Conduit shall not be used as a grounding conductor.

2.02 CONDUIT FITTINGS, PULLBOXES, JUNCTION BOXES, ETC.

- A. Indoor Use - All junction boxes and pull boxes for indoor use shall be of galvanized steel and provided with rubber or neoprene gasketed screwed-on covers of the same gauge as the box being provided unless otherwise specified or indicated on the Drawing.
- B. Outdoor Use - All junction boxes and pull boxes for outdoor use shall be of stainless steel Type 304 and 316, NEMA Type 4X construction. Covers shall be same material as box and shall be hinged. Screws and all metal parts shall be stainless steel. Use of expandable junction boxes and pull boxes is not permitted.
- C. Switch/Receptacle Boxes - All cast fittings or sheet metal boxes containing wiring devices such as receptacles and switches shall be of the deep type. All device boxes used in the process area shall be cast type except those shown as recessed.
- D. Cast fittings shall be non-ferrous metal or malleable iron thoroughly coated inside and outside with metallic zinc after all machining has been completed. Cast fittings shall be provided with heavy threaded hubs to fit the conduit required. Covers shall be of the same material as the fittings to which they are attached and shall be screwed on with rubber or neoprene gasket between the covers and fittings.

2.03 CONDUCTORS AND INSULATION

- A. Each coil or reel of insulated wire and cable furnished shall bear a tag at regular intervals on the outer covering containing the UL approval stamp (providing cable is of a class inspected by said laboratory), name of manufacturer, trade designation, voltage rating, size, grade of insulation, month and year of manufacture; and in no case shall be more than six months old, unless otherwise acceptable to the AW Project Manager.
- B. All wire and cable shall meet the requirements of the latest edition of the NEC and shall be soft drawn copper unless otherwise noted. All wires and cables used on the project shall be new.
- C. Wire and cable shall not be stored in the weather, and shall meet all requirements of the ICEA.
- D. Furnish and install all conductors, consisting of ninety-eight percent (98%) conductivity copper. All power wires shall be stranded and shall not be less than No. 12 AWG. All control wires shall be stranded and shall be not less than No. 14 AWG. All conductors shall be at least 600 V rated. All power and lighting feeder wire and cable shall be identified by color coding in all hand holes, motor control centers, panel boards, pull boxes and junctions boxes. All signal carrying cable shall be twisted shielded pairs or three (3) wire twisted with shield.
- E. Each conductor and the neutral conductor shall be factory color coded with a separate color for each. The color code indicated below shall be used consistently throughout the electrical system installation, unless otherwise specified:

Phase	480 V	208 V
A	Brown	Black
B	Orange	Red
C	Yellow	Blue
N	Gray w/ Purple Tape	White
G	Green	Green

- F. All wiring #2 or larger shall be THW-2 or RHW-2, stranded copper, 600 V rated insulation and suitable for wet location.
- G. All wiring #4 or smaller shall be THHN/THWN, stranded copper, 600 V rated insulation and suitable for wet locations.

2.04 CONNECTORS

- A. All wiring between various pieces of equipment shall be continuous, without splices.

- B. When field conductors are terminated to equipment conductors such as lighting fixtures, motors, etc., non-insulated ring connectors shall be bolted together, wrapped in rubber tape, and then electrical tape.
- C. Splice caps and wire nuts are prohibited.
- D. All motor conductors shall be 'meggered' before terminating.
- E. All conductors 1/0 and larger shall have each bare conductor end treated with an oxidation inhibitor such as Pentrox before connecting a crimp-on lug to it or connecting under a mechanical lug. Crimp-on lugs with an oxidation inhibitor already in the barrel of the lug are acceptable.

2.05 WIRING DEVICES

- A. General: Products of a single manufacturer shall be used for all receptacles and switches. All devices shall be UL listed.
- B. Provide wiring devices of the type, color, and electrical rating for the service indicated.
- C. Lighting Switches
 - 1. Single-pole, 20 amp, 125V
 - 2. 3-way, 20 amp, 125V
 - 3. 4-way, 20 amp, 125V
- D. Receptacles
 - 1. General Duty Duplex: Duplex general duty type receptacles shall be two-pole, 3 wire grounding with green hexagonal equipment ground screw, ground terminal internally connected to mounting yoke, 20 ampere, 125 V, with metal plaster ears, side wiring only, NEMA configuration type 5-20R unless and except where otherwise indicated. All receptacles shall be ivory colored, style 5362.
 - 2. Weatherproof Receptacles: Weatherproof receptacles shall consist of the receptacle type indicated, mounted in a box with a gasketed, weatherproof, cast metal cover plate and separate cap over each receptacle opening. The cap shall be permanently attached to the cover plate by a spring hinged flap. The weatherproof integrity shall not be affected when heavy duty specification attachment plugs are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.
 - 3. GFI Receptacles: Ground fault interrupter receptacles shall be feed-through type capable of protecting connected downstream receptacles on

single circuit, ivory, grounding type, UL rated Class A, Group 1, 20 ampere rating, 125 V with solid state ground fault sensing and signaling, with 5 milli-ampere ground fault trip level, equipped with 20 ampere plug configuration, NEMA type 5-20R.

4. All other receptacles shall be of the appropriate type and voltage.

E. Device Plates

1. Device plates shall be one piece type, single or multiple gang switch and duplex outlet wall plates for wiring devices. Device plates shall be provided with metal screws for securing plates to devices. Screws shall be stainless steel. All wall plates shall be stainless steel possessing the additional features as indicated on the Drawing.

F. Weather-protected cover plates

1. Outdoor locations – “in-use” type receptacle covers
2. Indoor locations – “in-use” receptacle covers
3. Indoor locations - flush-mount cover

2.06 PANELBOARDS

- A. General: All devices shall be UL listed.
- B. Panel boards shall be appropriately rated for this project. Each panel board shall consist of the required one-pole, two-pole, and three-pole branches of the ratings shown on the Drawing. It shall be dead front construction equivalent to the types shown in the panel board schedule. Panel boards shall be equipped with copper bussing; aluminum is not acceptable.
- C. All circuits controlled out of a panel board or by a breaker shall be identified. A directory holder with a neatly typed directory card and covered with a clear plastic protective plate shall be affixed to each panel board.
- D. Panel boards and circuit breakers shall comply with all pertinent sections of the NEC. Panel board enclosures shall be fitted with hinged doors having a combination lock and latch, with all locks keyed alike. Enclosures shall be painted with a baked light gray enamel or lacquer finish over a suitable prime coat.
- E. Circuit breakers shall be UL listed. All multiple circuit breakers, individual or in panel boards shall be common trip. Twin, tandem and half-size single-pole breakers will not be acceptable.

2.07 DISCONNECT SWITCHES

- A. The disconnect switches shall be 3 blade switches or as shown on the Drawing. For single-phase motors and other devices rated 120 V, disconnect switches shall be rated 240 V. For all devices rated 240 V and higher, switches shall be rated 600 V. Disconnect switches shall be capable of interrupting the full load current of the device to which they are attached. Switches shall have a withstand rating equal or greater the equipment supplying the switch.
- B. Switches shall be housed in NEMA Type 1 or NEMA Type 4X general purpose enclosures as required based on the project requirements or as shown on the Drawing. All switches shall be heavy duty industrial type and be capable of being locked in either the "ON" or "OFF" position. Toggle type single-pole manual starters in NEMA Type 1 enclosure are permitted to be used in lieu of disconnect switches for HVAC applications such as exhaust fans. For manual starters, the Contractor shall supply properly sized thermal overload units.

PART 3: EXECUTION

3.01 CONDUITS

- A. Connections to equipment. Connections from rigid conduit to motors, pressure switches, solenoid valves, level controls, etc., shall be made with short lengths of liquid-tight metal flexible conduit. These lengths shall be provided with appropriate connectors with devices which will provide an excellent electrical connection between equipment and the rigid conduit for the flow of ground current.
- B. Installation procedure. Each piece of conduit installed shall be free from blisters and other defects.
 - 1. Conduit systems shall be continuous from outlet to outlet, from outlets to cabinets and pull or junction boxes. They shall be rigid steel and rigid nonmetallic PVC electrical conduit as specified herein or as indicated on the Drawing. Lock nuts and bushings shall secure the system in such a way as to be electrically continuous throughout. Conduit ends shall be capped to prevent entrance of foreign materials during construction.
 - 2. Conduits shall be run parallel to building lines and long sweep bends shall be utilized. All exposed conduit shall be installed, either parallel or perpendicular to structural members, unless impractical, and shall be grouped wherever possible. Conduit shall be attached to structural components with approved supports spaced a maximum of eight (8) feet apart and shall form a neat rigid installation.
 - 3. Each piece installed shall be cut square, taper reamed, and a coat of conductive sealing compound applied to threads.
 - 4. Conduit connections shall be screwed tight with only incomplete threads exposed. All conduit joints shall be made with standard couplings and the ends of the conduit shall butt tightly into the couplings. In exposed work

only, where standard couplings cannot be used, only union type couplings are permitted.

5. Conduit threaded in the field shall have standard sizes and lengths.
6. If No. 4 or larger conductors enter a cabinet, pull box, junction box or auxiliary gutter, the conductors shall be protected by a bushing. Also, on all conduits one and one-fourth inches (1- $\frac{1}{4}$ ") and larger, insulated bushings shall be utilized.
7. Ropes shall be installed in all empty or spare conduits to facilitate the pulling of future conductors.
8. No single conduit run shall have more than the equivalent of four 90 degree bends. Bending radii shall comply with NEC requirement. Factory bent elbows or field bent elbows with approved tools may be used. Heating of conduit to facilitate bending is prohibited. Only bending methods approved by the PVC conduit manufacturer shall be used for this type of conduit.
9. Conduit supports from building walls shall be installed with at least a 1/4 - inch clearance from the walls to prevent the accumulation of dirt and moisture behind the conduit. Conduit and/or conduit fittings shall not be welded together or to any steel structure; however, conduit supports may be welded to flanges of steel beams, columns, etc., in accordance with approved welding techniques and engineering practice.
10. Contractor shall provide sleeves and inserts, correctly located in the structure, as required to complete the Work.
 - a. Inserts shall be steel and of proper size for loads encountered.
 - b. Sleeves shall be provided for all conduits passing through concrete or masonry walls, partitions, concrete slabs or beams. Install during construction to avoid later cutting. Sleeves placed horizontally in walls or in any position in beams shall be standard weight ASTM A53 steel pipe or length equal to thickness of wall or beam. Those placed vertically in non-waterproof floors shall be 20 gauge galvanized sheet steel of length equal to thickness of slab, flared and nailed to the form, or fastened to reinforcing fabric and filled with sand during pouring to prevent deformation. Sleeves in floors with waterproof membrane shall be provided with flanges or flashing rings and shall be clamped or flashed into the membrane. All sleeves shall be of sufficient diameter to clear conduit by $\frac{1}{4}$ -inch all around except sleeves on lines subject to movement by expansion shall clear the conduit by at least 1-inch all around.
 - c. Sleeves around conduit through exterior walls shall be caulked watertight with oakum and plastic cement.

11. Approved conduit expansion joints shall be provided wherever conduit crosses a structural expansion joint, is attached between two separate structures, and wherever the conduit run is 100 feet or more in a single straight length.
12. All conduit extending through the floor behind panels or into control centers or similar equipment shall extend a minimum of 6-inches above the floor elevations, with no couplings at floor elevations.
13. Horizontal conduit runs not in the floor slab shall be run above the ceiling wherever practical.
14. Conduit runs shall be installed in such locations as to avoid water pipes. A minimum separation of three (3) feet shall be maintained where conduit crosses or parallels water pipes. A minimum of 12 feet shall be maintained where conduit crosses or parallels hot water piping.
15. The cutting of walls or floors for conduit or other electrical equipment shall be kept to a minimum. Where such cutting is absolutely necessary, care must be taken so as not to weaken the wall or floor involved. Beams or other structural supports shall not be cut under any condition. All cutting, channeling and drilling of holes through walls, floors and ceilings, required for the correct installation of the electrical work, shall be done by and repaired by the Electrical Contractor. The cost of cutting and patching shall be borne by the Contractor. All work shall be finish painted (prime coat and two (2) finish coats) to match the existing finishes. All equipment fastenings to columns, steel beams, and trusses shall be by beam clamps or welded. No holes shall be drilled in the steel. All holes in hung ceilings for support rods, conduits and other equipment shall be made adjacent to bars where possible, to facilitate removal of ceiling panels.
16. Conduit shall be protected immediately after installation by installing flat non-corrosive metallic discs and steel bushings, designed for this purpose, at each end. Discs shall not be removed until it is necessary to clean the conduit and pull wire and cable. Before wire or cable is pulled, insulated bushings shall be installed at each end of the conduit. Prior to pulling in wire and cables, each conduit shall be thoroughly cleaned inside, by the use of compressed air, to remove all sand and other foreign matter.
17. Where used, transition from PVC coated rigid galvanized steel conduit to PVC schedule 80 conduit shall be not less than 6-inches from the outside surface.
18. Conduit buried in the earth (grade) shall be a minimum of 24-inches below grade. Trenching and backfilling shall be provided by the Contractor in accordance with AW Specifications.

3.02 CONDUIT FITTINGS, PULL BOXES, JUNCTION BOXES, ETC.

- A. Pull boxes and junction boxes shall be installed and located as indicated on the Drawing. The size of boxes shall comply with NEC Section 314.16.
- B. Where nipples are used between fittings and electrical equipment, they shall be so installed that no threads are exposed.
- C. All junction boxes, pull boxes, cabinets, lighting panels, switches, and similar devices shall be solidly attached to structural members prior to installation of conduit. These devices shall be set true and plumb. Wooden plugs are not permitted for securing equipment or conduit to concrete.
- D. Conduits shall be attached to all electrical equipment, such as sheet metal steel junction boxes, pull boxes, switches, etc., using watertight conduit hubs with threaded insulated throat. Stainless steel channels shall be used in chemical room. All hardware shall be stainless steel only.
- E. Where control wires must be interconnected in a junction box, terminal boards consisting of an adequate number of screw type terminals shall be installed. Terminal board current carrying parts must be of ample size to carry the full load current of the circuits connected thereto. Approximately 20 percent of the total number of terminals provided shall consist of spare terminals. Terminals shall be labeled to conform with Drawings and approved shop drawings.
- F. Mounting heights from the finished floor to the centerline of the various boxes and equipment shall be as follows except as otherwise indicated on the Drawing:
 - 1. P.B. Stations, Lighting Switches, etc., 4 ft. 6 in.
 - 2. Power Receptacles 1 ft. 6 in.
 - 3. Power Receptacles in Process Area 4 ft. 6 in.

3.03 INSTALLATION OF WIRE & CABLE

- A. The best of care shall be exercised while installing wire and cable so as not to injure the conductor or insulation. Cable lubricant used for pulling in any conductor such as oils, grease, or other compounds shall be recommended by the cable manufacturer.
- B. All grouping or bundling of control and circuit wiring in cabinets, panels, pull boxes and junction boxes shall be neatly trained and held with suitable cable ties. Where control or circuit baling is clamped or fastened in cabinets or other equipment, non-metallic cable clamps and mounting brackets shall be installed.
- C. All wiring shall be tagged at each end and at all junction points with suitable wire markers displaying unique identifying numbers.

- D. Connection of cable clamps or lugs shall be as follows: contact areas of bars, plates, and lugs shall be cleaned with steel wool, emery cloth or buffing machine, in such a manner as to leave the surfaces bright, clean, flat and/or parallel. Care shall be taken so that edges and corners are not rounded. Areas shall then be wiped with a clean cloth to remove all particles of abrasive matter, dust, and dirt. Each cleaned area shall then be completely covered with a thin layer of Vaseline, or other material approved for this purpose by the AW Project Manager; the parts tightly drawn together with bolts and locknuts and excess grease wiped off.
- E. Contractor shall be responsible for maintaining the proper electrical phasing of all equipment being installed. Where modifications are required to improperly phased equipment, the Contractor shall do the rewiring at no expense to AW. The Contractor shall replace or repair any equipment damaged because of improper phasing at no cost to AW.
- F. Grounding of signal cable shield shall be done only at the power source end. The opposite end shall be protected against accidental contact with ground by bending the drain wire back along the outer cable insulation and sleeving over the drain wire with heat shrink tubing. The insulated conductors of signal cable stripped from their outer insulation and shield shall be as short as practical at their termination points.
- G. Where long pulls are necessary, a messenger shall be pulled with the signal cable to relieve the stress of pulling on the cable.
- H. Contractor shall test wiring devices to ensure electrical continuity of grounding connections, after energizing circuitry, demonstrate compliance with requirements of the project. Contractor shall test each receptacle for proper polarization and ground continuity.

3.04 SPLICING OF CONDUCTORS

- A. Splicing shall be kept to a minimum. Splicing to extend the length of a wire is not permitted. If a wire is found to be too short, it shall be removed and a wire of adequate length installed. Under no circumstances shall signal wire be spliced. Splices shall not be made in cast fittings such as "Tee" or "L" types, but shall be made in junction boxes of adequate size. All splices shall be made via terminal connections to terminal strips in a junction box. Wire nuts are permitted for lighting and receptacle circuits only.

3.05 IDENTIFICATION OF CONDUCTORS

- A. Nameplates and labels shall be engraved on three-layer of laminated plastic with white letters on black background. Nameplates and labels shall be installed on each electrical distribution and control panel, communication cabinet, instrument and transmitter and device controller. Lettering size of 1/8-inch shall be used for identifying individual equipment and loads. Lettering size of 1/4-inch shall be used for identifying grouped equipment and loads

- B. Wire markers shall be of split sleeve or tubing type and located on each conductor in panel board gutter, pull boxes and junction boxes, terminal strips and each load connection. Wire markers shall show the following:
 - 1. Power and lighting loads: branch circuit or feeder number indicated on Drawing.
 - 2. Control circuits: control wire number indicated on schematics and interconnection diagrams indicated on Drawings and approved shop drawings.
 - C. Conduit markers shall be stainless steel with conduit run number embossed on the marker as indicated on Drawings and approved shop drawings. Conduit markers shall be installed on conduits longer than 6 feet, with spacing of 20 feet on center.
 - D. Underground warning tape shall be 4" yellow plastic with suitable warning legend describing buried electrical lines.
 - E. All nameplates and labels shall be installed on degreased and clean surfaces. Nameplates and labels shall be parallel to the equipment lines and secured with stainless steel screws in recessed finished locations. Underground warning tape shall be installed at 3-inch below finish grade, one per trench.
- 3.06 INSTALLATION OF PANELBOARDS, DISCONNECT SWITCHES AND OTHER DEVICES
- A. All devices shall be mounted true and plumb in accordance with the manufacturer's recommendation at the locations shown on the Drawing. Devices shall be located so as to be accessible once equipment is in place. Receptacles shall be arranged so as not to present a tripping hazard or interfere with the removal or normal service of equipment.
 - B. The power distribution and lighting panel boards shall be installed in accordance with the manufacturer's requirements. The power distribution and panel boards shall be wall-mounted where shown on the Drawing. All power panels shall have an engraved label securely attached to the front cover. Individual breakers shall be clearly marked indicating the equipment being served. Labels shall be typed or printed. Handwritten labels will not be accepted.
 - C. The disconnect switches shall be installed in accordance with the manufacturer's requirements. The disconnect switch shall be mounted true and plumb as shown on the Drawing and as described herein. Disconnects shall be permanently labeled with plastic laminated labels. Labels shall be attached in such a way as to resist heat and moisture.

END OF SECTION 26 00 20

SECTION 26 29 23**VARIABLE FREQUENCY DRIVES****PART 1 GENERAL****1.01 SCOPE**

- A. Furnish and install individual freestanding variable frequency AC drives (VFD) as shown on the Drawings and specified herein.

1.02 SUBMITTALS

- A. Submit shop drawings and manufacturer's literature to the Engineer for approval in accordance with Specification Section 01 33 00.
- B. Shop drawings shall be complete in all respects and shall indicate all dimensions, installation methods, size, weight, capacity, ratings, integral controls, elevations, and sections.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.03 QUALITY ASSURANCE

- A. The VFD assembly shall be built to applicable NEMA standards and be suitable for use as a component to meet NEC requirements. The VFD assembly is to be listed by UL.

1.04 FACTORY TESTING

- A. The completed drive / starter unit shall be functionally tested by the manufacturer with a motor before shipment to assure proper operation per specification.
- B. Contractor shall coordinate with the requirements associated with the process mechanical equipment. This coordination shall be provided to the VFD manufacturer to determine the specific requirements for the equipment to be furnished.
- C. The VFD unit shall meet all requirements as outlined by IEEE 519 for individual and total harmonic voltage and current distortion.

1.05 OPERATION AND MAINTENANCE DATA

- A. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.06 REGULATORY REQUIREMENTS

- A. Conform to the requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. All equipment and materials shall be delivered, stored and handled in strict accordance with the manufacturer's recommendations.

1.08 MAINTENANCE MATERIALS

- A. Provide maintenance materials as recommended by the manufacturer.

PART 2 PRODUCTS

2.01 VARIABLE FREQUENCY DRIVES

- A. General:
 - 1. The VFD shall convert a fixed frequency; three phase input power to an adjustable AC frequency and voltage source for controlling the speed of a standard, NEMA Design B, AC induction motor.
 - 2. The VFD shall be as specified on the Contract Documents or as directed by the AW Project Manager. The drive shall be fully digital; microprocessor controlled, and shall incorporate a diode bridge rectifier and a transistorized inverter section. Insulated-gate bipolar transistor (IGBT) type power transistor modules shall be utilized in the inverter section to invert a fixed DC bus voltage to a symmetrical three-phase pulse-width modulated (PWM) output voltage.
 - 3. The drives shall accept incoming 480 V, 60 Hz line power, and shall not be affected by voltage fluctuations of +/-10% or frequency fluctuations of +/-2%. The drive shall include phase-to-phase and phase-to-ground protection.
 - 4. Drive Enclosure / Mounting Locations (as indicated on the Drawing):

- a. Each VFD shall be mounted in a freestanding or wall mounted NEMA 1 enclosure sized to dissipate the heat generated by the unit.
 - b. For outdoor applications, the VFD shall be furnished in a NEMA 3R enclosure.
 - c. A main power input circuit breaker or disconnect switch, with flange mounted operator handle, shall be mounted in the drive enclosure. The disconnecting means shall be sized for the full output current rating of the drive.
 5. Compliance with IEEE 519 will determine if a phase shifting transformer is required. If a phase shifting transformer or isolation transformer is required, the transformer shall be integral to the VFD assembly. Separate isolation transformers and external transformers arrangements are not acceptable.
 6. The VFD shall be suitable for use with a standby generator.
- B. Operating Characteristics:
1. The drive operation shall be fully digital with microprocessor control of frequency, voltage and current. All drive set-up operations and adjustment shall be digital and stored in a non-volatile memory (EEPROM).
 2. To control the rate of change of output frequency for a step change in input reference, the drive shall have two independently adjustable acceleration and deceleration rates.
 3. The drive shall have a fold-back current limiting circuit. During acceleration, the circuit shall automatically reduce the acceleration rate to a slower rate should the load inertia cause excessive currents.
 4. The drive shall have a selectable deceleration voltage limiting circuit. The circuit shall extend the set deceleration ramp should the bus voltage approach high limits due to regeneration.
 5. The drive output frequency shall be adjustable from 0-60 Hz.
 6. The drive shall have selectable pre-programmed V/Hz ratios and the capability of programming a custom V/Hz pattern.
 7. The drive shall maintain set frequency to within 0.6 Hz during power line fluctuations.

8. The drive speed reference signal shall be an analog 4-20 mA signal from a PLC output module or a signal received from the human interface module.
 9. The drive output current rating shall equal or exceed the full load nameplate rating of the motor provided. The drive shall be capable of maintaining 110% of rated output current continuously, and shall be capable of delivering 150% of rated output current for up to one minute. The drive shall have a continuous output current rating of 100% of the motor nameplate current.
 10. The drive shall be capable of restoring motor operation after a 0.5 second line loss without shutting down on a fault.
 11. The drive input circuitry shall not generate line notches or large voltage transients on the incoming line.
 12. The drive shall present a displacement power factor of 0.95 or better to the AC line at any speed or load.
 13. The drive efficiency at rated load and frequency shall be 98% or better.
 14. The drive shall be suitable for use on constant torque or variable torque motor loads as indicated on the VFD schedule.
- C. Drive Controls:
1. The VFD shall be furnished with start-stop controls and speed controls as indicated on the Contract Drawing and in the Description of Operation.
 2. Control interfaces shall include, but not be limited to, the following:
 - a. Drive Run Auxiliary Contact
 - b. Common Drive Fault Contact
 - c. Isolated Analog Input Board
 - d. 120 V Control Interface Board
 - e. 4-20mA output signal proportional to % speed for report to the facility PLC
- D. Human Interface Module: A Human Interface Module (HIM) shall be mounted on the drive enclosure for digital set-up of the drive, drive parameter review, and drive fault annunciation. The module shall have a LCD display and a digital speed pot for local control of the drive speed.

- E. Drive Protection and Diagnostics: The VFD shall incorporate internal diagnostic and fault sensing circuits as an integral part of the drive. The following drive protection functions shall be monitored:
1. Momentary Overload Protection - Adjustable from 50 to 115% of Drive Rating
 2. Motor Overload Protection
 3. Under-voltage Sensing
 4. Overvoltage Sensing
 5. Phase Protection
 6. Drive Over-temperature
 7. Ground Fault Detection
 8. Signal isolation for control/monitor inputs and outputs

Each of the above fault conditions shall be annunciated on the digital display panel, and shall shut down the drive.

2.02 MISCELLANEOUS DRIVE CONTROL COMPONENTS

- A. Line Reactors: Provide line reactors in the drive enclosure for each drive to reduce nuisance overvoltage tripping and harmonic distortion. The line reactors shall be sized for the motor horsepower and shall be manufactured by TCI, provided by the VFD manufacturer.
- B. Control Power Transformers: Provide a control transformer(s) for each drive assembly control circuit as indicated on the Drawings. Control transformers shall be 480 V to 120 V and shall be provided with primary and secondary fused protection. Control transformer sizes shall be as required plus 250VA (minimum) additional capacity.
- C. Selector Switches: Selector switches shall be non-illuminated. Switches shall be 30.5 mm, heavy-duty, oil tight. Switches shall have double-break silver contacts. All switches shall be maintained contact type unless otherwise indicated on the Drawing. Provide auxiliary contact blocks as indicated on the Drawing or as directed by the AW Project Manager.
- D. Pilot Lights: Pilot lights shall be push-to-test, LED type. They shall be 30.5 mm, heavy-duty, oil tight. Voltage rating shall be 120 V. Color caps shall be red for "run", green for "off" or "stop", amber for "alarm," white for "open" and blue for "closed" unless otherwise noted.

E. AC Magnetic Interposing Relays - 120 V:

1. Power Relays used for inductive load switching / control shall be 120 volt ac magnetic type, shall have convertible contacts and shall be rated for 120 V inductive, 30 amp make, 30 amp break, 20 amp continuous, with a minimum of 2 DPDT contacts (timing), 4 DPDT (non-timing).
2. Control Relays used for interlock control functions to be general purpose, plug-in type construction, 10 amp continuous duty rated, and shall operate on 120 V, unless indicated otherwise on the Drawings. Relays shall have terminals which plug-in to a socket, mounted to the inside of the drive enclosure. Contact configuration shall be 3PDT, unless otherwise required or indicated on the Drawings. Provide complete with mating socket base and indicator light to indicate the relay coil is energized. Contact configuration and timing ranges to be as indicated on the Drawings.
3. Terminals shall be provided with pressure wire connectors.
4. Motor DV/DT Filter: Provide motor dv/dt filters in the drive enclosure for each drive to reduce transient voltage and peak voltages at the motor terminals that are associated with the distance between the drive and the motor.

2.03 SPARE PARTS

A. Provide the following spare parts for each size VFD provided:

1. Three (3) fuses for each size and type utilized
2. One (1) Bridge Rectifier Kit
3. One (1) Base Driver/Power Supply PCB Kit
4. One (1) Main Control PCB Kit
5. One (1) Pre-charge PCB Kit
6. One (1) Pre-charge Switch Kit
7. One (1) Surge Suppressor Kit
8. One (1) Transistor Kit

B. Contractor shall also provide the following other spare parts:

1. Five (5) of each type/color Pilot light bulbs with special tool to remove bulb.

2. Four (4) fuses for each type and size utilized
- C. Spare parts shall be the same type and size utilized in the drives and equipment provided for this Contract. Spare parts shall be packaged individually in boxes that are clearly labeled with part name and manufacturer's part/stock number. Contractor shall deliver all spares as one lot with parts list identifying each part and the equipment wherein the part is applied.

PART 3 EXECUTION

3.01 FIELD SERVICES

- A. Start-up and Testing:
 1. Contractor shall provide the services of a manufacturer's representative to start-up, adjust and test each variable frequency drive assemblies. Demonstrate start/stop control, fault diagnostics and variation of motor speeds in response to both the manual and automatic variable speed controls. Verify accuracy of speed variation and speed indication by means of a Strobotach which utilizes a light beam focused on the motor shaft. (Strobotach shall be furnished by the manufacturer's representative for testing.)
 2. All start-up and testing shall be performed in the presence of the AW Project Manager. All startup data and controls configuration and programming shall be recorded at startup or training on approved data recording sheets and verified. Completed data sheets shall accompany the Operations and Maintenance manuals provided for use in training. Scheduling and coordination arrangements are to be made a minimum of two weeks in advance, approved by AW.
- B. Training:
 1. Contractor shall provide a training session for one (1) normal workday at the project site. Training shall be specific for the VFD unit(s) provided and shall include theory of operation, maintenance and troubleshooting procedures. Training shall include control and monitoring/metering systems with specific emphasis on use and performance of these systems with VFD applications.
 2. The time associated with Start-up and Testing of the VFD equipment is NOT to be considered applicable to this training time.

END OF SECTION 26 29 23

SECTION 26 32 13.13**EMERGENCY GENERATOR****PART 1: GENERAL****1.01 SCOPE OF WORK**

- A. Provide complete factory assembled generator set equipment with digital (microprocessor-based) electronic generator set controls, digital governor, and digital voltage regulator.
- B. Provide factory testing.
- C. Provide field startup acceptance testing by a supplier authorized by the equipment manufacturer(s); include all required test equipment, load-bank, cabling and monitoring/recording equipment required to demonstrate operation and safety device(s) associated with the system.
- D. The generator set manufacturer shall warrant all equipment provided under this section in accordance with the Contract Documents for the Work.
- E. All installation and start-up services shall be provided by technicians specifically trained and certified by the manufacturer to support the products provided.

1.02 REFERENCES

- A. The generator set installation and on-site testing shall conform to the requirements of the latest codes and standards, as applicable. The generator set shall include necessary features to meet the requirements of these standards.
 - 1. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 - 2. NECA/EGSA 404 – Recommended Practice for Installing Generator Sets; National Electrical Contractors Association;.
 - 3. NFPA 110 – Emergency and Standby Power Systems
 - 4. NFPA 70 – National Electrical Code
 - 5. NFPA 37 – Combustion Engines and Gas Turbines
 - 6. NEMA MG1 – Motors and Generators; National Electrical Manufacturers Association; latest edition.
 - 7. UL 142 – Sub-base Tanks

8. UL 2200 – The generator set shall be listed to UL 2200 or submit to an independent third party certification process to verify compliance as installed.
- B. The control system for the generator set shall comply with the following requirements.
1. EN 50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.
 2. FCC Part 15, Subpart B – Unintentional Radiators
 3. IEC8528 part 4 – Control Systems for Generator Sets
 4. IEC Std 801.2, 801.3, and 801.5 – Susceptibility, conducted, and radiated electromagnetic emissions.
 5. UL 508 – The entire control system of the generator set shall be UL508 listed and labeled.
 6. UL 1236 – Battery Chargers
- C. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.03 SUBMITTALS

- A. Shall conform to the requirements of Section– Submittals.
- B. Product Data: Provide catalog data for nameplates, labels, and markers.
1. Manufacturer's product literature and performance data, sufficient to verify compliance to Specification requirements.
 2. Manufacturer's certification of prototype testing.
 3. Manufacturer's published warranty documents.
- C. Shop Drawings: Indicate electrical characteristics and connection requirements. Show plan and elevation views with certified overall dimensions, as well as wiring interconnection details. Provide fuel consumption rate curves at various loads, ventilation and combustion air requirements, electrical diagrams including schematic and interconnection diagrams.
1. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.

- D. Test Reports: Indicate results of performance testing.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- F. Operation Data: Include instructions for normal operation.
- G. Maintenance Data: Include instructions for routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

1.04 FACTORY TESTING

- A. The generator set manufacturer shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance.
- B. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. All equipment and materials shall be delivered, stored and handled in strict accordance with the manufacturer's recommendations.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Caterpillar, Cummins, Generac, or approved equal.

2.02 GENERATOR SET

- A. System Capacity
 - 1. The generator capacity shall be as specified on the Contract Documents or as directed by the AW Project Manager.
 - 2. The generator set rating shall be based on emergency / standby service. Generator shall begin providing rated power not greater than 10 seconds after loss of utility power.

B. Performance

1. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.5%.
3. The diesel engine generator set shall accept a single step load of 100% nameplate kW and power factor, less applicable de-rating factors, with the engine generator set at operating temperature.
4. The generator set shall be capable of recovering to a minimum of 90% of rated no load voltage following the application of the specified kVA load at near zero power factor applied to the generator set. Maximum voltage dip on application of this load, considering both alternator performance and engine speed changes shall not exceed 25%.
5. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic, and no 3rd order harmonics or their multiples. Telephone influence factor shall be less than 40.
6. The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating, and shall meet all applicable exhaust emission requirements at the time of commissioning.
7. The generator shall be compatible with VFD's on equipment motors.
8. Transient Frequency Performance: Less than 2-Hz variation for 50% step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.

C. Construction

1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
2. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. All active control components shall be installed within a UL/NEMA 3R enclosure. There shall be no exposed points in the control (with the door open) that operate in excess of 50 V.

D. Connections

1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the Drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the Drawings.
2. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.
3. Generator set control interfaces to other system components shall be made on a permanently labeled terminal block assembly. Labels describing connection point functions shall be provided.

2.03 ENGINE AND ENGINE EQUIPMENT

- A. The engine shall be diesel, 4 cycle, radiator and fan cooled. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable.
- B. Engine protection devices shall have sensing elements located on the engine to initiate preliminary alarms and engine shutdowns as per manufacturer's recommendation.
- C. Engine shall be radiator cooled by engine mounted radiator system including belt driven pusher fan, cooling pump, and thermostat temperature control. Performance of components shall be as required by set manufacturer. Radiator shall be provided with a duct adapter flange permitting the attachment of air discharge duct directing the discharge of radiator air through the wall.
- D. Contractor shall provide the generator set with suitable spring / pad type vibration isolators and mount on structural steel base.

2.04 STARTING AND CONTROL BATTERIES

- A. Starting and control batteries shall be calcium/lead antimony type, 24 V DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors. The batteries shall be capable of a minimum of three complete 15-second cranking cycles at 40°F ambient temperature when fully charged.

2.05 EXHAUST SYSTEM

- A. Provide critical grade exhaust muffler(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. Muffler shall be constructed from stainless steel unless specifically noted otherwise. The average noise emission shall be less than 85 dB(A) at 3 ft distance measured at 5 ft above grade, during full load operation. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards

2.06 BATTERY CHARGER

- A. Provide a minimum 10 amp battery charger for each generator set battery bank. Generator sets incorporating two battery banks shall be provided with two chargers connected together and operating in parallel, with alarm output(s) connected in parallel. The charger(s) shall include the following capabilities:
 - 1. Chargers shall be UL 1236-BBHH listed and CSA or C-UL certified for use in emergency applications.
 - 2. The charger shall be compliant with UL 991 requirements for vibration resistance.
 - 3. The charger shall comply with the requirements of EN 61000-4-5 for voltage surge resistance; EN 50082-2 for immunity; EN 61000-4-2 for ESD; EN 61000-4-3 for radiated immunity; ANSI/IEEE C62.41 category B and IN61000-4-4 for electrically fast transient; EN61000-4-6 for conducted emissions; and FCC Part 15 Class A for radiated emissions.

2.07 ENGINE FUEL SYSTEM

- A. Each generator set fuel tank shall be provided as specified in the Contract Document or as directed by the AW Project Manager.
- B. The fuel tank shall have adequate capacity in compliance with all national and local regulations.
- C. The sub-base fuel tank shall be double wall, constructed of corrosion resistant steel and shall comply with NFPA 37.
- D. The fuel tank shall be UL listed.
- E. Where required, the indoor day tank and in-skid fuel transfer tank shall be double wall, made of aluminized steel with welded construction, and pressure tested to 3 PSI.

2.08 AC GENERATOR

- A. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system and shall be UL 1446 listed. Actual temperature rise measured by resistance method at full load shall not exceed 125°C.

- B. The generator shall be capable of delivering rated output (KVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.
- C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.
- D. For generator set rated 600 V ac and lower: the sub-transient reactance of the alternator shall not exceed 15 percent, based on the standby rating of the generator set.
- E. For generator set rated higher than 600 V ac up to 15,000 V ac:
 - 1. Provide two embedded resistance temperature detectors per phase and temperature indication equipment. The control system shall annunciate high alternator temperature as a fault condition.
 - 2. Provide anti-condensation heater for the alternator.
 - 3. The sub-transient reactance of the alternator shall not exceed 12 percent, based on the standby rating of the generator set.

2.09 GENERATOR CONTROLS

- A. Provide a lighted, unit mounted control panel with NEMA 250, Type 1 enclosure with engine and generator controls and indicators. The control console shall be factory built, wired, tested, and shock-mounted.
- B. For outdoor applications, unit mounted control panel shall be provided with a NEMA 250 Type 3R enclosure.
- C. The generator set mounted control panel shall include the following features and functions:
 - 1. Control switches including emergency stop switch, reset switch, and panel lamp switch
 - 2. Generator set AC output metering
 - 3. Generator set alarm status display including alarm and status indication lamps
 - 4. Engine status monitoring including a digital status panel on generator set control for engine oil pressure, engine coolant temperature, engine oil temperature, engine speed, number of hours of operations, number of start attempts, battery voltage, etc
 - 5. Engine control functions
 - 6. Alternator control functions

- D. The control panel shall include provision for padlock and shall have standard manufacturer recommended features or as directed by the AW Project Manager.
- E. Where the height of the sub-base fuel tank is such that the level of the control panel is above the normal reach of site personnel. Contractor shall provide fixed access stairs with walking platform and handrails to all operating features.

2.10 MAIN LINE CIRCUIT BREAKER (FOR LOW VOLTAGE)

- A. The generator set shall be provided with a mounted main line circuit breaker, sized to carry the rated output current of the generator set. The circuit breaker shall incorporate an electronic trip unit that operates to protect the alternator under all over-current conditions, or a thermal-magnetic trip with other over-current protection devices that positively protect the alternator under over-current conditions. The supplier shall submit time over-current characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.

PART 3: EXECUTION

3.01 PREPARATION

- A. Verify site conditions and equipment mounting bases are ready for installation of the unit.

3.02 INSTALLATION

- A. Equipment shall be installed by the Contractor in compliance with applicable State and local codes accordance with manufacturer's instructions.
- B. Equipment shall be installed in accordance with requirements of local utility provider, where applicable.
- C. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The Contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- D. Equipment shall be installed on poured-in-place concrete housekeeping pad that extend 1 feet on all sides. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- E. Equipment shall be initially started and operated by representatives of the manufacturer.
- F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment

shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

3.03 ON-SITE ACCEPTANCE TEST:

- A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The AW Project Manager shall be notified in advance and shall have the option to witness the tests.
- B. Installation acceptance testing shall be coordinated with AW and the local electrical power provider as required.
- C. Installation acceptance tests to be conducted on-site shall include the use of a resistive load bank provided under this Contract; make all temporary connections for the testing outlined below.
- D. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel. Testing of the assembly shall include applying load steps in 25% increments to the generator for 15 minutes each before sustained 100% load for the 2 hour duration indicated. Upon completion of these tests, and engine cool-down, the testing shall include a "cold start" test; applying a one step 100% rated load pickup test in accordance with NFPA 110.

3.04 TRAINING:

- A. Contractor shall provide training for the facility operating personnel covering operation and maintenance of the generator set. Training date shall be coordinated with AW.

3.05 WARRANTY

- A. The generator set and associated equipment shall be warranted for a period of not less than 2 years or standard manufacturer warranty period from the date of commissioning against defects in materials and workmanship.
- B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

END OF SECTION 26 32 13.13

SECTION 26 36 23**AUTOMATIC TRANSFER SWITCH****PART 1: GENERAL****1.01 SCOPE**

- A. Furnish all labor, materials, equipment and appurtenances, install and test electrically operated, automatic transfer switch (ATS) equipment as shown on the Drawings and as specified herein.

1.02 REFERENCES

- A. Products for, and the execution of, the work of this Section shall satisfy the applicable requirements of the latest NEC Codes and Federal, State, and Local regulations.

1.03 SUBMITTALS

- A. Shall conform to the requirements of Specification Section 013 300 – Submittals.
- B. Shop drawings: Shop drawings shall indicate electrical characteristics and connection requirements, single-line diagrams, assembly wiring diagrams, equipment drawings, product description, and installation instructions. Shop drawings shall also clearly indicate enclosure size, gutter space, short circuit rating and continuous ampere rating of switch.
- C. Operation and Maintenance (O & M) Manuals: O&M manuals shall be submitted in accordance with the Contract Documents, and shall include detailed parts lists, lists of recommended spare parts, circuit diagrams, maintenance procedures and operating instructions. Contractor shall submit O&M manuals for each size of ATS.
- D. Product Data:
 - 1. Catalog sheets, specifications and installation instructions.
 - 2. Bill of materials.
 - 3. Detailed sequence of operations.
 - 4. Performance data: Performance data shall include equipment life, test, system functional flows, safety features and mechanical automated details.
 - 5. Company's data indicating maintenance schedule.
 - 6. Name, address and telephone number of nearest fully equipped service organization.

1.04 QUALITY ASSURANCE

- A. ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, and installation and servicing in accordance with ISO 9001.
- B. Contractor shall be an authorized distributor of the specified ATS manufacturer with minimum three years documented experience.
- C. List of Completed Installations: Contractor shall furnish the name, address and telephone number of a least 5 comparable installations which can prove the proposed products have operated satisfactorily for 3 years.
- D. Contractor shall be a fully equipped service organization capable of responding within 8 hours to service calls, and shall be available 24 hours a day, 7 days a week to service the completed work.

1.05 FACTORY TESTS

- A. ATS shall be thoroughly tested at the factory to ensure proper operation of the individual components and correct overall sequence of operation, and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the project requirements. Factory tests shall be conducted per UL standards, and a certified test report shall be submitted to AW for review.

PART 2: PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Furnish material and equipment bearing evidence of UL listing where UL standards exist and manufacturer identification and customary size or rating data.
- B. Provide products that are free from defects impairing performance, durability, or appearance, and of the commercial quality best suited for the purpose shown on the Drawings or specified herein.
- C. ATS shall be rated for application with upstream power circuit breaker over-current/short-circuit protection.
- D. The voltage rating of the transfer switch shall be no less than the system voltage rating. The continuous current rating of the transfer switch shall be no less than the maximum continuous current requirements of the system.
- E. ATS shall be capable of being operated manually under full load conditions. The manual operator shall provide true quick-make, quick break operation to prevent possible flashovers from switching the contacts slowly. The control panel shall direct

the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability and minimum maintenance. Where in-phase monitoring type switches are indicated, provide the assembly complete with all appurtenances and accessories needed to ensure in-phase monitoring of the transfer control to minimize transient disturbance and ensure that the voltage of the source being transferred is at least 85% nominal prior to transfer. The control panel shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the control panel to be disconnected from the transfer switch for routine maintenance.

- F. Wiring/Terminations: Terminal blocks shall conform to NEMA ICS4. Terminal facilities shall be arranged for entrance of external conductors from the top or bottom of the enclosure. The main transfer switch terminals shall be suitable for the termination of conductors shown on the plans.

2.02 MATERIALS AND EQUIPMENT

- A. Acceptable Manufacturers:
 - 1. Caterpillar. Alternate manufacturers will not be accepted. Contractor shall coordinate purchase of ATS with AW's Project Manager.
- B. ATS ratings and voltage shall be as indicated on the Drawings. Ampacity ratings indicated shall be full load (100%) acceptance values without de-rating.
- C. Ratings: ATS shall be rated for continuous duty at minimum of 125% of the required load capacity. Voltage rating, phase and pole shall match the available utility supply unless directed by the AW Project Manager or stated on the Drawings.
- D. ATS shall consist of an inherently double-throw power transfer switch unit and an electric controller interconnected to provide those complete operations and functions identified.
- E. ATS shall transfer the load utilizing in-phase monitor transition including voltage sensing modes in order to avoid out-of-phase transfer operation or shall be of the programmed transition type as indicated by these Contract Documents. Transfer Switch time-delay functions shall be adjustable for sequential transfer of equipment and load isolation as indicated

2.03 AUTOMATIC TRANSFER SWITCHES - GENERAL

- A. Each ATS unit shall be electrically operated and mechanically held. The electrical operator shall be a solenoid mechanism, momentarily energized. The switch shall be double throw being inherently interlocked both mechanically and electrically to ensure only one of two possible positions, normal or emergency (stand-by). All main contacts shall move simultaneously on the same shaft, without the utilization of multiple snap-action devices.

- B. ATS shall be fully completely factory assembled and wired such that only external circuit connections are required in the field.
- C. ATS shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.
- D. All main contacts shall be silver composition. Switches rated 600 amp and above shall have segmented blow-on construction for high withstand current capability and be protected by separate arcing contacts. Provide one set of auxiliary Form C (SPDT) contacts; rated 10 amp at 120 V for remote monitoring or control action. Auxiliary contacts to be provided on each source position of the switch.
- E. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.
- F. Where neutral conductors are to be solidly connected as shown on the Drawings, a neutral conductor terminal plate with fully-rated AL-CU pressure connectors shall be provided.
- G. Main contacts shall be designed to withstand multiple fault currents and shall meet UL 489 and/or UL 1087 requirements and shall be fully rated for all types of loads, inductive and resistive, without derating, either open or enclosed.
- H. Provide ATS complete with fully rated isolated by-pass switch where indicated.
- I. An engine generator exercise timer shall be provided, including a selector switch to select exercise with or without load transfer.

2.04 TIME DELAYS

- A. An adjustable time delay shall be provided to override the momentary normal source outages and delay all transfer and engine starting signals.
- B. An adjustable time delay shall be provided on transfer to emergency, adjustable from 0 to 5 minutes for controlled timing of transfer of loads to emergency.
- C. An adjustable time delay shall be provided on retransfer to normal, adjustable to 30 minutes. Time delays shall be automatically bypassed if emergency source fails and normal source is acceptable.
- D. A 5 minute cool down time delay shall be provided on shutdown of engine generator.
- E. All adjustable time delays shall be field adjustable without the use of tools.

2.05 ENCLOSURE

- A. In general, each ATS shall be furnished in a NEMA type 1 enclosure, unless otherwise directed by the AW Project Manager or shown on the Drawings.
- B. For outdoor applications, ATS shall be furnished in a NEMA type 3R enclosure. Contractor shall provide strip heater with thermostat for type 3R enclosure requirements.
- C. ATS shall be flush mounted display with LED indicators for switch position and source availability. ATS shall also include test and time delay by-pass switches.

2.06 NAMEPLATE

- A. ATS name plate markings shall include the following:
 - 1. Name of manufacturer and catalogue number, or equivalent serial number.
 - 2. Voltage and frequency ratings.
 - 3. Continuous current rating.
- B. Additional markings shall be those required by UL 1008.

PART 3: EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to the site under provisions of this Contract.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to internal components, enclosure and finish.

3.02 INSTALLATION

- A. Products shall be installed, connected, and interconnected, where indicated, and in accordance with the manufacturer's printed instructions, as specified herein and as indicated on the Drawings. Connections shall be made in a manner which will insure electrical continuity and operability of the products. Verify the work of other trades is complete to the extent that substrates on which electrical apparatus is to be installed is ready to receive same.

3.03 SERVICE WIRING

- A. Service installation as indicated on the Drawings except that the entire installation shall conform to the latest rules and regulations of the NEC.

3.04 TRAINING

- A. The ATS manufacturer shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. Training date shall be coordinated with AW.

3.05 ON-SITE ACCEPTANCE TEST

- A. The complete installation shall be tested for compliance with the Specification following the installation of the Standby Power Generator unit; testing of the generator shall include on-site testing of the ATS. Testing shall be conducted by the Contractor in accordance with the manufacturer's literature with AW representative being present. The AW Project Manager shall be notified in advance and shall have the option to witness the tests. The Contractor will be required to demonstrate operation of the transfer switch in bypass, normal and emergency modes.

END OF SECTION 26 36 23

DIVISION 31
EARTHWORK

**SECTION 31 10 00
SITE PREPARATION**

PART 1 - GENERAL

1.1 SUMMARY

- A. The Work of this Section includes all those measures required during the Contractor's initial move onto the site to protect existing fences, structures and associated improvements, streets, and utilities downslope of construction areas from damage due to boulders, trees or other objects dislodged during the construction process: clearing, grubbing and stripping; and regrading of areas to receive embankment fill.
- B. The Contractor is required to protect and preserve all things designated to remain. Where Contractor's operation causes damage or injury to trees and plants designated to remain, an arborist or other qualified professional shall be employed by the Contractor, at no additional cost to the Owner, to repair the damage or provide adequate replacement to the Owner's satisfaction where damage is beyond repair.

1.2 SITE INSPECTION

- A. Prior to moving onto the Project site, the Contractor shall inspect the site conditions and review maps of the existing plant site and off-site pipeline routes and facilities delineating the Owner's property and right-of-way lines.
- B. Contractor shall submit photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site preparation.
- C. The Contractor shall identify and accurately locate utilities and other subsurface structural, electrical, and mechanical conditions. Existing conditions shall be incorporated into the record drawings for the project.

1.3 DEFINITIONS

- A. The following definitions apply to the Work of this Section:
 - 1. Clearing is defined as cutting trees, removing fences and posts, removing curbs and other improvements to prepare the site for grubbing and stripping.
 - 2. Grubbing is defined as the below grade part of clearing to remove roots, small piping, irrigation systems, etc., to prepare the site for stripping.
 - 3. Stripping is defined as removing a surface layer of soil and organic material, sod, topsoil, and other unsuitable material as defined in Section 31 23 00 – Earthwork, to a depth that earthwork can proceed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Locate and clearly flag trees and vegetation to remain or to be relocated.
- D. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TREE PROTECTION

- A. Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.
 - 1. Do not store construction materials, debris, or excavated material within drip line of remaining trees.
 - 2. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.
- B. Do not excavate within drip line of trees, unless otherwise indicated.
- C. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
 - 1. Cover exposed roots with burlap and water regularly.
 - 2. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
 - 3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
 - 4. Cover exposed roots with wet burlap to prevent roots from drying out. Backfill with soil as soon as possible.
- D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Engineer.
 - 1. Employ a qualified arborist, licensed in jurisdiction where project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
 - 2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist.

3.3 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.
 2. Arrange to shut off indicated utilities with utility companies.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify Engineer not less than two days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Engineer's written permission.
- C. Excavate for and remove underground utilities indicated to be removed.

3.4 PRIMARY PLANT SITE ACCESS

- A. Develop any necessary access to the site, including barrier facilities to be installed at the beginning of construction in order to prohibit entry of unauthorized persons.
- B. Utility Interference: Where existing utilities interfere with the Work of this Section, notify the Engineer and work around the interferences until a directive is issued.

3.5 CLEARING, GRUBBING, AND STRIPPING

- A. All construction areas shall be cleared of grass and weeds to at least a depth of six inches and cleared of structures, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the Work, create a hazard to safety, or impair the Work's subsequent usefulness or obstruct its operation. Loose boulders within 10 feet of the top of cut lines shall be incorporated in landscaping or removed from the site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction, as directed by the Engineer.
- B. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove all stumps, roots, buried logs, and all other objectionable material. Debris or waste shall be totally removed if they are found on the site. All objectionable material from the clearing and grubbing process shall be removed from the site and wasted in approved safe locations in compliance with state and federal regulations.
- C. The area to be affected by construction that have not been pre-excavated to the subgrade elevation shall be removed and placed in the designated stockpile areas, and/or incorporated into landscaped areas or other nonstructural embankments.
- D. For all areas that have not been previously disturbed, including staging areas and temporary construction easements, topsoil-salvaging operation shall immediately follow clearing operations. The area shall be stripped of topsoil to a depth of 8 inches. Unsuitable materials, specified in Section 31 23 00, shall not be considered topsoil. The Contractor shall strip to the depth indicated regardless of the material encountered. All stripped topsoil shall be stockpiled within stripped areas in stockpiles not to exceed 15 feet in height. Vegetation shall be ground or chipped to a mulching consistency and mixed with the stripped soil. Stockpiles shall be placed away from high construction traffic areas and shall be fenced and signed to prevent accidental use as fill prior to topsoil replacement.

- E. Upon completion of Work within the construction areas stripped of topsoil, the stored topsoil shall be respread over the disturbed areas. Topsoil shall be spread in about a 6-inch layer. Respread topsoil shall match the existing terrain as much as possible. Interfaces between restored disturbed areas and undisturbed areas shall be chain dragged to eliminate obvious edges. All tracks and equipment marks shall be chain dragged or hand raked away. Replaced topsoil shall be thoroughly watered for dust control upon completion of the resspreading operations. Once topsoil replacement has been completed, no vehicles or other motorized equipment shall be allowed to travel on the finished surface.
- F. Unless otherwise indicated, native trees larger than three inches in diameter at the base shall not be removed without the Engineer's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if not necessary for the Contractor's choice of means and methods, shall be arranged with the property owner and be removed and replaced at no increased cost to the Owner.
- G. Except in areas to be excavated, holes and other holes resulting from Work of this section shall be backfilled with suitable material in accordance with Section 31 23 00 – Earthwork.

3.6 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincides with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

3.7 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION

**SECTION 31 23 00
EARTHWORK**

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall perform all earthwork indicated and required for construction of the Work, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

29 CFR 1926	OSHA Safety and Health Regulations for Construction
ASTM C150	Portland Cement
ASTM D 422	Method for Particle-Size Analysis of Soils
ASTM D 1556	Test Method for Density of Soil in Place by the Sand-Cone Method
ASTM D 1557	Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³) (2,700 kN-m/m ³)
ASTM D 1633	Test Method for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D 2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D 2487	Classification of Soils for Engineering Purposes
ASTM D 2901	Test Method for Cement Content of Freshly Mixed Soil Cement
ASTM D 2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods
ASTM D 4253	Test Methods for Maximum Index Density of Soils using a Vibratory Table
ASTM D4254	Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D 4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D4832	Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
ASTM D 5971	Practice for Sampling Freshly Mixed Controlled Low Strength Material (CLSM)
ASTM D 6023	Test Method for Unit Weight, Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low Strength Material (CLSM)
ASTM D 6024	Test Method for Ball Drop on Controlled Low Strength Material (CLSM) to Determine Suitability for Load Application
ASTM D 6103	Test Method for Flow Consistency of Controlled Low Strength Material (CLSM)

1.3 CONTRACTOR SUBMITTALS

- A. The Contractor's attention is directed to the provisions of Subpart P, 29 CFR 1926 of the OSHA Safety and Health Standards for Construction, which relate to protection of employees in excavations. The Contractor shall submit, for information to the Engineer, the project excavation plan and the name of the Contractor's competent person, prior to commencing any excavation.
- B. Submit samples of all materials proposed to be used in the work in accordance with the requirements in Section 01 33 20 - Contractor Submittals. Sample sizes shall be as determined by the testing laboratory.
- C. Submit dewatering and water removal plan prior to performing any dewatering or water removal.

PART 2 - PRODUCTS

2.1 SUITABLE FILL AND BACKFILL MATERIAL REQUIREMENTS

- A. General: Fill, backfill, and embankment materials shall be suitable material.
- B. Suitable Materials: Suitable material is defined as selected or processed clean, well graded earth material, sands and gravels free of excessive fines, less than 20 percent rock and boulders larger than 4 inches, grass, roots, brush, vegetation, or other deleterious materials.
- C. Fill and backfill materials within 6 inches of any structure or pipe shall be smaller than 1 inch in any dimension.
 - 1. Suitable materials may be obtained from onsite excavations, may be processed onsite materials, or may be imported. If imported materials are required by this Section or to meet the quantity requirements of the Project, provide the imported materials at no additional expense to the Owner, unless a unit price item is included for imported materials in the bidding schedule. Onsite materials shall be stockpiled and segregated prior to use.

2. The following types of suitable materials are defined:

Type A (Granular Backfill): Crushed rock or gravel, and sand well graded and readily compacted, non-plastic, meeting the following gradation requirements:

<u>Sieve Size</u>	<u>Percentage Passing</u>
1-inch	100
No. 40	15 - 60
No. 200	0 - 15

Type B (Crushed Rock): Manufactured angular, crushed rock, non-plastic, meeting the following gradation requirements:

<u>Sieve Size</u>	<u>Percentage Passing</u>
3/8-inch	100
No. 4	30 - 50
No. 200	0 - 5

Type C (Sand Backfill): Sand non-plastic, meeting the following gradation requirements:

<u>Sieve Size</u>	<u>Percentage Passing</u>
3/4-inch	100
No. 4	80 - 100
No. 10	30-50
No. 40	10-30
No. 200	7 - 15

Squeegee is not acceptable as sand backfill.

Type D (Select Backfill): Suitable material that can be readily compacted and meets the requirements of AASHTO M 145 classification A-1-a, non-plastic, well graded with a maximum particle size of 2 inches.

<u>Sieve Size</u>	<u>Percentage Passing</u>
2-inch	100
No. 10	30-50
No. 40	15-30
No. 200	0 - 15

Type E (Pea Gravel Backfill): Crushed rock or gravel with 100 percent passing a 1/2-inch sieve and not more than 10 percent passing a No. 4 sieve.

Type F (Drainrock): Crushed rock or gravel conforming to one of the following gradation requirements, as shown on the Drawings or approved by the Engineer:

Percentage Passing

<u>Sieve Size</u>	<u>3-inch Max.</u>	<u>2-inch Max.</u>	<u>3/4-inch Max.</u>
3-inch	100	-	-
2-inch	90 - 100	100	-
1-1/2 inch	70 - 100	90 - 100	-
3/4 inch	0 - 50	0 - 15	100
1/2-inch	-	-	95 - 100
3/8-inch	0 - 10	0 - 5	70 - 100
No. 4	0 - 25	-	-
No. 8	0 - 5	-	-
No. 200	0 - 3	-	0 - 3

Type G (Type II Aggregate Base): Well-graded, clean, hard, tough, durable, and sound mineral aggregates consisting of crushed stone, or crushed gravel, free of organic matter and contamination from chemical or petroleum products meeting State specification requirements and conforming to the following Table and gradations:

Aggregate Properties			
	Aggregate Class		
	A	B	
Dry Rodded Unit Weight	Not less than 75 lb/ft ³		AASHTO T 19
Liquid Limit/Plastic Index	Non-plastic	PI ≤ 6	AASHTO T 89 AASHTO 90
Aggregate Wear	Not to exceed 50 percent		AASHTO T 96
Gradation	Table 2		AASHTO T 11 AASHTO T 27
CBR with a 10 lb surcharge measured at 0.20 inch penetration	70% Minimum	N/A	AASHTO T 193
Two Fractured Faces	50% Min	N/A	AASHTO T 335

<u>Sieve Size</u>	<u>Percentage Passing</u>
1 ½ -inch	100
1-inch	90 - 100
3/4-inch	70 - 85
1/2-inch	65 - 80
3/8-inch	55 - 75
No. 4	40 - 60
No. 16	25 - 40
No. 200	8 - 13

Type H (Graded Drainrock): Graded drainrock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting and drying. The material shall be uniformly graded and shall meet the following gradation requirements:

<u>Sieve Size</u>	<u>Percentage Passing</u>
1-inch	100
3/4 inch	90 - 100
3/8-inch	40 - 100
No. 4	25 - 40
No. 8	18 - 33
No. 30	5 - 15
No. 50	0 - 7
No. 200	0 - 3

Type I: (Not Used):

Type J (Cement-Treated Backfill): Material which consists of Type F material, or any mixture of Types B, C, G, and H materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901. The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633.

Type K (Topsoil): Stockpiled topsoil material which has been obtained at the site by removing soil to a depth as defined in Section 31 10 00 - Site Preparation. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris.

Type M (Aggregate Subbase): Crushed rock aggregate subbase material non-plastic that can be compacted readily by watering and rolling to form a stable base. The sand equivalent value shall not be less than 18 and shall meet one of the following gradation requirements, as shown on the Drawings or approved by the Engineer:

<u>Sieve Size</u>	<u>Percentage Passing</u>	
	<u>3-inch Max.</u>	<u>2-inch Max.</u>
3-inch	100 -	
2-inch	90 - 100	100
1-1/2 inch	-	95 - 100
1-inch	70 - 90	-
No. 4	30 - 65	30 - 65
No. 16	15 - 40	15 - 40
No. 200	2 - 12	2 - 12

Type N (trench plug): Low permeable fill material, a nondispersable clay material having a minimum plasticity index of 10.

Type O (Controlled Low Strength Material (CLSM)): CLSM shall be in accordance with APWA standards.

Type P: (Suitable Trench Backfill): Suitable material that can be readily compacted, with less than 35 percent passing the No. 200 sieve and a plasticity index of 10 or less.

2.2 UNSUITABLE MATERIAL

- A. Unsuitable materials include but are not limited to the materials listed below.
 - 1. Soils which, when classified under ASTM D 2487 - Classification of Soils for Engineering Purposes, fall in the classifications of Pt, OH, CH, MH, or OL.
 - 2. Soils which cannot be compacted sufficiently to achieve the density indicated for the intended use.
 - 3. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, slag, and any material which may be classified as hazardous or toxic according to applicable regulations.
 - 4. Soils that contain greater concentrations of chloride or sulfate ions, or have a soil resistivity or pH less than the existing onsite soils.
 - 5. Topsoil, except as allowed below.
- B. All unsuitable excavated material shall be disposed off site.

2.3 USE OF FILL, BACKFILL, AND EMBANKMENT MATERIAL TYPES

- A. Use the types of materials as designated herein for all required fill, backfill, and embankment construction hereunder.
- B. Where these Specifications conflict with the requirements of any local agency having jurisdiction or with the requirements of a pipe material manufacturer, notify the Engineer immediately. In case of conflict between types of pipe embedment backfills, use the agency-specified backfill material if that material provides a greater degree of support to the pipe, as determined by the Engineer. In case of conflict between types of trench or final backfill types, use the agency-specified backfill material if that material provides the greater in-place density after compaction.
- C. Fill and backfill types shall be used in accordance with the following provisions:
 - 1. Embankment fills shall be constructed of Type P material, as defined herein, or any mixture of Type P and Type A through Type F materials.
 - 2. Pipe zone backfill, as defined under "Pipe and Utility Trench Backfill" below, shall consist of the following materials for each pipe material listed below.
 - a. Mortar coated pipe, concrete pipe, and uncoated ductile iron pipe shall be provided with Type C material in the pipe zone.
 - b. Coal tar enamel coated pipe, polyethylene encased pipe, tape wrapped pipe, and other nonmortar coated pipe shall be backfilled with Type C material in the pipe zone.
 - c. Plastic pipe and vitrified clay pipe shall be backfilled with Type C material in the pipe zone.
 - d. Where pipelines are installed on grades exceeding 4 percent, and where backfill materials are graded such that there is less than 10 percent passing a No. 4 sieve, trench plugs of Type J or N material shall be provided at maximum intervals of 200 feet unless indicated otherwise.
 - e. Type O material shall be used in the pipe zone where shown on plans, specified, or required by the Engineer for special crossings or other locations, or where otherwise approved.
 - f. Type E material will not be allowed for backfill within the pipe zone.

3. Trench zone backfill for pipelines as defined under "Pipe and Utility Trench Backfill" shall be Type D backfill material.
4. Final backfill material for pipelines under paved areas, as defined under "Pipe and Utility Trench Backfill" shall be Type G backfill material. Final backfill under areas not paved shall be the same material as that used for trench backfill.
5. Trench backfill and final backfill for pipelines under structures shall be Type A or B, except where concrete encasement is required by the Contract Documents.
6. Aggregate base materials under pavements shall be Type G material constructed to the thicknesses indicated. Aggregate subbase shall be Type M material.
7. Backfill around structures shall be Type P material, or Types A through Type F materials, or any mixture thereof, except as shown.
8. Backfill materials beneath structures shall be as follows:
 - a. Drainrock materials under hydraulic structures or other water retaining structures with underdrain systems shall be Type H material.
 - b. Under concrete hydraulic structures or other water retaining structures without underdrain systems, Types F, G or H materials shall be used.
 - c. Under structures where groundwater must be removed to allow placement of concrete, Type F material shall be used. Before the Type F material is placed, filter type geotextile fabric shall be placed over the exposed foundation.
 - d. Under all other structures, Type F, G or H material shall be used.
9. Backfill used to replace pipeline trench overexcavation shall be a layer of Type F material with a 6-inch top filter layer of Type E material or filter fabric to prevent migration of fines for wet trench conditions or the same material as used for the pipe zone backfill if the trench conditions are not wet.
10. Backfill used to replace overexcavation beneath structures shall be Type G.

2.4 PIPELINE MARKING TAPE

- A. **Metallic Tape:** Tape shall be minimum 5.5 mils thick aluminum foil imprinted on one side, encased in high visibility inert polyethylene jacket. Tape shall be a minimum of 6 inches wide. Imprinted lettering shall be 1 inch tall, permanent black, as indicated. Joining clips shall be manufacturer's standard tin or nickel coated. Tape shall be as manufactured by Reef Industries (Terra "D"), Allen (Detectatape), or equal.
- B. **Plastic Tape:** Tape shall be minimum 4-mil thick polyethylene which is impervious to alkalais acids, and chemicals and solvents which are likely in the soil. Tape shall be a minimum of 6 inches wide and lettering shall be 1-inch tall permanent black on a colored background. Tape shall be manufactured by Reef Industries (Terra Tape), Allen (Markline), or equal.
- C. **Warning Tape:** Warning tape manufactured for marking and identifying underground utilities continuously inscribed with a description of utility, colored as follows:
 1. Red; Electric.
 2. Yellow; Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water Systems.
 5. Green: Sewer Systems.

2.5 MATERIALS TESTING

- A. All soils testing of samples submitted by the Contractor will be done by a testing laboratory approved by the Owner at Contractor's expense. At its discretion, the Engineer may request that the Contractor supply samples for testing of any material used in the work.
- B. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Method for Particle-Size Analysis of Soils.
- C. Determination of sand equivalent value will be performed using ASTM D 2419 - Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
- D. Unified Soil Classification System: References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487. The Contractor shall be bound by all applicable provisions of said ASTM D 2487 in the interpretation of soil classifications.
- E. The testing for chloride, sulfate, resistivity, and pH will be done by a testing laboratory of the approved by the Owner at the Contractor's expense.

PART 3 - EXECUTION

3.1 EXCAVATION – GENERAL

- A. General: Except when specifically provided to the contrary, excavation shall include the removal of all materials of whatever nature encountered, including rock and all obstructions of any nature that would interfere with the proper execution and completion of the Work. The removal of said materials shall conform to the lines and grades indicated or ordered. Unless otherwise indicated, the entire construction site shall be stripped of all vegetation and debris, and such material shall be removed from the site prior to performing any excavation or placing any fill. Furnish, place, and maintain all supports and shoring that may be required for the sides of the excavations. Excavations shall be sloped or otherwise supported in a safe manner in accordance with safety requirements of the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).
- B. Maximum Length of Open Trench: The maximum length of open trench in urban and rural areas shall not exceed 500-feet at each pipe installation heading beyond the end of the installed pipeline, or the requirements of the agency with jurisdiction, whichever is lesser.
- C. Construction Delays: In the case of any construction delay in excess of five calendar days, whether Contractor or Owner caused, the Contractor shall backfill the excavation, install temporary paving including temporary traffic markings, and restore traffic to pre-construction condition to minimize disruption to traffic and the community at no additional cost to the Owner.
- D. Removal and Exclusion of Water: Remove and exclude water, including storm water, groundwater, irrigation water, and wastewater, from all excavations. Dewatering wells, well points, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least 2 feet below the bottom of excavations before the

excavation work begins at each location. Water shall be removed and excluded until backfilling is complete and all field soils testing has been completed.

3.2 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION

- A. Excavation Beneath Structures and Embankments: Except where otherwise indicated for a particular structure or ordered by the Engineer, excavation shall be carried to the grade of the bottom of the footing or slab. Where indicated or ordered, areas beneath structures or fills shall be overexcavated. The subgrade areas beneath embankments shall be excavated to remove not less than the top 6 inches of native material and where such subgrade is sloped, the native material shall be benched. When such overexcavation is indicated, both overexcavation and subsequent backfill to the required grade shall be performed. When such overexcavation is not indicated but is ordered by the Engineer, such overexcavation and any resulting backfill will be paid for under a separate unit price bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price. After the required excavation or overexcavation has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.
- B. Excavation Beneath Concrete Reservoirs: Excavation under reservoirs shall extend to the subgrade elevations shown in the Drawings. After such excavation has been completed, the exposed surface shall be rolled with heavy compaction equipment to 95 percent of maximum density and then graded to provide a reasonably smooth surface for placement of the structural fill. Areas under the reservoir upon which fill is to be placed shall be scarified to a depth of 6 inches, brought to optimum moisture content, and compacted to obtain 95 percent of maximum density with moisture content within plus and minus 2 percent of the optimum moisture content.
- C. Excavation Beneath Paved Areas: Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the bottom of the paving thickness. After the required excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.
- D. Notification of Engineer: Notify the Engineer at least 3 days in advance of completion of any structure excavation and allow the Engineer a review period of at least 1 day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

3.3 PIPELINE AND UTILITY TRENCH EXCAVATION

- A. General: Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with widths as indicated.

- B. Trench Bottom: Except when pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe zone. Excavations for pipe bells and welding shall be made as required.
- C. Open Trench: The maximum amount of open trench permitted in any one location shall be 500 feet, or the length necessary to accommodate the amount of pipe installed in a single day, whichever is greater. All trenches shall be fully backfilled at the end of each day or, in lieu thereof, shall be protected in accordance with Section 01 71 50 – Protection of Existing Facilities. The Contractor shall provide temporary 6-foot chain link fencing panels for protection of all open excavations and trenches within public streets, residential areas, and all other locations with the exception of unimproved open areas where excavations and/or pipeline trenches that can be safely sloped in accordance with current OSHA standards to provide safe access without the use of shoring devices. Temporary fencing panels shall fully enclose open excavations and trenches, and shall remain in place during all non-working hours.
- D. Trench Overexcavation: Where trenches are indicated to be overexcavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade of the bottom of the pipe bedding.
- E. Overexcavation: When ordered by the Engineer, whether indicated on the Drawings or not, trenches shall be overexcavated beyond the depth and/or width shown. Such overexcavation shall be to the dimensions ordered. The trench shall then be backfilled to the grade of the bottom of the pipe bedding. Overexcavation less than 6 inches below the limits on the Drawings shall be done at no increase in cost to the Owner. When the overexcavation ordered by the Engineer is 6 inches or greater below the limits shown, or wider, additional payment will be made. Said additional payment will be made under separate unit price bid items for overexcavation if such bid items have been established; otherwise payment will be made in accordance with a negotiated price.
- F. Where pipelines are to be installed in embankments, fills, or structure backfills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.
- G. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield so that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls. If the trench walls cave in or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.

3.4 OVEREXCAVATION NOT ORDERED OR INDICATED

- A. Any overexcavation carried below the grade ordered or indicated, shall be backfilled to the required grade with the indicated material and compaction. Such work shall be performed at no additional cost to the Owner.

3.5 EXCAVATION IN LAWN AREAS

- A. Where excavation occurs in lawn areas, the sod shall be carefully removed, dampened, and stockpiled to preserve it for replacement. Excavated material may be placed on the lawn;

provided, that a drop cloth or other suitable method is employed to protect the lawn from damage. The lawn shall not remain covered for more than 72 hours. Immediately after completion of backfilling and testing of the pipeline, the sod shall be replaced and lightly rolled in a manner so as to restore the lawn as near as possible to its original condition. Provide new sod if stockpiled sod has not been replaced within 72 hours.

3.6 EXCAVATION IN VICINITY OF TREES

- A. Except where trees are indicated to be removed, trees shall be protected from injury during construction operations. No tree roots over 2 inches in diameter shall be cut without express permission of the Engineer. Trees shall be supported during excavation by any means previously reviewed by the Engineer.

3.7 BACKFILL – GENERAL

- A. Backfill shall not be dropped directly upon any structure or pipe. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed. Backfill around water retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed. Structures shall not be constructed on CLSM backfill until the CLSM has obtained a 7-day minimum cure.
- B. Except for drainrock materials being placed in overexcavated areas or trenches, backfill shall be placed after all water is removed from the excavation, and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.
- C. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally. Do not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.
- D. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have all loose sloughing, or caving soil and rock materials removed. All materials disturbed from their intact condition that are 4 inches or larger in least dimension or aggregates of soil material thicker than 4 inches shall be removed from the excavation walls and base prior to placing pipe or any backfill material. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

3.8 PLACING AND SPREADING OF BACKFILL MATERIALS

- A. Backfill materials shall be placed and spread evenly in layers. When compaction is achieved using mechanical equipment, the layers shall be evenly spread so that the depth of each uncompacted layer shall not exceed 8 inches of compacted thickness.
- B. During spreading, each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer. Pipe zone backfill materials shall be manually spread around the pipe so that when compacted the pipe zone backfill will provide uniform bearing and side support.

- C. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.
- D. Where the backfill material moisture content is too high to permit the indicated degree of compaction the material shall be dried or mixed with drier material until the moisture content is satisfactory.

3.9 COMPACTION OF EARTH FILL, BACKFILL, AND EMBANKMENT MATERIALS

- A. Each layer of Types A, B, C, G, H, I, K, M, and P backfill materials as defined herein, where the material is graded such that at least 10 percent passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content.
- B. Each layer of Type E and J backfill materials shall be compacted by means of at least 2 passes from a flat plate vibratory compactor. When such materials are used for pipe zone backfill, vibratory compaction shall be used at the top of the pipe zone or at vertical intervals of 24 inches, whichever is the least distance from the subgrade.
- C. Fill on reservoir and structure roofs shall be deposited at least 30 days after the concrete roof slab has been placed. Equipment weighing more than 10,000 pounds when loaded shall not be used on a roof. A roller weighing not more than 8,000 pounds shall be used to compact fill on a roof.
- D. Pipe zone backfill materials that are granular, shall be compacted by using vibratory compactors.
- E. Equipment weighing more than 10,000 pounds shall not be used closer to structure walls than a horizontal distance equal to the depth of the fill at that time. Hand operated power compaction equipment shall be used where use of heavier equipment is impractical or restricted due to weight limitations.
- F. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand operated, vibratory compactors and rollers. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.
- G. **Compaction Requirements:** The following compaction test requirements shall be in accordance with ASTM D 1557, method C. Compaction shall be obtained with the moisture content within plus or minus 2 percent of the optimum moisture content. Where agency or utility company requirements govern, the highest compaction standards shall apply.

Location or Use of Fill	Percentage of Maximum Density
Pipe embedment backfill for flexible pipe	90

Pipe bedding and overexcavated zones under bedding for flexible pipe, including trench plugs	90
Pipe embedment backfill for steel yard piping	---
Pipe embedment backfill for rigid pipe	90
Pipe zone backfill portion above embedment for rigid pipe	90
Pipe bedding and overexcavated zones under bedding for rigid pipe	90
Final backfill, beneath paved areas or structures	95
Final backfill, not beneath paved areas or structures	85
Trench zone backfill, beneath paved areas and structures, including trench plugs	95
Trench zone backfill, not beneath paved areas or structures, including trench plugs	90
Embankments and fills	90
Embankments and fills beneath paved areas or structures	95

Backfill beneath structures and hydraulic structures	95
Backfill and fill around structures on reservoir or structure roof	90
Topsoil (Type K material)	80
Aggregate base or subbase (Type G or M material)	95

3.10 PLACEMENT OF CLSM

- A. Following placement and anchoring of the pipe, remove all loose soil from trench walls and floor. Remove any unstable soil at the top of the trench, which might fall into the trench during placement of the CLSM.
- B. Deliver the CLSM to the trench in ready mix trucks and utilize pump or chutes to place the CLSM in the trench. Direct CLSM to one side of the pipe, taking care not to displace the pipe at any time. Continue placing CLSM on one side of the pipe until CLSM has gone under the pipe and up the other side to a depth of 1.5 feet above the pipe bottom. Use at least two hand-held vibrators to continuously liquefy and move CLSM into all voids. Adjust water in mixture to maintain fluid consistency but maintain strength requirements. Continue placing CLSM on both sides of the pipe continuously using two vibrators for every 30 feet of pipe run.
- C. Maintain stability of pipe throughout CLSM placement. CLSM will likely require placement in lifts to prevent pipe flotation. No movement of the pipe caused by flotation will be allowed. If any movement occurs, the CLSM material shall be removed and the pipe placed back on line and grade. Any damage to the pipeline system caused by movement of the pipe shall be removed and/or repaired in full conformance with these Contract Documents at no additional cost to the Owner. Remove all sloughed material or other debris from top of previously placed CLSM.

3.11 PIPE AND UTILITY TRENCH BACKFILL

- A. Pipe Zone
 1. The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane 6 inches below the bottom surface of the pipe and a plane at a point 12 inches above the top surface of the pipe. The bedding is defined as that portion of pipe zone backfill material between the bottom of the trench and the bottom of the pipe. The embedment is defined as that portion of the pipe zone material between the bedding and a plane at a point 6 inches above the top surface of the pipe.

2. After compacting the bedding, perform a final trim using a string line for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe. Excavation for pipe bells and welding shall be made as required.
 3. The pipe zone shall be backfilled with the indicated backfill material. Exercise care to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.
 4. If a moveable trench shield is used during backfill operations the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer. Do not displace the pipe or backfill while the shield is being moved.
- B. Trench Zone: After the pipe zone backfills have been placed, backfilling of the trench zone may proceed. The trench zone is defined as that portion of the vertical trench cross-section lying between a plane 12 inches above the top surface of the pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.
- C. Marking Tape Installation
1. Continuously install metallic marking tape along the pipe at a depth of 3 feet below finish grade.
 2. Continuously install plastic marking tape along the pipe at the elevation indicated on the Drawings.
- D. Final Backfill: Final backfill is all backfill in the trench cross-sectional area within 18 inches of finished grade, or if the trench is under pavement, all backfill within 18 inches of the roadway subgrade.

3.12 FILL AND EMBANKMENT CONSTRUCTION

- A. The area where a fill or embankment is to be constructed shall be cleared of all vegetation, roots and foreign material. Following this, the surface shall be scarified to a depth of 6 inches, moisture conditioned, and rolled or otherwise mechanically compacted. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers. Each layer shall be moistened or aerated, as necessary. Unless otherwise approved by the Engineer, the depth of each uncompacted layer shall not exceed 8 inches of compacted thickness. The embankment, fill, and the scarified layer of underlying ground shall be compacted to 95 percent of maximum density under structures and paved areas, and 90 percent of maximum density elsewhere.
- B. When an embankment or fill is to be made and compacted against hillsides or fill slopes steeper than 5H:1V, the slopes of hillsides or fills shall be horizontally benched to key the embankment or fill to the underlying ground. A minimum of 12 inches normal to the slope of the hillside or fill shall be removed and recompacted as the embankment or fill is brought up in layers. Material thus cut shall be recompacted along with the new material at no additional cost to the Owner. Hillside or fill slopes 5H:1V or flatter shall be prepared in accordance with Paragraph A, above.

- C. Where embankment or structure fills are constructed over pipelines, the first 4 feet of fill over the pipe shall be constructed using light placement and compaction equipment that does not damage the pipe.
- D. The finish graded surface of the drainrock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs.

3.13 FIELD TESTING

- A. General: All field soils testing will be done by a testing laboratory approved by the Owner at the Contractor's expense.
- B. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557. Field density in-place tests will be performed in accordance with ASTM D 1556 or by such other means acceptable to the Engineer.
- C. In case the test of the fill or backfill show noncompliance with the required density, perform remedies as may be required to ensure compliance. Subsequent testing to show compliance shall be by a testing laboratory approved by the Owner, paid by the Contractor, at no additional cost to the Owner.
- D. Provide test trenches and excavations including excavation, trench support, and groundwater removal for required field soils testing operations. The trenches and excavations shall be provided at the locations and to the depths required by the Owner. All Work for test trenches and excavations shall be provided at no additional cost to the Owner.
- E. Frequency of Testing
 - 1. Backfill around structures and in embankments shall be tested every 300 square ft of each lift of placement.
 - 2. CLSM shall be tested each batch being placed or every 300 cubic yards that is placed.
 - 3. Pipe backfill shall have one test every 80 feet (2 joints) of backfill placed.

END OF SECTION

**SECTION 31 23 19
DEWATERING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes construction dewatering.

1.3 PERFORMANCE REQUIREMENTS

- A. The Contractor shall provide all labor, materials, and equipment necessary to dewater site excavations, in accordance with the requirement of the Contract Documents.
- B. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
 - 1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
 - 4. Remove dewatering system if no longer needed.
- C. To complete this Work, the Contractor shall secure a Utah Pollution Elimination Discharge System (UPDES) General Permit for Construction Dewatering and Hydrostatic Testing prior to commencing any dewatering work.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

1.5 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
 2. The geotechnical report is included elsewhere in the Project Manual.
- C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
- B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.
- C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
- D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
 1. Maintain free water level below bottom of excavation during construction.
- E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.
 1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.
- G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION

DIVISION 32
EXTERIOR IMPROVEMENTS

**SECTION 32 90 01
LANDSCAPE**

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide landscaping and appurtenant work, complete and in place, in accordance with the Contract Documents.
- B. Landscaping as referred to herein shall include supplying and placing topsoil, soil preparation, installation of headers, weed control, finish grading, furnishing and installing plant materials, seeding, erosion control, cleanup, and maintenance guarantee.

1.2 DEFINITIONS

- A. The terms "plant material" or "plants" refer to all vegetation, including but not limited to seed and seeded areas, etc.
- B. "Quality" refers to general development without consideration of size or condition. "Standard quality" indicates the least acceptable quality. "Standard quality" seeded and germinated plants shall be typical of the species and variety of good average uniform growth, shall be well formed.
- C. "Condition" is the factor controlled by vitality and ability to survive and thrive and be comparable with normal plants of the same species and variety in the vicinity at the same season of the year. Plants shall be free from physical damage or adverse conditions that would prevent thriving. "Condition" also sometimes refers to state of growth, i.e., whether "dormant condition" or "growing condition" and this state shall be comparable to plants of similar species in the vicinity for leaves, formation of buds, and the like.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Commercial Standards:

ASTM D 422 Method for Particle-Size Analysis of Soils

ANSI Z60.1 Nursery Stock

American Association of Rules and Grading Provisions Nurserymen, Inc.

1.4 CONTRACTOR SUBMITTALS

- A. General: Submittals shall be furnished in accordance with Section 01 33 20 - Contractor Submittals.
- B. Product Information
 - 1. Manufacturer's product information on slow release fertilizer, fertilizer tablets, seed, and erosion control materials.

2. **Topsoil Analysis Report:** A report certified by an analytical laboratory which shows results of analyzing representative samples of topsoil proposed for use. Approval of the report does not constitute final acceptance of the topsoil.
 3. Supplier's information and testing information on compost for soil amendment.
- C. Certificate
1. Certificates shall accompany each product delivery stating source, quantity, and type of material. All certificates shall be submitted to the Landscape Architect at the time of delivery.
 2. Certificates of inspection of plant material, as may be required by Federal, State, or other authorities having jurisdiction, which accompany the shipment, shall be submitted to the Landscape Architect at the time of delivery.
 3. Landscaping Subcontractor guarantee to perform seed maintenance and weeding services during the one-year correction of defects period.

1.5 QUALITY ASSURANCE

- A. General: All plants shall be true to type or name as indicated in the Contract Documents and shall be tagged in accordance with the standard practice recommended by the Agricultural Code of the State of Washington however, determination of plant species or variety will be made by the Landscape Architect.
- B. All plants shall comply with Federal and Washington State laws requiring inspection for plant diseases and infestations.
- C. The Contractor shall obtain clearance from the County Agricultural Commissioner, as required by law, before planting plants delivered from outside the County in which they are to be planted. Evidence that such clearance has been obtained shall be filed with the Engineer or Landscape Architect.
- D. Inspections will be made by the Engineer or Landscape Architect. The Contractor shall request inspection at least 24 hours in advance of the time inspection is required. Inspection is required on the following stages of the Work:
1. During preliminary grading, soil preparation, and initial weeding.
 2. When approved, amended topsoil is placed.
 3. When finish grading has been completed.
 4. When seed is to be applied.
 5. Once seed application has been complete and erosion control is in place.
 6. When all Work except the maintenance period has been completed.
 7. Final inspection before acceptance of the project.

1.6 CLEANUP

- A. Upon completion of all planting operations, the portion of the Site used for a work or storage area by the Contractor shall be cleaned of all debris, superfluous materials, and equipment. All such materials and equipment shall be entirely removed from the Site in accordance with Section 01 70 10 – Project Closeout.
- B. All walks or pavement shall be swept or washed clean upon completion of the Work of this Section.

C. During the entire Contract period, plant containers that have been cut or removed from plant materials shall be removed from the site daily.

D. All fertilizer packaging shall be cleared from the site at the end of every day.

1.7 MAINTENANCE OF LANDSCAPING PLANTING PRIOR TO ACCEPTANCE OF PROJECT

A. General: The Contractor shall be responsible for protecting and maintaining all seeded areas until final acceptance of all Work under the Contract.

B. Protection: The Contractor shall provide adequate protection to all newly seeded areas including the installation of approved temporary fences to prevent trespassing and damage, as well as erosion control, until the end of the correction of defects period.

C. The Contractor shall replace any materials or equipment that its employees or Subcontractors have damaged.

D. Partial utilization of the project shall not relieve the Contractor of any of the requirements contained in the Contract Documents.

E. Seeded areas shall be maintained by weeding, fertilizing, spraying, and other operations necessary.

F. Maintenance shall include, in addition to the foregoing, cleaning, the repair of erosion, reseed bare areas, and all other necessary maintenance work. Sidewalks, retaining walls and paved areas shall be kept clean while seeding and maintenance are in progress.

1.8 FINAL INSPECTION AND GUARANTEE

A. Inspection of all seeded areas will be part of final inspection under the Contract.

B. Written notice requesting inspection shall be submitted to the Landscape Architect at least 10 days prior to the anticipated inspection date.

C. Final acceptance prior to start of the guarantee period of the Contract will be on written approval by the Engineer or Landscape Architect, on the satisfactory completion of all Work, including maintenance, but exclusive of the replacement of plant material or reseed areas that have less than 60% coverage.

D. Any delay in the completion of any item of work in the planting operation which extends the seeding into more than one season shall extend the correction period in accordance with the date of completion given above.

E. The Contractor shall reseed, as soon as weather conditions permit, all bare areas or areas that show less than 60% seed germination which are noted at the end of the one-year correction period.

F. All Work under this Section shall be left in good order to the satisfaction of the Owner and the Landscape Architect, and the Contractor shall, without additional expense to the Owner.

1.9 MAINTENANCE AND GUARANTEE FOLLOWING ACCEPTANCE OF PROJECT

- A. General: The Contractor shall be responsible for a period of one year after date of acceptance of the Work of this Section, for maintaining all seeded areas, including fertilizing, controlling insects and diseases and weeding. The Contractor shall obtain a written guarantee from the landscaping Subcontractor embodying the provisions of this paragraph.
- B. The Work covered by the maintenance and guarantee portions of this paragraph includes providing all reseeding of seeding areas for the one year maintenance period or for 2 full growing seasons if the maintenance periods starts in the fall or winter, labor, materials, chemicals, equipment, and supplies and in performing all operations in connection with maintenance and guarantees.
- C. The Contractor shall clean-up and remove unused or waste materials from the Site and leave the area in a neat condition satisfactory to the Owner whenever it performs work during the maintenance period.
- D. Final Inspection: The Owner and Contractor shall make a final inspection at the end of the one-year maintenance and correction period. Any bare seed areas or less than 60% coverage at time of final inspection shall be reseeded within a time agreed upon by both parties. If it is outside of the seeding window for seeding, seeding shall take place within the next seeding window even though reseeding may run beyond the maintenance and correction period.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All landscaping materials including but not limited to, soil amendments, fertilizer, herbicides, pesticides, seed mixtures and erosion control materials shall be first-grade, commercial quality and shall have certificates indicating the source of material, analysis, quantity, or weight attached to each sack or container or furnished with each delivery. Delivery certificates shall be given to the Landscape Architect as each shipment of material is delivered. A list of the materials used, together with typical certificates of each material, shall be submitted to the Landscape Architect prior to final acceptance.

2.2 TOPSOIL

- A. Imported topsoil shall be obtained from naturally drained areas and shall be fertile, friable loam suitable for plant growth. Topsoil shall be subject to inspection and approval by the Landscape Architect at the source of supply and upon delivery to the site. All laboratory soil testing shall be ordered and paid by the Contractor.
- B. Onsite or imported topsoil shall be of uniform quality, free from toxic substances, subsoil, stiff or lumpy clay, hard clods, hardpan, rocks, disintegrated debris, plants, roots, seeds, and any other materials that would be toxic or harmful to plant growth. **Topsoil shall contain no noxious weeds or noxious weed seeds.**
- C. Topsoil used for this Work shall meet the composition and hydraulic conductivity standards requirements determined by the Stormwater Management Manual for Western Washington.

2.3 FERTILIZER AND AMENDMENTS

- A. Fertilizer shall be furnished in bags or other standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon.
- B. Chemical fertilizers shall be a mixed commercial fertilizer with percentages of nitrogen, phosphoric acid, and potash at 16-16-8 slow release formula. Fertilizers shall be uniform in composition, dry, and free flowing.
- C. Fertilizer tablets shall be 12 grams each 20-10-5 "Agriform," "Lesslie", or equal.
- D. Compost: Onsite topsoil shall be amended with compost per the Stormwater Management Manual for Western Washington. Compost shall consist of composed leaves and yard grass. Compost shall meet the following requirements:
 - 1. Compost shall be dark brown to black in color,
 - 2. Compost shall have no objectionable odor,
 - 3. Compost shall have a particle size of ½ inch or less,
 - 4. Compost shall have a pH of 5.0 to 7.8,
 - 5. Compost shall have a soluble salt concentration (mmhos/cm or dS/m) of less than 5 and
 - 6. Compost shall have a carbon-to-nitrogen ration of less than 25:1.

2.4 SEED

- A. Seed shall conform with applicable City, County, State, Federal regulations and meet Washington Seed Law. Seed shall be mixed by dealer. The Contractor shall furnish dealer's guaranteed germination figure for each variety. Grass seed shall not be delivered until samples have been approved in writing by the Engineer, Landscape Architect or its authorized landscape representative. Approval of samples, however, shall not affect the right of the Engineer, Landscape Architect or the authorized landscape representative to reject seed upon or after delivery. Seed that has become wet, moldy, or otherwise damaged prior to use will not be accepted.
- B. Seed shall be fresh, clean, new-crop seed, composed of the following varieties mixed in the proportions by weight. Purity and germination percentage shall be the results of testing.
- C. Weather Conditions: Fertilizing, seeding, or mulching operations will not be permitted when wind velocities exceed 5 miles per hour or when the ground is frozen, unduly wet, or otherwise not in a tillable conditions. Seeding shall not be conducted when temperatures exceed 75°F.
- D. Topsoil: 6.25 inches of approved, onsite or imported, amended topsoil shall be placed in all areas delineated to be seeded. Imported, amended topsoil shall be placed and raked smooth prior to seeding. Topsoil shall be amended with 1.75 inches of composted material.
- E. Soil Preparation: The ground to be seeded shall be graded in conformance with the Drawings and shall be loose and reasonably free of large rocks, roots, and other material which will interfere with the work. The site shall be rough and scraped with the teeth of a track hoe bucket, hand rake, or similar.

- F. Supply seed on a pure live seed (PLS) basis.
- G. Obtain seed from lots that have been tested by a state certified seed testing laboratory. (Association of Seed Analyst (AOSA) or Society of Commercial Seed Technologists (SCST)). Seed germination tests older than 18 months for seed are not acceptable.
- H. Do not use wet, moldy or otherwise damaged seed.
- I. See the end of this specification for seed mix(s).
- J. In disturbed areas, complete all weed removal, final grading, trench settling, surface preparation and irrigation work (if applicable) before seeding begins.
- K. Roughen soil receiving seed.
- L. Do not install when seed or soil is saturated or frozen.
- M. MAINTENANCE
 - 1. During the maintenance period the contractor shall be responsible for removing weeds and maintaining the site to provide as good of conditions as possible for seed to grow.
 - 2. Contractor shall plan on one re-seeding if the upland and wetland seed has not established to a minimum of 60% coverage at the end of the warranty period.

2.5 BROADCAST SEED

- A. Broadcast seed is not allowed. Only hydroseeding is allowed.

2.6 HYDROSEEDING

- A. Hydroseeding shall only be used in CAVFS areas.
- B. Hydroseeding of the native seed mix may occur between September 15 to November 15. Fall seeding is preferred. The actual seeding period must be approved by the Engineer or Landscape Architect because weather conditions vary from year to year. No seed shall be conducted until approved.
- C. Hydromulch or slurry shall conform to the following:
 - 1. Echofiber or Conwed or approved equal wood fiber mulch, applied at a rate of 2000 pounds per acre.
 - 2. M-binder or Plantego tackifier, applied at a rate of 100 pounds per acre.
 - 3. 16-16-8 slow release fertilizer, applied at a rate of 150 pounds per acre
 - 4. Water at a rate of 4000 gallons per acre.
- D. Hydromulch shall be applied using a hydro-seeding equipment manufactured by Finn or Bowie or approved equal. Machines shall be equipped with heavy duty cast iron pumps and agitators capable of thoroughly mixing the slurry.
- E. Spray of hydromulch shall begin immediately after the tank is full and the slurry components are mixed.

- F. Apply hydromulch in a downward drilling motion using a fan stream nozzle. It is important to ensure that all of the components enter and mix with the topsoil.
- G. Only qualified and trained personnel shall perform hydroseeding to insure the uniformity of the hydroseeding application.
- H. Tracer to allow for visual application and coverage verification.

2.7 EROSION CONTROL BLANKET

- A. Erosion Control Blanket shall be AEC Premier Coconut or approved equivalent and placed on slopes 3:1 or greater.
- B. Erosion control blanket shall be keyed in at the top of the slope as per manufacturer specifications.
- C. Anchorage devices shall be 9-inch, two-legged staples furnished by the manufacturer, or staples of the proper length as recommended by the manufacturer for specific soil conditions.

PART 3 - EXECUTION

3.1 GENERAL

- A. The landscape work shall not be performed at any time when it may be subject to damage by climatic conditions.
- B. The Contractor shall carefully scale or otherwise verify all dimensions in the Contract Documents. Dimensions and plant locations shall be coordinated with Engineer or Landscape Architect and final location shall be Site-oriented by the planter and Engineer or Landscape Architect. Any discrepancies or inconsistencies shall be brought to the attention of the Engineer.
- C. In case of conflict between the Plant List totals and total plant count of the Contract Documents, the Contractor shall provide the higher number of plants.
- D. Delivery of materials may begin only after samples and tests have been approved by the Engineer or Landscape Architect. Materials provided shall be not less quality than the approved sample.
- E. Substitutions for the indicated plant materials may be considered pursuant to the Contract Documents.
- F. The Contractor shall provide temporary fencing, barricades, covering, or other protections to preserve existing landscaping items indicated to remain and to protect the adjacent properties and other structures when they may be damaged by the landscape work.
- G. Waste materials shall be removed and disposed of off the Site, unless otherwise indicated.

- H. It shall be the responsibility of the Contractor to obtain information regarding utilities in the area of work and to prevent damage to the same. The Contractor shall protect the utilities as necessary.
- I. Burning of combustible materials on the Site shall not be permitted.
- J. The Contractor shall protect structures, sidewalks, pavements, existing irrigation system, and other facilities that are subject to damage during landscape work. Open excavations shall be provided with barricades and warning lights which conform to the requirements of governing authorities and the State's OSHA safety requirements from dusk to dawn each day and when needed for safety.
- K. Planting areas include all areas to be landscaped unless indicated otherwise.

3.2 SOIL PREPARATION

- A. The landscape work shall not begin until all other trades have repaired all areas of settlement, erosion, rutting, etc., and the soils have been re-established, recompact, and refinished to finish grades. The Engineer or Landscape Architect shall be notified of all areas that prevent the landscape work from being executed.
- B. Areas requiring grading by the landscaper including adjacent transition areas shall be uniformly level or sloping between finish elevations to within 0.10-ft above or below required finish elevations.
- C. The landscape work shall not proceed until after walks, roads, vaults, trenching, and reservoir construction is in place. Work under the Contract shall be completed to a point where the landscape areas will not be disturbed. The subgrade shall be free of waste materials of all kinds.
- D. During grading, waste materials in the planting areas such as weeds, rocks 3-inches and larger, building materials, concrete rubble, wires, cans, glass, lumber, masonry, sticks, etc., shall be removed from the Site. All weeds shall be dug out by the roots.
- E. Fertilizers, soil additives, seed, etc. subject to moisture damage shall be kept dry in a weatherproof storage place.
- F. After removal of waste materials, the planting and sod area subgrade shall be scarified and pulverized to a depth of not less than 6 inches, and all surface irregularities below the cover of topsoil shall be removed.
- G. Finish grading shall consist of:
 - 1. Final contouring of the planting areas.
 - 2. Removal of 6 inches of hardpan material and placement of four inches of imported, amended topsoil over all areas to be planted, deeded or sodded unless indicated otherwise.
 - 3. Placing all soil additives and fertilizers.
 - 4. Tilling of planting areas.
 - 5. After tilling, bringing areas to uniform grades by floating and/or hand raking.

6. Making minor adjustment of finish grades as directed by the Engineer or Landscape Architect.
 7. Removing waste materials such as stones, roots, weeds or other undesirable foreign material and raking, disking, dragging, and smoothing soil ready for planting.
 8. Finished grades shall be one inch below the top of curbs, sills and walkways in all areas for seed, one and a half inches for sod and three inches for areas with mulch or groundcover.
 9. Finished grades shall be smoothed to eliminate large puddling or standing water but rough to keep seed in place.
- H. Any unusual subsoil condition that will require special treatment shall be reported to the Engineer or Landscape Architect.
- I. **Unless otherwise specified, seeding areas shall receive a minimum of 6.25 inches of topsoil amended with 1.75 inches of compost.**
- J. Surface drainage shall be provided as indicated by shaping the surfaces to facilitate the natural run-off of water. Low spots and pockets shall be filled with topsoil and graded to drain properly.
- K. Finish grade of all planting areas shall be 1-1/2 inches below finish grade of adjacent pavement of any kind.

3.3 SEED MIX, AS SHOWN ON C-05 IS ALSO PROVIDED BELOW:

- A. Application rate for seeding: 69.25 lbs/acre.

B. Seed Mix:

SEED NO.	SPECIES NAME		Number of Seeds per Pound (LBS)	SEED		
	BOTANICAL NAME	COMMON NAME		Pounds (LBS) of Pure Live Seed (PLS)/Acre	Percentage of Seed mixture	Number of Seeds (PLS/Sq. Foot)
	<i>Wetland Mix</i>					
1	<i>Bromus vulgaris</i>	Columbia Brome	108,000	8.00	17.96%	20
2	<i>Deschampsia cespitosa</i>	Tufted Hairgrass	2,000,000	0.25	10.39%	11
3	<i>Symphotrichum chilense</i>	Pacific Aster	2,668,000	1.00	55.44%	61
4	<i>Triticum aestivum x Secale cereale</i>	Triticale	13,000	60.00	16.21%	18
			TOTALS =	69.25	100.00%	110

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

DIVISION 33
UTILITIES

SECTION 33 01 10.13**PRESSURE AND LEAKAGE TESTS****PART 1: GENERAL****1.01 SCOPE OF WORK**

- A. Test all piping, valves, and appurtenances installed under this Contract. Testing shall be performed concurrent with installation. Do not install more than 1,000 feet of pipe without being tested, unless approved by AW.

1.02 SUBMITTALS

- A. Prepare and submit schedules and procedures to AW for testing of all parts of the water main installed in accordance with this Contract. Submit the schedule at least seven days prior to any testing.

PART 2: PRODUCTS**2.01 EQUIPMENT**

- A. Furnish the pump, pipe connections, and all necessary apparatus for the pressure and leakage tests including gauges and metering devices. AW reserves the option to furnish the gauges and metering devices for the tests. Excavate, backfill, and furnish all necessary assistance for conducting the tests.
- B. Pressure gauges used for testing shall have no greater than 5 psi increment markings or shall be as directed by the AW Project Manager for the satisfactory evaluation of the required testing.

PART 3 EXECUTION**3.01 GENERAL**

- A. Leakage Tests must be in accordance with ASTM C969 and C1244. Leakage test are required for all gravity lines. Perform hydrostatic pressure tests in accordance with AWWA C600, Section 5.2 - Hydrostatic Testing after the pipe or section of pipe has been laid, thrust blocking cured (min. 5 days), and the trench is completely or partially backfilled. Where practical, testing shall be performed fully isolated from the active distribution system.
- B. Contractor may, at his option, completely backfill the trench or partially backfill the trench over the center portion of each pipe section to be tested. However, AW may direct the Contractor to completely backfill the trench if local traffic or safety conditions require.

- C. For system operating pressures of 200 psi or less, perform the hydrostatic test at a pressure of no less than 100 psi above the normal operating pressure without exceeding the rating of the pipe and appurtenances. For system operating pressures in excess of 200 psi, perform the hydrostatic test at a pressure that is 1.5 times the normal operating pressure, but no more than the design rating of the pipe and appurtenances.
- D. Valves shall not be operated in either direction at a differential pressure exceeding the rated valve working pressure. A test pressure greater than the rated valve working pressure can result in trapped test pressure between the gates of a double-disc gate valve. For tests exceeding the rated valve working pressure, the test setup should include a provision, independent of the valve, to reduce the line pressure to the rated valve working pressure on completion of the test. The valve can then be opened enough to equalize the trapped pressure with the line pressure, or the valve can be fully opened if desired.
- E. The test pressure shall not exceed the rated working pressure or differential pressure of the valves when the pressure boundary of the test section includes closed, resilient-seated gate valves or butterfly valves.
- F. Contractor shall attach a tapping sleeve and valve assembly to the main, and pressure test the assembly prior to making the tap. The required test pressure shall be determined in the same manner as for pipe. The test is acceptable if there is no pressure drop in 15 minutes at test pressure.

3.02 FILLING AND TESTING

- A. Slowly fill each segregated section of pipeline with water ensuring that all air is expelled. Extreme care must be taken to ensure that all air is expelled during the filling of pipe. The line shall stand full of water for at least twenty-four hours prior to testing to allow all air to escape. If necessary, tap the main at points of highest elevation to expel air as the pipe is filled. Remove the corporation stops and plug the taps after successfully filling the pipeline and expelling all air as approved by AW.
- B. Apply the specified test pressure, measured at the point of lowest elevation, using a suitable pump connected to the pipe in a manner satisfactory to the AW Project Manager. If the elevation of the high point of the pipeline being tested is such that the pressure during testing will be below 85% of the required test pressure, AW will require a separate test to be performed on this section of pipeline. In lieu of a separate test, the test pressure measured at the lowest elevation may be increased, within the pressure rating of the pipeline material, such that the resulting pressure at the highest point exceeds 85% of the required test pressure. The test will be conducted for at least two (2) hours at the required test pressure ± 5 psi.
- C. Conduct a leakage test concurrently with the pressure test. Leakage is defined as the volume of water that must be supplied into the newly laid pipeline to

maintain pressure within ± 5 psi of the test pressure after it is filled and purged of air. Measure the volume of water using a calibrated container or meter.

- D. No pipeline installation will be accepted by AW if the leakage is greater than that shown in the following table:

Allowable Leakage per 1000 ft. of Pipeline*—gph

Avg. Test Pressure <i>psi</i>	Nominal Pipe Diameter— <i>in.</i>													
	4	6	8	10	12	14	16	18	20	24	30	36	42	48
450	0.57	0.86	1.15	1.43	1.72	2.01	2.29	2.58	2.87	3.44	4.30	5.16	6.02	6.88
400	0.54	0.81	1.08	1.35	1.62	1.89	2.16	2.43	2.70	3.24	4.05	4.86	5.68	6.49
350	0.51	0.76	1.01	1.26	1.52	1.77	2.02	2.28	2.53	3.03	3.79	4.55	5.31	6.07
300	0.47	0.70	0.94	1.17	1.40	1.64	1.87	2.11	2.34	2.81	3.51	4.21	4.92	5.62
275	0.45	0.67	0.90	1.12	1.34	1.57	1.79	2.02	2.24	2.69	3.36	4.03	4.71	5.38
250	0.43	0.64	0.85	1.07	1.28	1.50	1.71	1.92	2.14	2.56	3.21	3.85	4.49	5.13
225	0.41	0.61	0.81	1.01	1.22	1.42	1.62	1.82	2.03	2.43	3.04	3.65	4.26	4.86
200	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72	1.91	2.29	2.87	3.44	4.01	4.59
175	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61	1.79	2.15	2.68	3.22	3.75	4.29
150	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99	2.48	2.98	3.48	3.97
125	0.30	0.45	0.60	0.76	0.91	1.06	1.21	1.36	1.51	1.81	2.27	2.72	3.17	3.63
100	0.27	0.41	0.54	0.68	0.81	0.95	1.08	1.22	1.35	1.62	2.03	2.43	2.84	3.24

*If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.

The table has been generated from the formula:
$$L = \frac{S * D \sqrt{P}}{148,000}$$

Where:

L is the allowable leakage in gallons per hour,
 S is the length of pipe in feet,
 D is the nominal pipe diameter in inches, and
 P is the average test pressure in psig.

- E. Should any test disclose damaged or defective materials or leakage greater than that permitted, the Contractor shall, at the Contractor's expense, locate and repair and/or replace the damaged or defective materials. Materials used for repair must be approved by AW and meet the relevant specifications. Repeat the tests until the leakage is within the permitted allowance and is satisfactory to AW.

END OF SECTION 33 01 10.13

SECTION 33 01 10.15**DISINFECTING PIPELINES****PART 1 GENERAL****1.01 SCOPE OF WORK**

- A. Flush and disinfect all pipelines installed under this Contract as indicated in the Drawings. This would include furnishing the necessary labor, tools, transportation, and other equipment for the operation of valves, hydrants, and blowoffs during chlorination. Install, and if directed by the AW Project Manager, remove all chlorination taps required for disinfection. Disinfection will be performed under the supervision of AW.

1.02 WORK BY AW

- A. AW reserves the option to provide/furnish the chlorine and chlorination equipment. AW will furnish water for testing, flushing and disinfecting pipelines. AW will also reserve the right to perform bacteriological testing and may collect the sample.

1.03 PROTECTION

- A. Chlorine disinfection and dechlorination shall be under the direct supervision of someone familiar with the physiological, chemical, and physical properties of the form of chlorine used. They shall be trained and equipped to handle any emergency that may arise. All personnel involved shall observe appropriate safety practices to protect working personnel and the public.
- B. The forwards of AWWA Standards B300 and B301 contain information and additional reference material regarding the safe handling of hypochlorites and liquid chlorine. The Contractor shall familiarize himself with this information prior to performing any disinfection work.

1.04 SUBMITTAL

- A. Conform to the requirements of Section – Submittal Procedures

1.05 RELATED WORK

- A. Observe the precautions described in Section – Piping – General Provisions to avoid contamination during installation of the pipeline.

1.06 REFERENCES

- A. Refer to current AWWA Standard C651 for Disinfecting Water Mains.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Furnish liquid chlorine and/or calcium hypochlorite and injection equipment as needed to disinfect all pipelines and appurtenances.
- B. Liquid chlorine contains 100% available chlorine and is packaged in steel containers, usually of 100 lb, 150 lb, or 1 ton net chlorine weight. Liquid chlorine shall be furnished in accordance with AWWA B301.
- C. Calcium hypochlorite is available in granular form or in approximately 5-g tablets, and contains approximately 65% available chlorine by weight. The material should be stored in a cool, dry, and dark environment to minimize its deterioration. Do not use calcium hypochlorite intended for swimming pool disinfection, as this material (containing trichloroisocyanuric acid) has been sequestered and is extremely difficult to eliminate from the pipe after the desired contact time had been achieved.
- D. Calcium hypochlorite must conform to AWWA B300.

PART 3 EXECUTION

3.01 PREPARATION

- A. All pipelines shall be pressure and leak tested, flushed, and cleaned of debris and dirt prior to application of the disinfectant. Flushing shall continue until the volume in the newly installed main has turned over at least one time unless AW determines that conditions do not permit the required volume to be safely discharged to waste.

3.02 APPLICATION OF DISINFECTANT

- A. Methods to be used for disinfection are those detailed in ANSI/AWWA C651 Disinfecting Water Mains.

3.03 WATER MAINS

Three methods of chlorination are described below. The third method, using tablets of hypochlorite, is only permitted by expressed approval of AW and under no circumstance allowed for projects of 2000 feet or more. Otherwise,

information in the forward of AWWA Standard C651 will be helpful in determining the best method to be used.

A. Continuous Feed Method

1. Set-up

- a. The continuous feed method consists of completely filling the main with potable water to remove all air pockets, flushing the completed main to remove particulates, and then refilling the main with potable water that has been chlorinated to 25mg/l. After a 24-hour holding period in the main, there shall be a free chlorine residual of not less than 10 mg/L in collected samples.
- b. Chlorine can be applied in advance of preliminary flushing by swabbing joints with bleach or placing calcium hypochlorite granules in the pipe in areas where contamination is suspected. In any such case, the Contractor shall make sure and take appropriate action to make sure that the flushed water is dechlorinated.
- c. Preliminary flushing - Prior to being chlorinated, fill the main to eliminate air pockets and flush to remove particulates. The flushing velocity in the main shall be not less than 3 ft/sec unless the AW Project Manager determines that conditions do not permit the required flow to be discharged to waste. Table 1 below shows the rates of flow required to produce a velocity of 3 ft/sec in pipes of various sizes.

NOTE: Flushing is no substitute for preventive measures during construction. Certain contaminants such as caked deposits resist flushing at any feasible velocity.

TABLE 1
Required Flow and Openings to Flush Pipelines
(40 psi Residual Pressure in Water Main)*

Pipe Diameter (inches)	Flow Required to Produce 3 ft/sec velocity in main (gpm)	Size of Tap, (inches)			Number of 2½-inch Hydrant Outlets to Use
		1	1-1/2	2	
		Number of taps on Pipe †			
4	120	1	-	-	1
6	260	-	1	-	1
8	470	-	2	-	1
10	730	-	3	2	1
12	1060	-	-	3	2
16	1880	-	-	5	2

*With a 40 psi pressure in the main with the hydrant flowing to atmosphere, a 2½-inch hydrant outlet will discharge approximately 1,000 gpm and a 4½-inch hydrant outlet will discharge approximately 2,500 gpm.

† Number of taps on pipe based on discharging through 5 feet of galvanized iron pipe with one 90° elbow.

- d. In mains of 24-inches or larger diameter, an acceptable alternative to flushing is to broom-sweep the main, carefully removing all sweepings prior to chlorinating the main.

OSHA requirements for confined space need to be addressed prior to entering a pipeline.

2. Chlorinating the Main

- a. Potable water may be supplied from a temporary backflow-protected connection to the existing distribution system or other supply approved sources. The cross connection control device shall be consistent with the degree of hazard for backflow protection of the active distribution system. The flow shall be at a constant, measured rate into the newly installed water main. In the absence of a meter, approximate the rate by placing a Pitot gauge in the discharge or measuring the time to fill a container of known volume. The main should undergo hydrostatic pressure testing prior to disinfection.
- b. At a point not more than 10 feet downstream from the beginning of the new main, dose the water entering the new main with chlorine fed at a constant

rate such that the water will have not less than 25 mg/L free chlorine. Measure the chlorine concentration at regular intervals to ensure that this concentration is provided. Measure chlorine in accordance with the procedures described in the current edition of the AWWA Manual M12 or of *Standard Methods for the Examination of Water and Wastewater*.

- c. Table 2 below gives the amount of chlorine required for each 100 feet of pipe of various diameters. Solutions of 1 percent chlorine may be prepared with calcium hypochlorite. The solution requires 1 pound of calcium hypochlorite in 8 gallons of water.

TABLE 2
Chlorine Required to produce 25 mg/L
Concentration in 100 feet of Pipe by Diameter

Pipe Diameter (inches)	100% Chlorine (lb)	1% Chlorine Solution (gallons)
4	0.013	0.16
6	0.030	0.36
8	0.054	0.65
10	0.085	1.02
12	0.120	1.44
16	0.217	2.60

- d. During the application of chlorine, position valves so that the strong chlorine solution in the main being treated will not flow into water mains in active service. Do not stop the chlorine application until the entire main is filled with heavily chlorinated water. Keep the chlorinated water in the main for at least 24 hours. During this time, operate all valves and hydrants in the section treated in order to disinfect the appurtenances. At the end of this 24-hour period, the treated water in all portions of the main shall have a residual of not less than 10 mg/L free chlorine.
- e. Hypochlorite solution may be applied to the water main with a gasoline or electrically powered chemical feed pump designed for feeding chlorine solutions. Feed lines shall be of such material and strength as to safely withstand the corrosion caused by the concentrated chlorine solutions and the maximum pressures that may be created by the pumps. Check all connections for tightness before the solution is applied to the main.
- f. If gaseous chlorine in solution is permitted by the AW Project Manager and proposed by the Contractor, the preferred equipment for the gas application employs a feed vacuum-operated chlorinator to mix the chlorine gas, in

combination with a booster pump for injecting the chlorine gas solution water into the main to be disinfected. Direct feed chlorinators cannot be used. (A direct feed chlorinator is one which operates solely from the pressure in the chlorine cylinder.)

B. Slug Method

1. Set-up

- a. The slug method consists of placing calcium hypochlorite granules in the main during construction; completely filling the main to eliminate all air pockets, flushing the main to remove particulates, and slowly flowing a slug of water containing 100 mg/L of free chlorine through the main so that all parts of the main and its appurtenances will be exposed to the highly chlorinated water for a period of not less than 3 hours.

2. Chlorinating the main.

- a. Potable water may be supplied from a temporary backflow-protected connection to the existing distribution system or other supply approved sources. The cross connection control device shall be consistent with the degree of hazard for backflow protection of the active distribution system. The flow shall be at a constant, measured rate into the newly installed water main. In the absence of a meter, approximate the rate by placing a Pitot gauge in the discharge or measuring the time to fill a container of known volume. The main should undergo hydrostatic pressure testing prior to disinfection.
- b. At a point not more than 10 feet downstream from the beginning of the new main, dose the water entering the new main with chlorine fed at a constant rate such that the water will have not less than 100 mg/L free chlorine. Measure the chlorine concentration at regular intervals to ensure that this concentration is provided. Measure chlorine in accordance with the procedures described in the current edition of the AWWA Manual M12 or of *Standard Methods for the Examination of Water and Wastewater*. The chlorine shall be applied continuously and for a sufficient period to develop a solid column or "slug" of chlorinated water that will, as it moves through the main, expose all interior surfaces to a concentration of approximately 100 mg/L for at least 3 hours.
- c. The free chlorine residual shall be measured in the slug as it moves through the main. If at any time it drops below 50 mg/L, stop the flow, relocate the chlorination equipment to the head of the slug, and as flow is resumed, apply chlorine to restore the free chlorine in the slug to not less than 100 mg/L.

- d. As the chlorinated water flows past fittings and valves, operate related valves and hydrants so as to disinfect appurtenances and pipe branches.

C. Tablet Method

1. Set-up

- a. The tablet method consists of adhering calcium hypochlorite tablets in the water main as it is being installed and then filling the main with potable water when installation is completed. This method may be used only if the pipes and appurtenances are kept clean and dry during construction and with permission by AW for short main installations.

2. Chlorinating the Main

- a. Placing of Calcium Hypochlorite Tablets -. During construction, 5-g calcium hypochlorite tablets shall be placed in each section of pipe. Also, one such tablet shall be placed in each hydrant, hydrant branch, and other appurtenance. The number of 5-g tablets required for each pipe section shall be $0.0012 d^2L$ rounded to the next higher integer, where d is the inside pipe diameter, in inches, and L is the length of the pipe section, in feet. Table 3 below shows the number of tablets required for commonly used sizes of pipe. The calcium hypochlorite tablets shall be attached by an adhesive meeting the NSF/ANSI 61 requirements. There shall be no adhesive on the tablet except on the broadside attached to the surface of the pipe and no adhesive applied or spilled on the pipe surface. Excess adhesive must be removed immediately using mechanical means or an NSF-approved adhesive solvent. Attach all the tablets inside and at the top of the main, with approximately equal numbers of tablets at each end of a given pipe length. If the tablets are attached before the pipe section is placed in the trench, their position shall be marked on the section so it can be readily determined that the pipe is installed with the tablets at the top.

TABLE 3
 Number of 5-g Calcium Hypochlorite Tablets required for dose of 25 mg/L *

	Length of Pipe Section, ft				
Pipe Diameter	13 or less	18	20	30	40
inches	Number of 5-g Calcium Hypochlorite Tablets				
4	1	1	1	1	1
6	1	1	1	2	2
8	1	2	2	3	4
10	2	3	3	4	5
12	3	4	4	6	7
16	4	6	7	10	13

* Based on 3.25g available chlorine per tablet.

- b. Filling and Contact - When installation has been completed, the main shall be filled with water at a rate such that water within the main will flow at a velocity no greater than 1 ft/sec. Precautions shall be taken to ensure that air pockets are eliminated. Fill rate must be carefully controlled to ensure tablets do not come loose from the pipe. This water shall remain in the pipe for at least 24 hours. If the water temperature is less than 41°F (5°C), the water shall remain in the pipe for at least 48 hours. A detectable free chlorine residual (≥ 0.2 mg/l) shall be found at each sampling point after the 24 or 48 hr period.

D. Spray Disinfection For Large Transmission Main

For very large transmission mains (where equipment and personnel may safely enter the main), spray disinfection may be appropriate and efficient means of achieving disinfection. For this method, refer to ANSI/AWWA C652, Sec. 4.3.2 (Disinfection of Water Storage Facilities; Chlorination Method 2.) In general, once the pipe is cleaned, spray a 200 mg/l free chlorine solution on all surfaces. After 30 min, fill line and sample as described in Sec 3.05.

3.04 DISPOSAL OF HEAVILY CHLORINATED WATER

- A. Do not keep heavily chlorinated water in contact with pipe for more than 48 hours after the applicable retention period. In order to prevent damage to the pipe lining or corrosion damage to the pipe itself, flush the heavily chlorinated water

from the main fittings, valves, and branches until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system or is acceptable for domestic use. Take all steps necessary to dechlorinate water where required per Paragraph 3.04B and 3.04C below. Contact the local sewer department to arrange for disposal of the heavily chlorinated water to the sanitary sewer if applicable or permissible.

- B. Neutralize the chlorine residual of the water being disposed of by treating with one of the chemicals listed in Table 4 below. Select an alternative disposal site if a sanitary sewer system is unavailable for disposal of the chlorinated water.
- C. The proposed alternative disposal site shall be inspected and approved by AW. Apply a reducing agent to the chlorinated water to be wasted to completely neutralize the chlorine residual remaining in the water. (See Table 4 for neutralizing chemicals. Do not overdose neutralizing chemicals as this may result in adverse environmental impacts. Only dose the amount required to neutralize the amount of chlorine present). Contact Federal, State and local regulatory agencies, where necessary, to determine special provisions for the disposal of heavily chlorinated water.

TABLE 4
Pounds of chemicals required to neutralize various
residual chlorine concentrations in 100,000 gallons of water

Residual Chlorine Concentration mg/L	Sulfur Dioxide (SO_2) lb	Sodium Bisulfite (NaHSO_3) lb	Sodium Sulfite (Na_2SO_3) lb	Sodium Thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$) lb	Ascorbic Acid ($\text{C}_6\text{O}_8\text{H}_6$) lb
1	0.8	1.2	1.4	1.2	2.1
2	1.7	2.5	2.9	2.4	4.2
10	8.3	12.5	14.6	12.0	20.9
50	41.7	62.6	73.0	60.0	104.0

- D. Test for chlorine residual throughout the disposal process to be sure that the chlorine is neutralized.
- E. Submit a plan of disposal of flushed water to AW for approval

3.05 BACTERIOLOGICAL TESTING

A. Standard conditions for new mains.

It should be recognized that the primary means of ensuring the sanitary integrity of a main are the sanitary handling of materials, the practices during construction, and continual inspection of work. After disinfection and final flushing such that typical system chlorine residuals are present, if the system operates with a residual, samples shall be collected as follows:

- a. For new mains, the purchaser has two options for the bacteriological testing for total coliform analysis.

Option A: Before approving a main for release, take an initial set of samples and then resample again after a minimum of 16 hr using the sampling site procedures outlined. Both sets of samples must pass for the main to be approved for release.

Option B: Before approving a main for release, let it sit for a minimum of 16 hr without any water use. Then collect, using the sampling site procedures outlined and without flushing the main, two sets of samples a minimum of 15 min apart while the sampling taps are left running. Both sets of samples must pass for the main to be approved for release.

A set of samples includes all samples collected along the length of the pipeline, as described below:

- i. For new mains, sets of samples shall be collected every 1,200 ft (370 m) of the new water main, plus one set from the end of the line and at least one from each branch greater than one pipe length.
- ii. If trench water has entered the new main during construction or if, in the opinion of the purchaser, excessive quantities of dirt or debris have entered the new main, bacteriological samples shall be taken at intervals of approximately 200 ft (61 m), and the sampling location shall be identified (see Sec. 5.1.3 for sampling location details). Samples shall be taken of water that has stood in the new main for at least 16 hr after final flushing has been completed.
- iii. A standard heterotrophic plate count (HPC) test may be required at the option of the purchaser because new mains do not typically contain coliform bacteria but often contain HPC bacteria. If sample results show HPC greater than 500 CFU/mL, flushing should resume and another set of HPC and coliform samples collected until no coliform are present and the HPC is less than 500 CFU/mL.

b. Standard conditions for repaired mains.

For repaired mains that were depressurized and/or wholly or partially dewatered, one set of samples may be required, and depending upon the sanitary conditions, the line may be reactivated prior to the completion of bacteriological testing. Samples shall be collected downstream of the repair site and at intervals of approximately 200 ft (61 m) within the length of pipe that was shut down. If direction of flow is not known, samples shall be collected on either side of the repair site.

- B. Samples shall be collected by a person knowledgeable in collecting samples for bacteriological sampling or arrange for AW to collect the sample. Coordinate with AW and submit samples to AW for testing of bacteriological (chemical and physical) quality. Testing will be in accordance with *Standard Methods of the Examination of Water and Wastewater*. Samples shall show the absence of coliform organisms; and the presence of a chlorine residual. Samples shall also be tested for turbidity, pH, and standard heterotrophic plate count (HPC). HPC levels must be consistent with levels normally found in the distribution system to which the new main is connected.
- C. Bacteriological tests must show complete absence of coliforms and acceptable HPCs. If tests show the presence of coliform or unacceptable HPCs, perform additional flushing and disinfection of the pipeline until acceptable tests are obtained, all at no cost to AW. The Contractor will not be charged for the additional testing performed by AW.

3.06 RETESTING AND TESTING SOURCE WATER

- A. At the time of initial flushing the main to remove material and test for air pockets, Contractor may request AW to continue flushing until the desired chlorine residual is met at the discharge point. Notification must be provided in advance and the Contractor shall be prepared to test for chlorine at intervals of no more than five minutes as the water clears. This will provide the Contractor with some assurance that the source water is chlorinated.
- B. If the subsequent tests for bacteriological contamination conducted by the Contractor fail, the Contractor may request AW to continue flush from the source water into the new pipe system until a chlorine residual is found at the discharge point. Notification must be provided in advance and the Contractor shall be prepared to test for chlorine at intervals of no more than five minutes as the water clears. The operation of all existing system valves shall be by AW at the Contractor's expense and the discharge point must be opened prior to opening existing valves to avoid contamination. This will provide the Contractor with some assurance that the source water is chlorinated for subsequent tests.

3.07 DISINFECTION PROCEDURES FOR CUTTING INTO OR REPAIRING EXISTING MAIN

The planned, unplanned, or emergency repair of a water main or appurtenance (e.g., valve) is time sensitive—an important goal is to minimize the disruption of water service to customers. Nonetheless, the repair work needs to be accomplished using sanitary and safe procedures by well-trained crews with proper supervision and guidance.

A. Basic disinfection.

Work should follow basic disinfection and contamination prevention procedures:

1. Preventing contaminants from entering the existing pipe during the repair such as by maintaining positive pressure in the leaking pipe until the repair site on the pipe is fully exposed, by maintaining a dewatered trench, and by keeping all pipe materials being used in the repair in a clean and sanitary condition.
2. Inspecting and cleaning, followed by disinfection of spraying or swabbing with a minimum 1 percent chlorine solution:
 - Exposed portions of existing pipe interior surfaces
 - Pipe materials used in the repair
 - Handheld materials and tools used to make the repair
3. As appropriate, advising affected customers to adequately flush their service lines upon return to service.

B. Selection of disinfection procedure.

The disinfection procedure selected should be determined by the conditions and severity of the main break. Many leaks or breaks can be repaired under controlled conditions without depressurizing the water main, such as when applying a clamp to a small crack or hole, thus preventing contaminants from entering the water system. In most other situations, the water main can be maintained pressurized until the break site is secured and the pipe is fully exposed. Some circumstances (e.g., severe erosion of the local environment or icing of the roadway) that impact public safety may require that water pressure be substantially reduced prior to exposing the pipe in the area of the leak. In some cases, situations become catastrophic where there is a pipe blowout and a loss of water pressure prior to shutdown, requiring disinfection procedures equivalent to those of a new main installation.

The procedures below describe the contamination risks and the associated disinfection and sampling requirements for different scenarios of pipeline repair.

Specific situations not captured below need to be evaluated and the appropriate disinfection and sampling methods followed.

I. Controlled pipe repair without depressurization.

In this situation, activities are well controlled and a full shutdown is not needed, thus maintaining positive pressure to the area of shutdown and around the break site at all times. The repair site is exposed and the trench is adequately dewatered so that the repair site can be cleaned and disinfected by spraying or swabbing with a minimum 1 percent chlorine solution. The water main is then returned to service with flushing to obtain three volumes of water turnover, making sure that the flushed water is visually clear. No bacteriological testing is necessary.

II. Controlled pipe repair with depressurization after shutdown.

In this situation, after the repair site has been exposed and secured from trench soil/ water contamination, the water main is depressurized by a shutdown to complete the repair. The repair site should be cleaned and disinfected by spraying or swabbing with a minimum 1 percent chlorine solution. The water main is then returned to service with flushing to scour the pipe and obtain three volumes of water turn- over, making sure that the flushed water is visually clear. It is advisable to check for a typical system chlorine residual, and if not found, to continue flushing until residuals are restored to levels maintained in the distribution system by the water utility—if the system operates with a disinfectant residual. When the existing pipe has to be opened and the interior surfaces of the water system exposed to the environment, additional procedures need to be followed. The existing pipe should be inspected and cleaned with the help of flushing water into the trench, where possible, until the flush water runs visually clear. The repair site should be accessible and the trench adequately dewatered so that the repair site can be cleaned and disinfected by spraying or swabbing with a minimum 1 percent chlorine solution. Additionally, any accessible upstream and downstream interior of the existing pipe should be disinfected by swabbing or spraying with a minimum 1 percent chlorine solution. If the repair requires a full pipe section replacement, the new pipe should be inspected, cleaned, and disinfected from both ends by swabbing with a minimum 1 percent chlorine solution. The water main may then be returned to service after flushing to scour the pipe and obtain three volumes of water turnover. The flushed water should run visually clear, have measurable chlorine residual if the system operates with a residual, and be checked with bacteriological testing. The pipeline may be returned to service prior to obtaining bacteriological results.

- III. Uncontrolled pipe break with a likelihood of water contamination or loss of sanitary conditions during repair.

In situations in which the existing main to be repaired could not be protected and kept free of contamination and there are obvious signs of contamination (e.g., muddy trench water flowing into the broken pipe and a leaking sewer pipe in the trench, or catastrophic pipe failure where pipe is open and there is a likelihood that contamination was drawn into the active system) or when a controlled repair situation turns into a situation in which the internal pipe and water have become contaminated, the procedures outlined under Section 3.03 should be followed where practical. These methods specify chlorine doses of 25–300 mg/L; however, such levels may present greater harm if the line or services cannot be reliably isolated or shut down and exposure of customers to high concentrations of chlorine cannot be controlled. Free chlorine residuals up to 4 mg/L (based on annual averages) are allowed by federal drinking water regulations; therefore this level is suggested as a minimum to be maintained for at least 16 hr in conjunction with flushing, coliform sampling, and associated customer education.

- C. Flushing – Thorough flushing is the most practical means of removing contamination introduced during repairs. If valve and hydrant location permit, flushing toward the work location from both directions is recommended. Flushing shall be started as soon as the repairs are completed and shall be continued until discolored water is eliminated.
- D. Slug Chlorination – Where practical, in addition to flushing, the section of the main in which the break is located shall be isolated, all service connections shut off, and the section flushed and chlorinated as described in Paragraph 3.03B above (Slug Method). The dose may be increased to as much as 300 mg/L and the contact time reduced to as little as 15 minutes. After chlorination, flushing shall be resumed and continued until discolored water is eliminated and the chlorine concentration in the water exiting the main is no higher than the prevailing water in the distribution system or that which is acceptable for domestic use.
- E. Bacteriological Samples – Bacteriological samples following procedures in Paragraph 3.05 above shall be taken after repairs are completed to provide a record for determining the procedure's effectiveness. If the direction of flow is unknown, then samples shall be taken on each side of the main break. If positive bacteriological samples are recorded, then the situation shall be evaluated by AW to determine corrective action. Daily sampling shall be continued until two consecutive negative samples are recorded.

END OF SECTION 33 01 10.15

SECTION 33 05 27**TRACER WIRE****PART 1: GENERAL****1.01 SCOPE**

- A. Install electrically continuous tracer wire with access points as described herein to be used for locating pipe with an electronic pipe locator after installation. Tracer wire shall be installed on all water mains and services, all wastewater lines and sewer mains and services and all wastewater force mains.

1.02 SUBMITTALS

- A. Submit shop drawings and manufacturer's literature to the Engineer for approval in accordance with Specification Section 01 33 00.

PART 2: PRODUCTS**2.01 TRACER WIRE MATERIAL**

- A. Tracer wire shall meet minimum State requirements.
- B. Tracer wire to be twelve gauge minimum solid copper with thermoplastic insulation recommended for direct burial. Wire connectors to be 3M DBR, or approved equal, and shall be watertight to provide electrical continuity.
- C. Tracer wire color shall be blue for all water construction and green for all wastewater construction.

2.02 TRACER WIRE ACCESS BOXES

For locations where valve boxes are not present, the tracer wire access point shall be composed of one SnakePit Tracer Wire Access Box, or approved equal, installed at each proposed access point.

2.03 TESTING REQUIREMENTS

- A. Contractor shall perform a continuity test on all tracer wire in the presence of AW or AW's representative. If the tracer wire is found to be not continuous after testing, Contractor shall repair or replace the failed segment of the wire at their own expense.

PART 3: EXECUTION

3.01 INSTALLATION - GENERAL REQUIREMENTS

- A. Tracer wire shall be installed on all water and sewer mains and services. The wire shall be installed in such a manner as to be able to properly tracer all mains without loss or deterioration of signal or without the transmitted signal migrating off the tracer wire.
- B. Marking tape shall be installed in the same trench pipe during pipe installation. It shall be laid in the trench 12-inches above the pipe, to ensure that it is not damaged during future repair operations.
- C. The tracer wire shall be securely bonded together at all wire joints with an approved watertight connector to provide electrical continuity, and it shall be accessible at all tracer wire access points.
- D. Tracer wire access points shall in general be no more than five-hundred feet and at every proposed concrete valve box collar (or manhole where required). Concentrations of multiple proposed valves near pipe intersections, i.e. tees or crosses, may require more than one access point assembly in each concrete valve box collar. Tracer wire access points shall be within public right-of-way or public utility easements.
- E. At each valve location, (including fire hydrant isolation valves), a loop of wire is to be brought up the outside of the valve box and looped inside the box through a hole drilled 2-inch below the bottom of the lid.
- F. At the point of connection between cast or ductile iron mains, with any non-iron main, the tracer wire shall be properly connected to the iron pipe with a cad weld or approved equivalent. Tracer wire welds shall be completely sealed with the use of an approved mastic type sealer specifically manufactured for underground use. Mastic shall be applied in a thick coat a minimum of 2 inches thick and shall be protected from contamination by the backfill material with the use of a plastic membrane.
- G. Tracer wire shall be laid flat and securely affixed to the pipe at 10 foot intervals. The wire shall be protected from damage during the execution of the Work. No breaks or cuts in the tracer wire or tracer wire insulation shall be permitted. At service saddles, the tracer wire shall not be allowed to be placed between the saddle and the main.
- H. Except for approved spliced-in connections, tracer wire shall be continuous and without splices from each tracer wire access point. Where any approved spliced-in connections occur, 3M DBR water tight connectors, or approved equal, shall be used to provide electrical continuity.

- I. At all main end caps, a minimum of 6 feet of tracer wire shall be extended beyond the end of the pipe, coiled and secured for future connections. The end of the tracer wire shall be spliced to the wire of a six pound zinc anode and is to be buried at the same elevation as the water main.
- J. For directional drilling, auguring or boring installations, two #12 tracer wires shall be installed with the pipe and connected to the tracer wire at both ends, or cad welded to the existing iron pipe at both ends or cad welded to the steel casing pipe at both ends.
- K. Spliced connections between the main line tracer wire and branch connection tracer wire shall only be allowed at water main tees, crosses or at iron or copper water services where a portion of the branch connection water main or water service is replaced with non-iron or non-copper material. The branch connection tracer wire shall be a single tracer wire properly spliced to the main line tracer wire. Where the existing branch connection is neither iron nor copper, then the new branch connection tracer wire shall be properly spliced to the existing tracer wire on the branch connection.
- L. At all repair locations where there is existing tracer wire, the tracer wire shall be properly reconnected and spliced as outlined above.

END OF SECTION 33 05 27

SECTION 33 11 00**PIPING AND ACCESSORIES - GENERAL PROVISIONS****PART 1: GENERAL****1.01 DRAWINGS**

Dimensions shown on Drawings are approximate only. Verify all piping geometry in the field and to ensure proper alignment and fit of all piping consistent with the intent of the Drawings. Submit field layout drawings as required for approval.

PART 2: PRODUCTS**2.01 CONTRACTOR'S RESPONSIBILITY FOR MATERIAL**

- A. Examine all material carefully for defects. Do not install material which is known, or thought to be, defective.
- B. AW reserves the right to inspect all material and to reject all defective material shipped to the job site or stored on the site. Failure of AW to detect damaged material shall not relieve the Contractor from his total responsibility for the completed work if it leaks or breaks after installation.
- C. Lay all defective material aside for final inspection by AW. AW will determine if corrective repairs may be made, or if the material is rejected. AW shall determine the extent of the repairs.
- D. Classify defective pipe prior to AW's inspection as follows:
 - 1. Damage to interior and/or exterior paint seal coatings.
 - 2. Damage to interior cement-mortar or epoxy lining.
 - 3. Insufficient interior cement-mortar lining or epoxy thickness.
 - 4. Excessive pitting of pipe.
 - 5. Poor quality exterior paint seal coat.
 - 6. Pipe out of round.
 - 7. Pipe barrel area damaged to a point where pipe class thickness is reduced (all pipe).
 - 8. Denting or gouges in plain end of pipe (all pipe).
 - 9. Excessive slag on pipe affecting gasket seal (DIP).

10. Any visible cracks, holes.
 11. Embedded foreign materials.
 12. Non-uniform color, density and other physical properties along the length of the pipe.
- E. The Contractor shall be responsible for all material, equipment, fixtures, and devices furnished. These materials, equipment, fixtures and devices shall comply with the requirements and standards of all Federal, State, and local laws, ordinances, codes, rules, and regulations governing safety and health.
- F. The Contractor shall take full responsibility for the storage and handling of all material furnished until the material is incorporated in the completed project and accepted by AW. Contractor shall be solely responsible for the safe storage of all material furnished to or by him until incorporated in the completed project and accepted by AW.
- G. Load and unload pipe, fittings, valves, hydrants and accessories by lifting with hoists or skidding to avoid shock or damage. Do not drop these materials. Pipe handled on skidways shall not be skidded or rolled against other pipe. Handle this material in accordance with AWWA C600, C605 or C906 whichever is applicable.
- H. Drain and store fittings and valves prior to installation in such a manner as to protect them from damage due to freezing of trapped water.

2.02 REDUCTION OF LEAD IN DRINKING WATER ACT COMPLIANCE

- A. The Contractor shall comply with the requirements and standards of the Reduction of Lead in Drinking Water Act.
- B. Any pipe, fitting or fixture (e.g. corp stops, curb valves, gate valves less than 2 inches in diameter, backflow prevention devices, water meters, hose bibs, etc.), solder and flux installed or requiring replacement as of January 4, 2014 must be "lead free". The Contractor shall be responsible to comply with the State, local laws, ordinances, codes, rules, and regulations governing the Reduction of Lead in Drinking Water Act that may have additional limitations or requirements."
- C. The definition of 'lead free' is as follows:
1. Not containing more than 0.2 percent lead when used with respect to solder and flux; and
 2. Not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures.

2.03 PETROLATUM TAPE COATING

- A. The tape coating shall be a cold applied, saturant tape made from either petrolatum or petroleum wax with a noncellulosic synthetic fiber fabric. The fabric shall be encapsulated and coated on both sides with the petrolatum or petroleum wax. The thickness of the tape shall be no less than 40 mil. The petrolatum or petroleum wax shall be at least 50% of the product by weight.
- B. The tape coating shall be supplied in sheets, pads or rolls. Pads and sheets shall be sized to fit the area that is to be covered, allowing for an overlap per AWWA Standards.

2.04 RUBBERIZED-BITUMEN BASED SPRAY-ON UNDERCOATING

Subject to approval by AW, an alternative corrosion protection for exposed buried metal is an aerosol applied rubberized coating. The material shall be rapid dry and specifically designed for corrosion protection. 3M Rubberized Underseal Undercoating 08883 or any equivalent rubberized-bitumen based spray-on undercoating may be used. Follow manufacturer's recommendations for storage and application.

2.05 PRESSURE GAUGES

- A. General Use - Provide liquid filled, diaphragm-isolated pressure gauges, location of gauges as shown on drawing and range suitable for the particular service.
- B. Provide 2 1/2" diameter dial white face, black lettering/markings.
- C. Minimum suggested gauge shall be:
 - a. Bronze isolation valve provided between the pipe and gauge
 - b. Gauge to read in both feet and psi
 - c. Range of gauge to be such that the design total dynamic head (tdh) of the pump should be located at about the 50% point of the gauge's range.
 - d. A pressure dampener should be provided with each gauge to moderate the vibration of the gauge needle.

PART 3: EXECUTION

3.01 INSTALLATION - GENERAL REQUIREMENTS

- A. Lay and maintain all pipe to the required lines and depths. Install fittings, valves and hydrants in strict accordance with the Specifications at the required locations with joints centered, spigots home, and all valve and hydrant stems plumb. Do not deviate from the required alignment, depth or grade without the written consent of AW.
- B. Buried steel lugs, rods, brackets, and flanged joint nuts and bolts are not permitted unless specifically shown on the Drawings or approved in writing by AW. Cover any and all buried steel lugs, rods, brackets, and flanged joint nuts and bolts with approved coating in accordance with AWWA Standard C217 prior to backfilling. Encase the same in polyethylene encased if the Specifications require polyethylene encasement of the pipe, valves or fittings..

- C. Lay all pipe to the depth specified. Measure the depth from the final surface grade to the top of the pipe barrel. The minimum pipe cover shall be as shown on the Drawings or as specified in the Specifications.
- D. Do not lay pipe in a wet trench, on subgrade containing frost, or when trench conditions are unsuitable for such work. If all efforts fail to obtain a stable dry trench bottom and AW determines that the trench bottom is unsuitable for such work, AW will order the kind of stabilization to be constructed, in writing. In all cases, water levels must be at least 6" below the bottom of the pipe.
- E. Thoroughly clean the pipes and fittings before they are installed. Keep these materials clean until the acceptance of the completed Work. Lay pipe with the bell ends facing in the direction of laying, unless otherwise shown on the Drawings, or directed by AW. Exercise care to ensure that each length abuts the next in such a manner that no shoulder or unevenness of any kind occurs in the pipe line.
- F. Do not wedge or block the pipe during laying unless by written order of AW.
- G. Before joints are made, bed each section of pipe the full length of the barrel, at the required grade, and at the invert matching the previously laid pipe. Dig bell holes sufficiently large to permit proper joint making. Do not bring succeeding pipe into position until the preceding length is embedded and secure in place.
- H. Take up and relay pipe that is out of alignment or grade, or pipe having disturbed joints after laying. Take up such in-place pipe sections found to be defective and replace them with new pipe. Take up, relaying, and replacement will be at the Contractor's expense.
- I. Place enough backfill over the center sections of the pipe to prevent floating. Take all other necessary precautions to prevent the floating of the pipeline by the accumulation of water in the trench, or the collapse of the pipeline from any cause. Should floating or collapse occur, restoration will be at the Contractor's expense.
- J. Contractor shall install tracer wire along all pipelines. Tracer wire shall be placed and centered on the bottom of the trench to prevent disturbance or damage to the tracer wire during repairs.
- K. Bedding materials and concrete work for the pipe bedding and thrust restraint shall be as specified.
- L. Prevent foreign material from entering the pipe while it is being placed. Do not place debris, tools, clothing, or other materials in the pipe during laying operations. Close all openings in the pipeline with watertight plugs when pipe laying is stopped at the close of the day's work, or for other reasons such as rest breaks or meal periods.
- M. Only cut pipe with equipment specifically designed for cutting pipe such as an abrasive wheel, a rotary wheel cutter, a guillotine pipe saw, or a milling wheel saw.

Do not use chisels or hand saws. Grind cut ends and rough edges smooth. Bevel the cut end slightly for push-on connections as per manufacturer recommendations.

- N. In distributing material at the site of the Work, unload each piece opposite or near the place where it is to be laid in the trench. If the pipe is to be strung out, do so in a straight line or in a line conforming to the curvature of the street. Block each length of pipe adequately to prevent movement. Block stockpiled pipe adequately to prevent movement. Do not place pipe, material, or any other object on private property, obstructing walkways or driveways, or in any manner that interferes with the normal flow of traffic.
- O. Exercise special care to avoid damage to the bells, spigots or flanged ends of pipe during handling, temporary storage, and construction. Replace damaged pipe that cannot be repaired to AW's satisfaction, at the Contractor's expense.
- P. Remove all existing pipe, fittings, valves, pipe supports, blocking, and all other items necessary to provide space for making connections to existing pipe and installing all piping required under this Contract.
- Q. Maintain the minimum required distance between water and sewer lines and other utility lines in strict accordance with all Federal, State, and local requirements and all right-of-way limitations.
- R. Provide and install polyethylene encasement for ductile iron pipe, fittings and valves as required. See Specification Section - .Polyethylene Wrap.
- S. The maximum allowable deflection at the joints for push-on joint pipe shall be the lesser of manufacturer's recommendations or as described in the DIPRA Guideline, *Ductile Iron Pipe Joints and Their Uses*, as follows:

Size of Pipe	Deflection Angle	Maximum Deflection	
		(18-ft. Length)	(20-ft. Length)
3"-12"	5 degrees	19"	21"
14"-42"	3 degrees	11"	12"
48"-64"	3 degrees	N/A	12"

- T. The maximum allowable deflection at the joints for PVC pressure pipe shall be as follows:

Size of Pipe	Deflection Angle	Maximum Deflection (20-ft. Length)
4"-12"	2 degrees	8"
14" +	1.5 degrees	6"

- U. Use short lengths of pipe (minimum length 3 feet, no more than three short sections) , when approved by the AW Project Manager, to make curves that cannot be made

with full length sections of pipe without exceeding the allowable deflection. Making these curves will be at no additional cost to AW.

- V. Furnish air relief valve assemblies in accordance with Drawings provided or as specified in Specification Special Conditions section. AW Project Manager will provide standard detail for additional air release valve assemblies. Any deviation from the standard detail, proposed by Contractor must be approved in advance.
- W. Exercise particular care so that no high points are established where air can accumulate. Install an air release valve and manhole, as extra Work to the Contract, when the AW Project Manager determines that unforeseen field conditions necessitate a change in the pipe profile that requires the installation of an air release valve and manhole. If the Contractor requests a change in the pipe profile solely for ease of construction, and the requested change requires the installation of an air release valve and manhole as determined by the AW Project Manager, the cost of furnishing and installing the air release valve and manhole will be at the expense of the Contractor.
- X. All water mains 20" and greater in diameter shall be constructed using DIP only. Other construction materials, such as PVC and HDPE, are limited to water mains 16" and under in diameter. Alternate materials for larger water mains may be approved by AW on a case-by-case basis.
- Y. A minimum 3" wide marking tape to be provided along all mains and service lines installed. Marking tape to be installed 12" below grade. Foil backing is not required on marking tape. Tape shall be colored blue for water mains and green for sewer. Marking tape along pressurized force mains shall be labeled "Pressurized Wastewater".

3.02 CONSTRUCTION METHODS TO AVOID CONTAMINATION

- A. Heavy particulates generally contain bacteria and prevent even very high chlorine concentrations from contacting and killing such organisms. It is essential that the procedures of this Section be observed to assure that a water main and its appurtenances are thoroughly clean for the final disinfection by chlorination.
- B. Take precautions to protect the interior of pipes, fittings, and valves against contamination. String pipe delivered for construction so as to keep foreign material out of the pipe. Close all openings in the pipeline with watertight plugs when pipe laying is stopped at the close of the day's work or for other reasons, such as rest breaks or meal periods. Use rodent-proof plugs approved by AW, where it is determined that watertight plugs are not practical and where thorough cleaning will be performed.
- C. Delay in placement of delivered pipe invites contamination. The more closely the rate of delivery is correlated to the rate of pipe laying, the lower the likelihood of contamination. Complete the joints of all pipe in the trench before stopping work. If water accumulates in the trench, keep the plugs in place until the trench is dry.

- D. When encountering conditions on pre-existing pipe that requires packing, employ yarning or packing material made of molded or tubular rubber rings, or rope of treated paper or other approved materials. Do not use materials such as jute, asbestos, or hemp. Handle packing material in a manner that avoids contamination.
- E. Do not use contaminated material or any material capable of supporting prolific growth of microorganisms for sealing joints. Handle sealing material or gaskets in a manner that avoids contamination. The lubricant used in the installation of sealing gaskets shall be suitable for use in potable water. Deliver the lubricant to the job in closed containers and keep it clean.
- F. If dirt enters the pipe, and in the opinion of AW the dirt will not be removed by the flushing operation, clean the interior of the pipe by mechanical means, then swab with a 1% hypochlorite disinfecting solution. Clean using a pig, swab, or "go-devil" only when AW has specified such and has determined that such operation will not force mud or debris into pipe joint spaces.
- G. If the main is flooded during construction, the flooded section must be isolated from the remainder of the installation as soon as practical. Submit a plan to AW on correcting the condition and do not proceed until authorized by AW. Replace or fully clean and disinfect the affected pipe at no additional cost to AW.

3.03 VALVE INSTALLATION

- A. Prior to installation, inspect valves for direction of opening, freedom of operation, tightness of pressure containing bolting, cleanliness of valve ports and especially of seating surfaces, handling damage, and cracks. Correct defective valves or hold for inspection by the AW Project Manager.
- B. Set and join to the pipe in the manner specified in Paragraph 3.01. Provide valves with adequate support, such as crushed stone and concrete pads, so that the pipe will not be required to support the weight of the valve. Set truly vertical. If polyethylene is applied to the pipe, the entire valve shall be encased in polyethylene encasement prior to backfill. The polyethylene encasement shall be installed up to the operating nut leaving the operating nut, exposed and free to be operated.
- C. Provide a valve box for each valve. Set the top of the valve box neatly to existing grade, unless directed otherwise by AW. Do not install in a way that allows the transfer of shock or stress to the valve. Center and plumb the box over the wrench nut of the valve. Do not use valves to bring misaligned pipe into alignment during installation. Support pipe in such manner as to prevent stress on the valve.
- D. Provide extension stem for each valve, with a standard 2-inch AWWA nut. Pin the extension stem to the operating nut on the valves. Extension stem shall extend to with 12-inches of finished grade.

- E. Provide valve marking posts, when authorized by AW, at locations designated by AW and in accordance with detail drawings.

3.04 THRUST RESTRAINT

- A. Provide all plugs, caps, tees, and bends (both horizontal and vertical) with concrete thrust blocking and/or restrained joint pipe as represented on the Drawings, or specified in the Specification Special Conditions.
- B. Place concrete thrust blocking between undisturbed solid ground and the fitting to be anchored. Install the concrete thrust blocking in accordance with Section Cast-In-Place Concrete and Standard Details provided. Locate the thrust blocking to contain the resultant thrust force while keeping the pipe and fitting joints accessible for repair, unless otherwise shown or directed.
- C. Use restrained joints for fittings and valves for a minimum distance on either side as calculated using DIPRA guidance - "Thrust Restrained Design for Ductile Iron Pipe". Refer to Table 1 at the end of this section, for minimum lengths restrained for 12" – 24" diameter pipe. If soil conditions other than those listed in the table are encountered, contractor shall provide engineering calculation performed by a local P.E for the minimum required restraining length.
- D. Provide temporary thrust restraint at temporary caps and plugs. Submit details of temporary restraint to AW for approval.
- E. At connections with existing water mains where there is a limit on the time the water main may be removed from service, use metal harnesses of anchor clamps, tie rods and straps; mechanical joints utilizing set-screw retainer glands; or restrained push-on joints as permitted by AW. No restraining system can be installed without the approval of AW. Submit details of the proposed installation to AW for approval. For pipe up to 12-inches in size, use a minimum of two 3/4-inch tie rods. If approved for use, install retainer glands in accordance with the manufacturer's instructions. Material for metal harnessing and tie-rods shall be ASTM A36 or A307, as a minimum requirement.
- F. Protection of Metal Harnessing: Protect ties rods, clamps and other metal components against corrosion and by encasement of the entire assembly with 8-mil thick (12 mil thick in corrosive soils) loose polyethylene film in accordance with AWWA C105. Apply tape on all exposed tie rods prior to installing polyethylene.

Table 1
 Required Restrained Lengths On Each Side of Bend (ft)

Pipe Diameter	Type of Bend	Bend Angle						Soil Conditions
		5°-11.25°	11.25°-22.5°	22.5°-30°	30°-45°	45°-60°	60°-90°	
12	Horizontal Bend	4	9	12	16	25	43	Rock
12	Vertical Up Bend	4	9	12	16	25	43	Rock
12	Vertical Down Bend	15	31	41	64	89	155	Rock
16	Horizontal Bend	5	11	15	23	32	55	Rock
16	Vertical Up Bend	5	11	15	23	32	55	Rock
16	Vertical Down Bend	20	40	53	82	115	199	Rock
24	Horizontal Bend	7	15	20	31	44	76	Rock
24	Vertical Up Bend	7	15	20	31	44	76	Rock
24	Vertical Down Bend	28	56	75	117	183	281	Rock
12	Horizontal Bend	7	14	19	29	40	69	Clay
12	Vertical Up Bend	7	14	19	29	40	69	Clay
12	Vertical Down Bend	17	35	47	73	102	77	Clay
16	Horizontal Bend	9	18	24	37	52	77	Clay
16	Vertical Up Bend	9	18	24	37	52	77	Clay
16	Vertical Down Bend	23	46	62	97	135	233	Clay
24	Horizontal Bend	13	26	35	54	76	131	Clay
24	Vertical Up Bend	13	26	35	54	76	131	Clay
24	Vertical Down Bend	34	69	93	143	200	346	Clay

The following assumptions were used in calculating required restrained lengths: 42" burial depth, 250 psi, 1.5 safety factor. In areas of multiple bands where required restrained lengths overlap,

END OF SECTION 33 11 00

SECTION 33 11 00.11**POLYVINYL CHLORIDE (PVC) PIPE****PART 1: GENERAL****1.01 SECTION INCLUDES**

PVC pressure pipe and fabricated fittings in nominal sizes 4-inches through 12-inches with cast iron pipe equivalent outside diameters.

1.02 SUBMITTALS

Submit manufacturer's product data, installation instructions and certification for all materials to be furnished in accordance with Specification Section 01 33 00. Submit classification and gradation test results for embedment and pipe backfill material.

PART 2: PRODUCTS

Research has documented that certain pipe materials (such as polyvinyl chloride, polyethylene, and polybutylene) and certain elastomers (such as those used in gasket material) may be subject to permeation by lower-molecular weight organic solvents or petroleum products. Products supplied under this Section assume that petroleum products or organic solvents will not be encountered. If during the course of pipeline installation the Contractor identifies, or suspects the presence of petroleum products or any unknown chemical substance, notify AW immediately. Stop installing piping in the area of suspected contamination until direction is provided by AW Project Manager..

PVC Schedule 40 or 80 is not permitted for conveying wastewater or potable water within distribution or collection systems. However, it may be used in other applications, such as conveying chemicals or for drainage.

2.01 PIPE MATERIALS – WATER DISTRIBUTION

All PVC pipe shall be PVC 1120 pressure pipe made from class 12454 material as defined by ASTM D1784 with outside diameter dimensions of steel or cast iron pipe. The PVC compounds shall be treated or certified suitable for potable water products by the National Sanitation Foundation Testing Laboratory (NSF Standard No. 61). PVC pipe to be used for potable water shall be blue in color.

PVC Pipe 4-inch through 12-inch:

AWWA Standard C900, DR14 and where permitted DR18. DR25 pipe will not be allowed. PVC pipe has recently been upgraded by pressure class, however American Water does not allow pipe in its system to be fully subject to the revised pressures in AWWA C900. DR14 shall not be subjected to pressures exceeding 250 psi. DR18 shall not be subjected to pressures exceeding 200 psi.

2.02 GRAVITY SEWER PIPE

- A. PVC gravity sanitary sewer pipe shall be green in color and in accordance with provisions in following table except where specified differently on the Drawings:

B.

Type of service	Acceptable Materials
Gravity Mains with depth of cover \leq 10 feet	PVC SDR 35
Gravity Mains with depth of cover 10-15 feet	PVC SDR 26
Gravity Mains with depth of cover > 15 feet	Ductile Iron Pipe

- C. When solid wall PVC pipe 18-inches to 27-inches in diameter is required in SDR 26, provide pipe conforming to ASTM F679, except provide wall thickness as required for SDR 26 and pipe strength of 115 psi.
- D. For sewers up to 12-inch diameter crossing over water lines, or crossing under water lines with less than 2-feet separation, provide minimum 150 psi pressure rated pipe conforming to ASTM D2241 with suitable PVC adapter couplings.
- E. Joints: Spigot and integral wall section bell with solid cross section elastomeric or rubber ring gasket conforming to requirements of ASTM D3212 and ASTM F477, or ASTM D3139 and ASTM F477. Gaskets shall be factory-assembled and securely bonded in place to prevent displacement. Manufacturer shall test sample from each batch conforming to requirements ASTM D2444
- F. Fittings: Provide PVC gravity sewer sanitary bends, tee, or wye fittings for new sanitary sewer construction. PVC pipe fittings shall be full-bodied, either injection molded or factory fabricated. Saddle-type tee or wye fittings are not acceptable.
- G. Pipe Stiffness. Determine pipe stiffness at 5 percent deflection in accordance with Test Method D 2412. Minimum pipe stiffness shall be 46 psi. For diameters 4-inches through 18-inches, test three specimens, each a minimum of 6-inches (150 mm) in length. For diameters 21-inch through 36-inch, test three specimens, each a minimum of 12-inch (300 mm) in length.
- H. Flattening. Flatten three specimens of pipe, prepared in accordance with Paragraph 2.04F, in suitable press until internal diameter has been reduced to 60 percent of original inside diameter of pipe. Rate of loading shall be uniform. Test specimens, when examined under normal light and with unaided eye, shall show no evidence of splitting, cracking, breaking, or separation of pipe walls or bracing profiles. Perform the flattening test in conjunction with pipe stiffness test.
- I. Joint Tightness. Test for joint tightness in accordance with ASTM D3212, except that joint shall remain watertight at minimum deflection of 5 percent. Manufacturer will be

required to provide independent third party certification for joint testing each diameter of storm sewer pipe.

- J. Purpose of Tests. Flattening and pipe stiffness tests are intended to be routine quality control tests. Joint tightness test is intended to qualify pipe to specified level of performance.

2.03 SANITARY SEWER FORCE MAIN PIPE

- A. PVC sanitary sewer force main pipe shall be green in color. Provide approved PVC pressure pipe conforming to requirements for water service pipe, and conforming to minimum working pressure rating specified in Section 33 34 00 - Sanitary Sewer Force Mains.
- B. Acceptable pipe joints are integral bell-and-spigot, containing a bonded-in elastomeric sealing ring meeting requirements of ASTM F477. In designated areas requiring restrained joint pipe and fittings, use approved joint restraint device conforming to UNI-B-13, for PVC pipe 12-inch diameter and less.
- C. Fittings: Provide ductile iron fittings as per Section - Ductile Iron Pipe and Fittings, except furnish fittings with one of following approved internal linings:
 - 1. Nominal 40 Mils (35 Mils minimum) virgin polyethylene complying with ASTM D 1248, heat fused to interior surface of fitting
 - 2. Nominal 40 Mils (35 Mils minimum) polyurethane
 - 3. Nominal 40 Mils (35 Mils minimum) ceramic epoxy
 - 4. Nominal 40 Mils (35 Mils minimum) fusion bonded epoxy
- D. Exterior Protection: Provide polyethylene wrapping of ductile-iron fittings as required by Section 33 11 00.17 - Polyethylene Wrap.
- E. Hydrostatic Tests: Hydrostatically test pressure rated pipe in accordance with Specifications.

2.04 RECEIVING, HANDLING AND STORAGE

- A. Inspect pipe and appurtenances for defects prior to installation in the trench. Set aside and clearly mark defective, damaged or unsound material and hold material for inspection by AW.
- B. Load and unload all materials in accordance with the manufacturer's recommendations and in such a manner as to prevent damage. Do not drop pipe and accessories or handle them in a rough manner.
- C. Provide safe storage for all materials. Cover stored pipe that will be exposed to sunlight for periods longer than 6 months. Cover with canvas or other opaque material with provision for adequate air circulation. PVC pipe shall not be stored close to heat sources, such as heaters, boilers, steam lines, or engine exhaust.

PART 3: EXECUTION

3.01 INSTALLATION

Follow the provisions of Section - Piping - General Provisions, and Sanitary Sewer Force Mains in addition to the following requirements:

- A. Remove all dirt and foreign matter from pipe before lowering it into the trench. Do not place debris, hand tools, clothing or other materials in the pipe. Keep pipe clean during and after laying.
- B. Lay pipe with the bell end pointing in the direction of work progress. Do not roll, drop or dump pipe or appurtenances into the trench.
- C. Assemble push-on joints in accordance with the pipe manufacturer's recommendations. Assemble mechanical joints in accordance with the fitting manufacturer's recommendations.
- D. Cut pipe with pipe saws, circular saws, handsaws, or similar equipment. Provide a smooth end at a right angle to the longitudinal axis of the pipe. Deburr, bevel, and re-mark insertion line on spigot ends. Match factory bevel length and angle for field bevels. When connecting to certain shallow depth bells, such as those on some cast iron fittings and valves, cut off the factory bevel and prepare a deburred, square cut end with a slight outer bevel.
- E. Clean the sealing surface of the spigot end, the pipe bell, the coupler or fitting, and the elastomeric gaskets immediately before assembly. Do not remove factory installed gaskets for cleaning. Keep the joint free of dirt, sand, grit, grease or any foreign material. Apply approved lubricant when assembling gasketed joints in accordance with the pipe manufacturer's requirements. The use of improper lubricants can damage gaskets. Excessive lubricant use can make disinfection more difficult and cause taste and odor problems when the line is placed in service.
- F. Good pipe alignment is essential for proper joint assembly. Align the spigot to the bell and insert the spigot into the bell until it contacts the gasket uniformly. Do not swing or "stab" the joint; that is, do not suspend the pipe and swing it into the bell. The spigot end of the pipe is marked by the manufacturer to indicate the proper depth of insertion. Avoid metal to plastic contact with the pushing the pipe home (use wood or other material to cushion moving the pipe).
- G. Assemble pipe using the following types of joints:
 - 1. Gasketed bell joint – Integral with the pipe or fitting
 - 2. Gasketed coupling – A double gasketed coupling
 - 3. Mechanical joint – Any of the several joint designs that have gaskets and bolts manufactured in accordance with AWWA standards.

H. Tracer Wire

1. Place tracer wire in accordance with Section - Tracer Wire.
2. The wire shall be contiguous except at test stations, valve boxes, and where splicing is required. All splices shall be encased with a 3M DBR or approved equal.

I. All pressure and leakage testing shall be done in accordance with Specification Section 33 01 10.13 – Pressure and Leakage Tests**J. PVC pipe fittings shall employ ductile iron pipe fittings per Specifications 15 1 05. See detail drawings for transitions between different pipe materials.****K. Gaskets - Gaskets shall be as provided or recommended by the manufacturer and satisfy AWWA standard C111 in all respects. Where ductile iron pipe and PVC pipe are directly connected, the appropriate gasket material for this purpose shall be employed. As noted in the products section of this specification, some gasket materials are prone to permeation of certain hydrocarbons which may exist in the soil (see Part 2). Under these conditions and at the discretion of AW's Project Manager, Contractor shall require contractor to provide FKM (Viton, Flourel) gasket material in areas of concern.****3.02 SERVICE CONNECTIONS**

- A. Install service connections in accordance with AWWA Standard C605 and the manufacturer's recommendations using the following methods:**
1. Tapping is only permitted through the use of service clamps or saddles.
 2. Using injection molded couplings with threaded outlets.
 3. Tapping with large service connections through appropriately sized tang sleeves and valves.
 4. Direct tapping of 1-inch and smaller service connections is not permitted. Use service saddles only for AWWA Standard C900 pipe, for nominal pipe sizes 6-inch through 12-inch. Corporation stops shall be threaded and conform to AWWA Standard C800.
 5. The distance between the PVC pipe joint and a service tap (2-inches and smaller) shall be a minimum of 3 feet. The distance between the PVC pipe joint and a service tap (4-inches and larger) shall be a minimum of 4 feet. Where necessary, excavate along the pipe to confirm the acceptable distance before starting the tap.

END OF SECTION 33 11 00.11

SECTION 33 11 00.15**DUCTILE IRON PIPE AND FITTINGS****PART 1: GENERAL****1.01 COORDINATION OF WORK**

Connection to existing pipelines may require shutdown of AW facilities. Closely coordinate construction work and connections with AW through AW Project Manager. The AW Project Manager, in consultation with the AW, may select the time for connection to existing pipelines, including Saturdays, Sundays, or holidays, which, in the opinion of the AW Project Manager, will cause the least inconvenience to the AW and/or its customers. Make such connections at such times as may be directed by the AW, at the Contract prices, with no claim for premium time or additional costs.

1.02 RELATED WORK

Section - Piping - General Provisions.
Section - Polyethylene Wrap

1.03 SUBMITTALS

Submit shop drawings and manufacturer's literature for all Contractor supplied materials promptly to the AW Project Manager for approval in accordance with Specification Section - Submittals.

PART 2: PRODUCTS

Research has documented that certain elastomers (such as those used in gasket material) may be subject to permeation by lower-molecular weight organic solvents or petroleum products. Products supplied under this Section assume that petroleum products or organic solvents will not be encountered. If during the course of pipeline installation the Contractor identifies, or suspects the presence of petroleum products or any unknown chemical substance, notify AW immediately. Stop installing piping in the area of suspected contamination until direction is provided by AW Project Manager.

2.01 REDUCTION OF LEAD IN DRINKING WATER ACT COMPLIANCE

- A. The Contractor shall comply with the requirements and standards of the Reduction of Lead in Drinking Water Act.
- B. Any pipe, fitting or fixture (e.g. corp stops, curb valves, gate valves less than 2 inches in diameter, backflow prevention devices, water meters, hose bibs, etc.), solder and flux installed or requiring replacement as of January 4, 2014 must be "lead free". The Contractor shall be responsible to comply with the State, local laws, ordinances, codes, rules, and regulations governing the Reduction of Lead in Drinking Water Act that may have additional limitations or requirements."

- C. The definition of 'lead free' is as follows:
1. Not containing more than 0.2 percent lead when used with respect to solder and flux; and
 2. Not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures.

2.02 PIPE MATERIAL

A. General

Ductile iron pipe shall conform to the latest specifications as adopted by the ANSI and AWWA. Specifically, ductile iron pipe shall conform to AWWA Standard C151.

The pipe or fitting exterior shall be coated with a bituminous coating in accordance with AWWA Standard C151. The pipe or fitting interior shall be cement mortar lined and seal coated in compliance with the latest revision of AWWA Standard C104.

For wastewater systems, the pipe or fitting interior shall be lined with ceramic epoxy in accordance with ASTM Standards.

B. Quality

Pipe and fittings shall meet the following minimum quality requirements by conforming to the following:

1. AWWA C104 / ANSI A21.4 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
2. AWWA C105 / ANSI A21.5 Water Polyethylene Encasement for Ductile - Iron Pipe Systems
3. AWWA C110 / ANSI A21.10 Ductile Iron and Gray Iron Fittings, 3 NPS through 48 NPS for Water
4. AWWA C111 / ANSI A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
5. AWWA C115 / ANSI A21.15 Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
6. AWWA C116 / ANSI A21.16 Protective Fusion-Bonded Epoxy Coating for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service
7. AWWA C150 / ANSI A21.50 Thickness Design of Ductile-Iron Pipe
8. AWWA C151 / ANSI A21.51 Ductile-Iron Pipe, Centrifugally Cast, for Water

9. AWWA C153 / ANSI A21.53 Ductile-Iron Compact Fittings, 3 NPS through 24 NPS and 54 NPS through 64 NPS, for Water Service

Ductile iron water pipe and fittings will be accepted on the basis of the Manufacturer's certification that the material conforms to this specification. The certification for iron fittings shall list a fitting description, quantity, bare fitting weight and source, (AWWA Standard C110, C153 or Manufacturer, if fitting is not listed in either standard). The certification shall accompany the material delivered to the project site. AW reserves the right to sample and test this material subsequent to delivery at the project site. If foreign manufactured fittings are provided, then the Contractor is obligated to notify AW with a submittal and provide the necessary documentation to satisfy AW that the materials provided meet the specified AWWA standards and, among other documentation that may be required, provide certificates of compliance on the component supplied.

C. Pipe Class

The pressure class of pipe to be furnished shall be in accordance with Table 1 and the notes listed below.

Table 1	
MINIMUM RATED WORKING PRESSURE FOR DUCTILE IRON PIPE MANUFACTURED IN ACCORDANCE WITH AWWA Standard C151	
Pipe Size (Inch)	Pressure Class
6	350
8	350
12	350
16	300
20	300
24	250

NOTES:

1. Larger pipe sizes up to 54-inch can be installed as pressure Class 200 with cover up to 9 feet and an operating pressure of 200 psi, where approved by the AW Project Manager. When trench depths exceed 15 feet for pipe sizes of 16-inch or larger, AW shall direct the Contractor on the proper class pipe to use.
2. The noted pressure class is adequate to support 3/4 and 1-inch corporation stops. Use a full saddle for larger taps (e.g., air relief valves or larger corporations) due to limited wall thickness.
3. There are special conditions where a larger wall thickness is required. AW shall direct the Contractor on the proper pressure class pipe to use in

specific instances; e.g. at treatment plant or booster station sites where frequent excavation can be anticipated in the vicinity of pipe, where the pipeline is laid on a river channel bottom to prevent external damage to the pipe and minimize the potential for costly pipe replacement, etc.

D. Testing

Perform a hydrostatic test of all pipe and appurtenances as required by AWWA Standard C151 and Section - Pressure and Leakage Tests.

E. Joints

1. Mechanical and Push-On

Mechanical and push-on joints including accessories shall conform to AWWA Standard C111.

2. Flanged

Flanged joints shall conform to AWWA Standard C110 or ANSI B16.1 for fittings and AWWA Standard C115 for pipe. Do not use flanged joints in underground installations except within structures.

Furnish all flanged joints with 1/8-inch thick, red rubber or styrene butadiene rubber gaskets. The bolts shall have American Standard heavy unfinished hexagonal head and nut dimensions all as specified in American Standard for Wrench Head Bolts and Nuts and Wrench Openings (ANSI B18.2). For bolts of 1-3/4-inches in diameter and larger, bolt studs with a nut on each end are recommended. The high-strength, low-alloy steel for bolts and nuts shall have the characteristics listed in Table 6 of AWWA Standard C111.

Stainless steel nuts and bolts are required on piping within wastewater treatment plants and pump stations.

3. Restrained Joint Pipe

Restrained joints for pipes shall be of the boltless push-on type which provides joint restraint independent of the joint seal. Restrained push-on joints allowed for pipe only shall have accessories conforming to AWWA Standard C111. Restrained system shall be suitable for the following minimum working pressures:

<u>Size</u>	<u>Pressure</u>
<u>(Inch)</u>	<u>(psi)</u>

Less than 20	300
20	300
24	250
30 - 64	200

2.03 FITTINGS

A. Ductile Iron Fittings

Standard fittings shall be ductile iron conforming to AWWA Standard C110. Compact ductile iron fittings shall meet the requirements of AWWA Standard C153.

1. Working Pressures

Fittings shall be suitable for the following working pressures unless otherwise noted in AWWA Standard C110 or C153:

Working Pressure		
<u>Size</u>	Compact Fittings	Standard Fittings
<u>(Inch)</u>	Ductile Iron (psi)	
3 - 24	300	250, 300 (with special gaskets)
30 - 48	250	250
54 - 64	150	N/A

The use of standard ductile iron fittings having a 250 psi pressure rating with ductile iron pipe (having a rating of 350 psi) is not permitted except by the express written approval of the AW Project Manager.

2. Coating and Lining

The fittings shall be coated on the outside with a petroleum asphaltic coating in accordance with AWWA Standard C110 or fusion-bonded epoxy in accordance with AWWA Standard C116 and lined inside with cement-mortar and seal coated in accordance with AWWA Standard C104 or fusion-bonded epoxy in accordance with AWWA Standard C116.

B. Joints

1. Mechanical and Push-On

Mechanical and push-on joints including accessories shall conform to AWWA Standard C111. Anti-Rotation T-Bolts shall be used on mechanical joints shall be of domestic origin, high strength, low alloy steel bolts only, meeting the current provisions of ANSI/AWWA C111/A21.1 for rubber gasket joints for cast iron or ductile iron pipe and fittings. Bolt manufacturer's certification of compliance must accompany each

shipment. T-bolts shall be corrosion resistant to handle corrosive conditions on any buried bolts.

2. Flanged

Flanged joints shall meet the requirements of AWWA Standard C115 or ANSI B16.1. Do not use flanged joints in underground installations except within structures. Furnish all flanged joints with minimum 1/8-inch, thick red rubber or styrene butadiene rubber full-face gaskets. The bolts shall have heavy unfinished hexagonal head and nut dimensions all as specified in ANSI B18.2. Corrosion resistant hex bolts to handle corrosive conditions shall be used on any buried flanged bolts.

Bolts and nuts shall be threaded in accordance with ASME/ANSI B1.1, Unified Inch Screw Threads (UN and UNR Thread Form) class 2A external and class 2B internal. For bolts of 1-3/4-inches in diameter and larger, stud bolts with a nut on each end are recommended. Material for bolts and nuts shall conform to ASTM A307, 60,000 PSI Tensile Strength, Grade B, unless otherwise specified. Bolt manufacturer's certification of compliance must accompany each shipment.

3. Restrained

Restrained joints for valves and fittings shall be of the boltless push-on type which provides joint restraint independent of the joint seal. Field Lok gaskets are not permitted on valves or fittings. Restrained push-on joints allowed for pipe only shall have accessories conforming to AWWA Standard C111. Restrained system shall be suitable for the following minimum working pressures:

<u>Size</u> <u>(Inch)</u>	<u>Pressure</u> <u>(psi)</u>
Less than 20	300
20	300
24	250
30 - 64	250

Where adjacent fittings are to be placed (as in a mechanical joint hydrant tee and a mechanical joint hydrant valve), the use of a suitably sized Foster adaptor is permitted to facilitate restraint between the fittings.

2.04 POLYETHYLENE WRAP

Polyethylene wrap shall only be used on projects where explicitly required in the Scope of Work within the project Request for Proposal (RFP). The determination for use of polyethylene wrap shall be determined by the AW Project Manager.

PART 3: EXECUTION

3.01 INSTALLATION

Follow the provisions of Section- Piping - General Provisions in addition to the following requirements:

A. Push-On Joints

Clean the surfaces that the gasket will contact thoroughly, just prior to assembly using a bacteria free solution (bleach, potable water or NSF approved material). Insert the gasket into the groove in the bell. Apply a liberal coating of special lubricant to the gasket and the spigot end of the pipe before assembling the joint. Center the spigot end in the bell and push home the spigot end.

B. Mechanical Joints

Clean and lubricate all components with soapy water prior to assembly. Slip the follower gland and gasket over the pipe plain end making sure that the small side of the gasket and lip of the gland face the bell socket. Insert the plain end into socket. Push gasket into position with fingers. Seat gasket evenly. Slide gland into position, insert bolts, and tighten nuts by hand. Tighten bolts alternately (across from one another) to the recommended manufacturing rating or if not provided, to the following normal torques:

<u>Bolt Size</u>	<u>Range of Torque In Foot-Pounds</u>
5/8	40 - 60
3/4	60 - 90
1	70 - 100
1-1/4	90 - 120

After field installation, all bolts shall receive petrolatum tape or petroleum wax protection or other approved coating material. Protection shall be applied before applying polywrap per Section - Polyethylene Wrap, if required.

C. Restrained Joints

1. Ball and Socket

Assemble and install the ball and socket joint according to the manufacturer's recommendations. Thoroughly clean and lubricate the joint. Check the retainer ring fastener.

2. Push-On

Assemble and install the push-on joint according to the manufacturer's recommendations. Thoroughly clean and lubricate the joint. Check the retainer ring fastener.

Protect pipe from damage from the jacking device (backhoe bucket, pipe jack, etc.) when "pushing home" any pipe by using wood or other suitable (non metallic) material.

3. Mechanical Joint

Assemble and install the mechanical joint according to the manufacturer's recommendations. Thoroughly clean and lubricate the joint. Use approved restrained joint device on fittings and valves where required and approved for use by AW.

D. Pipe Protection

Protect pipe from damage from the jacking device (backhoe bucket, pipe jack, etc.) when "pushing home" any pipe. Wood or other suitable material (non metallic) shall be used to push home the pipe.

E. Gaskets

Gaskets shall be as provided or recommended by the manufacturer and satisfy AWWA Standard C111 in all respects with the exception of requirements noted in Part 2.

END OF SECTION 33 11 00.15

SECTION 33 11 00.17**POLYETHYLENE WRAP****PART 1: GENERAL****1.01 SECTION INCLUDES**

- A. The minimum requirements for polyethylene wrap to be used for external corrosion protection of buried ductile iron pipe, fittings, and appurtenances and for cast iron and ductile iron fittings on PVC pipe, and for barrier valves.

1.02 SUBMITTALS

- A. Conform to requirements of Section 01 33 00 - Submittals.
- B. Submit product data for proposed film and tape for approval.

PART 2: PRODUCTS**2.01 MATERIALS**

- A. Polyethylene Film: Tubular or sheet form without tears, breaks, holidays, or defects; conforming with requirements of AWWA C105, 2.5 to 3 percent carbon black content, either low or high density:
 - 1. Low-density polyethylene film shall be manufactured from virgin polyethylene material conforming to the following requirements of ASTM D4976.
 - a. Raw material.
 - 1) Group: 2 (linear)
 - 2) Class: C (black).
 - 3) Density: 0.910 to 0.935 g/cm³
 - 4) Dielectric strength: Volume resistivity, 10¹⁵ ohm-cm, minimum
 - b. Physical properties.
 - 1) Tensile strength: 3600 psi, minimum.
 - 2) Elongation: 800 percent, minimum.
 - 3) Dielectric strength: 800 V/mil thickness, minimum.
 - c. Thickness: Low-density polyethylene film shall have normal thickness of 0.008 inch. Minus tolerance on thickness is 10 percent of nominal thickness.

2. High-density, cross laminated polyethylene film shall be manufactured from virgin polyethylene material conforming to the following requirements of ASTM D4976.
 - a. Raw material.
 - 1) Group: 2 (linear)
 - 2) Density: 0.940 to 0.960 g/cm³
 - 3) Class: C (black)
 - 4) Dielectric strength: Volume resistivity, 10¹⁵ ohm-cm, minimum.
 - b. Physical properties.
 - 1) Tensile strength: 6300 psi, minimum.
 - 2) Elongation: 100 percent, minimum.
 - 3) Dielectric strength: 800 V/mil thickness, minimum.
 - c. Thickness: Film shall have nominal thickness of 0.004 inch. Minus tolerance of thickness is 10 percent of nominal thickness.
- B. Polyethylene Tape: Provide minimum 2-inch-wide (3-inch typical), plastic-backed, adhesive tape.

PART 3: EXECUTION

3.01 PREPARATION

- A. Remove lumps of clay, mud, and cinders from pipe surface prior to installation of polyethylene encasement. Prevent soil or embedment material from becoming trapped between pipe and polyethylene.
- B. Fit polyethylene film to contour of pipe to affect snug, but not tight fit; encase with minimum space between polyethylene and pipe. Allow sufficient slack in contouring to prevent stretching polyethylene where it bridges irregular surfaces, such as bell-spigot interfaces, bolted joints, or fittings, and to prevent damage to polyethylene due to backfilling operations. Secure overlaps and ends with adhesive tape to hold polyethylene encasement in place until backfilling operations are complete.
- C. For installations below water table or in areas subject to tidal actions, seal both ends of polyethylene tube with adhesive tape at joint overlap.

3.02 INSTALLATION

A. Tubular Type (Method A):

1. Cut polyethylene tube to length approximately 2 feet longer than pipe section. Slip tube around pipe, centering tube to provide 1-foot overlap on each adjacent pipe section, and bunching it accordion-fashion lengthwise until it clears pipe ends.
2. Lower pipe into trench and make up pipe joint with preceding section of pipe. Make shallow bell hole at joints to facilitate installation of polyethylene tube.
3. After assembling pipe joint, make overlap of polyethylene tube. Pull bunched polyethylene from preceding length of pipe, slip it over end of adjoining length of pipe, and secure in place. Then slip end of polyethylene from adjoining pipe section over end of first wrap until it overlaps joint at end of preceding length of pipe. Secure overlap in place. Take up slack width at top of pipe to make snug, but not tight, fit along barrel of pipe, securing fold at quarter points.
4. Repair cuts, tears, punctures, or other damage to polyethylene. Proceed with installation of next section of pipe in same manner.

B. Tubular Type (Method B):

1. Cut polyethylene tube to length approximately 1 foot shorter than pipe section. Slip tube around pipe, centering it to provide 6 inches of bare pipe at each end. Take up slack width at top of pipe to make snug, but not tight, fit along barrel of pipe, securing fold at quarter points; secure ends.
2. Before making up joint, slip 3 foot length of polyethylene tube over end of preceding pipe section, bunching in accordion-fashion lengthwise. After completing joint, pull 3 foot length of polyethylene over joint, overlapping polyethylene previously placed on each adjacent section of pipe by at least 1 foot; make each end snug and secure.
3. Repair cuts, tears, punctures, or other damage to polyethylene. Proceed with installation of next section of pipe in same manner.

C. Sheet Type:

1. Cut polyethylene sheet to length approximately 2 feet longer than pipe section. Center length to provide 1-foot overlap on each adjacent pipe section, bunching sheet until it clears pipe ends. Wrap polyethylene around pipe so that sheet circumferentially overlaps top quadrant of pipe. Secure cut edge of polyethylene sheet at intervals of approximately 3 feet.

2. Lower wrapped pipe into trench and makeup pipe joint with preceding section of pipe. Make shallow bell hole at joints to facilitate installation of polyethylene. After completing joint, make overlap and secure ends.
 3. Repair cuts, tears, punctures, or other damage to polyethylene. Proceed with installation of next section of pipe in same manner.
- D. Pipe-shaped Appurtenances: Cover bends, reducers, offsets, and other pipe-shaped appurtenances with polyethylene in same manner as pipe.
- E. Odd-shaped Appurtenances: When it is not practical to wrap valves, tees, crosses, and other odd-shaped pieces in tube, wrap with flat sheet or split length of polyethylene tube by passing sheet around appurtenance and encasing it. Make seams by bringing edges together, folding over twice, and taping down. Tape polyethylene securely in place at valve stem and other penetrations.
- F. Openings in Encasement: Create openings for branches, service taps, blow-offs, air valves, and similar appurtenances by making X-shaped cut in polyethylene and temporarily folding back film. After appurtenance is installed, tape slack securely to appurtenance and repair cut, as well as other damaged area in polyethylene, with tape. Service taps may also be made directly through polyethylene, with resulting damaged areas being repaired as specified.
- G. Junctions between Wrapped and Unwrapped Pipe: Where polyethylene-wrapped pipe joins adjacent pipe that is not wrapped, extend polyethylene wrap to cover adjacent pipe for distance of at least 3 feet. Secure end with circumferential turns of tape. Wrap service lines of dissimilar metals with polyethylene or suitable dielectric tape for minimum clear distance of 3 feet away from cast or ductile iron pipe.

3.03 REPAIRS

- A. Repair cuts, tears, punctures, or damage to polyethylene with adhesive tape or with short length of polyethylene sheet or cut open tube, wrapped around pipe to cover damaged area, and secured in place.

END OF SECTION 33 11 00.17

SECTION 33 11 00.19**ABANDONMENT OF WATER MAINS****PART 1: GENERAL****1.01 SCOPE**

- A. Abandonment in place, by cutting and capping, of existing water mains, hydrants, service lines, and valves.
- B. Abandonment in place of water mains using flowable fill. Flowable fill will be utilized when abandoning water mains underneath roadways and paved areas, and at the direction of the AW Project Manager as field conditions dictate, or as specified on the Drawings.

1.02 SUBMITTALS

- A. Conform to requirements of Section 01 33 00 - Submittals.
- B. Submit product data for proposed plugs and clamps for approval.
- C. Technical information for equipment and operational procedures including projected slurry injection rate, grout pressure, method of controlling grout pressure, bulkhead and vent design, and number of stages of grout application.
- D. At least 15 days prior to commencing flowable fill abandonment activities, submit plan for abandonment, describing proposed grouting sequence and other information pertinent to completion of Work.

PART 2: PRODUCTS**2.01 GENERAL MATERIALS**

- A. Concrete for reaction blocks: Minimum 3,000 psi concrete conforming to requirements of Section – Cast-In-Place Concrete.
- B. Plugs and clamps: Applicable for type of pipe to be plugged.

2.01 FLOWABLE FILL REQUIREMENTS

- A. Unconfined compressive strength: minimum 75 psi and maximum 150 psi at 56 days as determined based on an average of three tests for same placement. Present at least three acceptable strength tests for proposed mix design in mix design report.
- B. Placement characteristics: self-leveling.
- C. Shrinkage characteristics: non-shrink.

- D. Water bleeding for fill to be placed by grouting method in sewers: not to exceed 2 percent according to ASTM C940.
- E. Minimum wet density: 90 pounds per cubic foot.

2.02 BALLAST

- A. Ballast Material: Natural rock or concrete pieces with minimum size equal to at least 10 times maximum aggregate size of flowable fill and maximum size of 24 inches. Maximum dimension shall not be more than 20 percent of minimum dimension of space to be filled.
- B. Ballast Composition: Free of regulated waste material.

PART 3: EXECUTION

3.01 DEMOLITION OF FIRE HYDRANTS, VALVES, AND PIPELINE STRUCTURES PRIOR TO ABANDONMENT

- A. Remove all watermain appurtenances, such as hydrants, valves, and valve boxes. Appurtenances shall be returned to AW for future use.
- B. Demolish and remove precast concrete adjustment rings, concrete vaults and covers, or other pipeline structures, to minimum depth of 4 feet below finished grade. Structure may be removed to greater depth, but not deeper than 18 inches above crown of abandoned water main. Poke holes in floor prior to filling.
- C. Until a fire hydrant is physically removed, any hydrant that becomes non -usable during abandonment procedures shall have a heavy duty cover placed over it and secured and marked "Abandoned" so that fire department personnel know its status.

3.02 CUTTING AND CAPPING OF MAINS

- A. Do not begin cut, plug, and abandonment operations until replacement water main has been constructed and tested, all service connections have been installed, and replacement main is approved for use.
- B. Install plug, clamp, and concrete reaction block and make cut **at the water main and/or** at the location shown on Drawings.
- C. Main to be abandoned shall not be valved off and shall not be cut or plugged other than as shown on Drawings.
- D. After main to be abandoned has been cut and capped, check for other sources feeding abandoned water main. When sources are found, notify AW Project Manager immediately. Cut and cap abandoned main at point of other feed as directed by AW Project Manager.
- E. Plug or cap ends or opening in abandoned main in manner approved by AW Project Manager. Install concrete around cap and over pipe to ensure it is not penetratable by groundwater.

- F. Backfill excavations in accordance with Section – Excavation and Backfill for Utilities.
- G. Repair street surfaces in accordance with local base and DPW regulations.
- H. Mark location of abandoned water service laterals on Drawings and provide to AW Project Manager.

3.03 CUTTING AND CAPPING OF WATER SERVICES

- A. Do not begin cut, plug, and abandonment operations until replacement service, if necessary, has been constructed and tested, and all service connections have been installed.
- B. Service lines shall be cut and capped at the water main and/or as directed by AW Project manager.
- C. Before backfilling of a capped service line is started, the capping must be observed by a representative of AW.
- D. After service to be abandoned has been cut and capped, check for any other sources feeding abandoned water service. When sources are found, notify AW Project Manager immediately. Cut and cap abandoned main at point of other feed as directed by AW Project Manager.
- E. Plug or cap ends or opening in abandoned service in manner approved by AW Project Manager. Install concrete around cap and over pipe to ensure its not penetratable by groundwater.
- F. Remove all water service surface identifications and appurtenances such as valves and valve boxes, meters, and backflow devices. Return appurtenances to AW.
- G. Backfill excavations in accordance with Section 31 23 33 – Excavation and Backfill for Utilities.
- H. Repair paved surfaces in accordance with local base and DPW regulations.
- I. Mark location of abandoned water services on Drawings and provide to AW Project Manager.

3.04 PREPARATION FOR ABANDONMENT VIA FLOWABLE FILL

- A. Have fill mix design reports and other submittals required by Paragraph 1.05 accepted by the AW Project Manager prior to start of placement. Notify the AW Project Manager at least 24 hours in advance of grouting with flowable fill.
- B. Select fill placement equipment and follow procedures with sufficient safety and care to avoid damage to existing underground utilities and structures. Operate equipment at pressure that will not distort or imperil portion of work, new or existing.
- C. Clean water lines and video with closed circuit television to identify connections, locate obstructions, and assess condition of pipe. Locate previously unidentified connections, which have not been redirected and reconnected as part of the Work,

and report them to the AW Project Manager. During placement of fill, compensate for irregularities in water pipe, such as obstructions, open joints, or broken pipe to ensure no voids remain unfilled.

- D. Perform demolition work prior to starting fill placement. Clean placement areas of water mains of debris that may hinder fill placement. Remove excessive amounts of tuberculations and other substances that may degrade performance of fill. Do not leave debris in place if filling more than 2 percent of placement volume.
- E. Remove free water prior to starting fill placement.

3.05 EQUIPMENT FOR ABANDONMENT VIA FLOWABLE FILL

- A. Mix flowable fill in automated batch plant and deliver it to site in ready-mix trucks. Performance additives may be added at placement site if required by mix design.
- B. Use concrete or grout pumps capable of continuous delivery at planned placement rate.

3.06 INSTALLATION OF FLOWABLE FILL

- A. Abandon existing water lines underneath roadways, paved areas and other required locations by completely filling water mains with flowable fill.
- B. Place flowable fill to fill volume between abandonment points. Continuously place flowable fill with no intermediate pour points, but not exceeding 500 feet in length.
- C. Have filling operation performed by experienced crews with equipment to monitor density of flowable fill and to control pressure.
- D. Pump flowable fill through bulkheads constructed for placement of two 2-inch PVC pipes or use other suitable construction methods to contain flowable fill in lines to be abandoned. These pipes will act as injection points or vents for placement of flowable fill.
- E. Place flowable fill under pressure flow conditions into properly vented open system until flowable fill emerges from vent pipes. Pump flowable fill with sufficient pressure to overcome friction and to fill water main from downstream end, to discharge at upstream end.
- F. Inject flowable fill through replaced ballast using grouting equipment and series of grout pipes discharging at bottom of placement, allowing fill to rise through ballast effectively filling all voids. Alternatively, sequentially place individual pieces of ballast at same time as flowable fill is placed. Do not fill with ballast more than 50 percent of volume at any level, to prevent nesting and void formation.
- G. Remediate placement of flowable fill which does not fill voids in water main or where voids develop due to excessive shrinkage or bleeding of fill, by using pressure grouting either from inside watermain or from surface.
- H. Plug each end of the water main being abandoned.
- I. Backfill to surface, above pipe left in place. Place and compact backfill in compliance with Section - Excavation and Backfill for Utilities.

- J. Collect and dispose of excess flowable fill material and other debris in accordance with waste material disposal or as directed by the AW Project Manager.

3.07 PROTECTION OF PERSONS AND PROPERTY

- A. Provide safe working conditions as required by OSHA and applicable State and local laws for employees throughout demolition and removal operations. Observe safety requirements for work below grade.
- B. Maintain safe access to adjacent property and buildings. Do not obstruct roadways, sidewalks or passageways adjacent to work.

3.08 ASBESTOS CONCRETE PIPE

- A. Any work involving or impacting asbestos concrete pipe must be in accordance with the EPA's document titled "Demolition Practices Under the Asbestos NESHAP".

END OF SECTION 33 11 00.19

SECTION 33 12 16.11**GATE VALVES****PART 1: GENERAL****1.01 SCOPE**

Furnish, install, and test all gate valves shown on the Drawings.

1.02 SUBMITTALS

Submit shop drawings and manufacturer's literature to the AW Project Manager for approval in accordance with Section 01 33 00.

1.03 APPLICATION

All valves shall be resilient-seated type gate valves.

PART 2: PRODUCTS**2.01 REDUCTION OF LEAD IN DRINKING WATER ACT COMPLIANCE**

- A. The Contractor shall comply with the requirements and standards of the Reduction of Lead in Drinking Water Act.
- B. Any pipe, fitting or fixture (e.g. corp stops, curb valves, gate valves less than 2 inches in diameter, backflow prevention devices, water meters, hose bibs, etc.), solder and flux installed or requiring replacement as of January 4, 2014 must be "lead free". The Contractor shall be responsible to comply with the State, local laws, ordinances, codes, rules, and regulations governing the Reduction of Lead in Drinking Water Act that may have additional limitations or requirements."
- C. The definition of 'lead free' is as follows:
 - 1. Not containing more than 0.2 percent lead when used with respect to solder and flux; and
 - 2. Not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures.

2.02 GATE VALVES

- A. All gate valves, shall be iron body, resilient-seated, nut-operated, non-rising stem gate valves suitable for buried service. The valve interior and exterior shall be epoxy coated at the factory by the valve manufacturer in accordance with AWWA Standard C550 (6-8 mil average, 4 mil minimum). The valves shall be designed for minimum differential pressure

of 250 psi and a minimum internal test pressure of 500 psi unless otherwise noted on the Drawings. Valves shall be designed to operate in the vertical position. All valves shall open left (CCW).

- B. Valves shall comply fully with AWWA Standard C509. Reduced-wall resilient seated gate valves shall comply fully with AWWA Standard C511. Valve ends shall be restrained mechanical joint or as shown on the plans or approved in writing in accordance with AWWA Standard C111. Stems shall be made of a low zinc alloy in accordance with AWWA C509 or AWWA Standard C515. Stem seals shall be double O-ring stem seals. Square operating nuts conforming to AWWA Standard C509 or AWWA Standard C515 shall be used. Valves shall open left in accordance with AW standard. All valve materials shall meet the requirements of NSF 61.

For exposed piping, valves shall be flanged joint.

2.03 VALVE EXTENSIONS

- A. Valve extensions will be required on any gate valve where the distance from the finished grade to the top of the operating nut exceeds 4 foot. Extension shall be of a locking type to prevent it from coming off the valve. Top of extension will be no deeper than 1 foot from finished grade.

PART 3: EXECUTION

3.01 INSTALLATION

- A. Install the valves in strict accordance with the requirements contained in Section 33 11 00 and detail Drawings. All valves shall be restrained.

3.02 PROTECTION

- A. After field installation of the valve all external bolts except the operating nut shall receive a layer of tape coating or approved rubberized-bitumen based spray-on undercoating applied before backfill. All buried valves shall be encased in polyethylene encasement prior to backfill. The polyethylene encasement shall be installed up to the operating nut leaving the operating nut exposed and free to be operated. Valve box shall be installed per Specification Section 33 11 00.

END OF SECTION 33 12 16.11

SECTION 33 12 16.19**AIR RELEASE AND VACUUM RELIEF VALVES****PART 1: GENERAL****1.01 SCOPE**

Furnish, install, and test all air release valves, vacuum relief valves, and combination air valves as shown on the Drawings.

1.02 SUBMITTALS

Submit shop drawings and manufacturer's literature to the AW Project Manager for approval in accordance with Section 01 33 00.

PART 2: PRODUCTS**2.01 MATERIALS**

- A. Bodies and Covers: shall be of cast iron (ASTM A126, Class B, or ASTM A48, Class 35) or ductile iron (ASTM A536, Grade 65-45-12). Cover Bolts and nuts shall be stainless steel.
- B. Valve Connections: Flanged-end dimensions and drilling for cast-iron bodies and covers shall conform with ASME B16.1, Class 125 or Class 250. Flanged-end dimensions and drilling for ductile-iron bodies and covers shall conform with ASME B16.42, Class 150 or Class 300. Flanges shall be flat-faced unless otherwise specified by AW. Threaded-end connections shall conform with the requirements for tapered pipe threads for general use, per ASME B1.20.1.
- C. Floats: Float balls and guides shall be stainless steel. For valves with inlet sizes less than 4 inches, the float shall be capable of withstanding a collapse pressure of 1,000 psig. For valves with inlet sizes 4 inches and larger, the float shall be capable of withstanding collapse pressures of 750 psig.
- D. Venting: Air release valves and the air release mechanism of combination valves shall be designed to open positively and vent air to the atmosphere at system pressures up to the maximum working pressure. Orifices shall be sized accordingly. The vent pipe shall be continuous from the valve to 2 ft (minimum) above finished grade and shall be provided with a #14 mesh screened, downward-facing elbow.
- E. For sewage force main applications, provide special long-body sewage air release valves, complete with top and bottom flushing connections and hose(s).

PART 3: EXECUTION

3.01 INSTALLATION

- A. Install the valves in strict accordance with the requirements contained in Section 33 11 00 and Drawings.
- B. If required by AW Project Manager, provide services of technical representative of valve manufacturer available on site during installation of valves.
- C. Prior to installation, remove foreign matter from within valves. Inspect valves in open and closed position to verify that the parts are in satisfactory working condition.
- D. Install valves and valve manholes and vaults where indicated on Drawings or as located by the AW Project Manager. Set manholes and vaults plumb and as detailed. Center manholes on valves. Compact around each manhole and vault for a minimum radius of 4 feet, or to undisturbed trench face, when less than 4 feet. Provide above-ground vents for manholes and vaults as indicated on Drawings.

3.02 DISINFECTION AND TESTING

- A. Disinfect water lines, valves, and appurtenances as required by Section 33 01 10.15.
- B. Conduct pressure and leakage tests as required by Section 33 01 10.13.

3.01 PAINTING OF PIPING AND VALVES

- A. Paint piping and valves located in vaults, stations, and above ground.

END OF SECTION 33 12 16.19

SECTION 33 12 19

FIRE HYDRANTS

PART 1: GENERAL

1.01 SCOPE

- A. Fire hydrants.
- B. Adjustment of fire hydrants and gate valves.

1.02 SUBMITTALS

- A. Conform to requirements of Section 01 33 00 - Submittals.
- B. Submit name of hydrant manufacturer, type of bonnet paint, and engineering control drawing number for hydrant proposed for use.

PART 2: PRODUCTS

2.01 HYDRANTS

- A. Provide hydrants in conformance with AWWA Standard C502, Dry Barrel Fire Hydrants (Latest Edition). Hydrants are approved by AW by issuance of a Certificate of Responsibility. Hydrants shall open left (counterclockwise). The following hydrant has been approved. Alternate hydrants will not be considered.

APPROVED HYDRANT TYPE

- The AW approved hydrant at all locations is Mueller Model Super Centurion 250.
- B. The AW Project Manager may, at any time prior to or during installation of hydrants, randomly select furnished hydrant for disassembly and laboratory inspection, at AW's expense, to verify compliance with Specifications. When hydrant is found to be non-compliant, replace, at Contractor's expense, hydrants, with hydrants that comply with Specifications.
- C. Provide lower hydrant barrel fabricated from Ductile Iron Pipe as single piece, connected to upper hydrant barrel by means of joint coupling that will provide three hundred sixty (360) degree rotation of upper barrel.

2.02 HYDRANT TEE

- A. Fire hydrant installations shall require the use of a hydrant tee on the main line. Hydrant valves shall be bolted to the hydrant tee for all installations. Mechanical joint hydrant tee shall be ductile iron class 350 and shall be produced in accordance with ANSI/AWWA A21.53/C153 and ANSI/AWWA A21.11/C111 for joints and ANSI/AWWA A21.4/C-104 for cement lining in sizes 3" through 24". Hydrant tee mechanical joint nuts and bolts shall be ductile iron, high strength, low alloy steel per ANSI/AWWA A21.11/C-111.

2.03 LEADS

- A. Branches (Leads): Conform to requirements of Section 33 11 00.15 - Ductile Iron Pipe and Fittings and Section 33 11 00.11 - Polyvinyl Chloride Pipe.

2.04 HYDRANT PAINTING

- A. New hydrants and refurbished hydrants shall be shop coated as specified herein.
- B. Exterior Above Traffic Flange (Including Bolts & Nuts).
 - 1. Surface preparation to be in accordance with SSPC-SP 10 (NACE 2) near white blast cleaned surface.
 - 2. Coat with three coat alkyd/silicone alkyd system with total dry film thickness (DFT) of 6 - 9 mils as follows:
 - a. Prime Coat - Oil modified alkyd primer, to be in general conformance with SSPC Paint Specification No. 25. Total dry film thickness (DFT) 2 - 3 mils.
 - b. Intermediate Coat - Heavy Duty Industrial Alkyd Enamel to be in general conformance with SSPC Paint Specification No. 104, and Federal Standard A-A-2962A. Total dry film thickness (DFT) of 2 -3 mils.
 - c. Finish Coat - Silicone Alkyd Resin Enamel to be in general conformance with SSPC Paint Specification No. 21. Total dry film thickness (DFT) to be 2 - 3 mils. Exception - hydrant bonnet shall not be finished shop coated, only intermediate coated. Install color coded finish coating of bonnet in field.
 - d. Bonnet Paint - Field apply finish coat of Silicone Alkyd Resin Enamel to be in general conformance with SSPC Paint Specification No. 21. Dry film thickness of 2 - 3 mils. Bonnet colors are to be as specified in Paragraph 3.01 to designate the available fire flow at 20 psi residual.
 - 3. Colors - Primer: Manufacturers standard color. Finish coat of hydrant body and connection caps, to be painted to match the color of existing in service hydrants on the base. Approval of the color paint to be used on the hydrants shall be approved by the American Water Project Manager prior

to the final application of paint to the newly installed hydrant.

C. Field Maintenance Painting (Exterior Above Traffic Flange)

1. Surface Preparation to be in accordance with SSPC - SP2, Hand Tool Cleaning, or SSPC - SP3, Power Tool Cleaning, depending on condition of existing paint and extent of corrosion. It is not necessary to remove tightly adhered mill scale, rust, and paint. Mill scale, rust and paint are considered tightly adherent when they cannot be removed with dull putty knife. In some severe cases where it is necessary to remove majority of existing paint, surface should be cleaned in accordance with SSPC - SP11, Power Tool Cleaning to Bare Metal.
2. When surface is cleaned to bare metal (SSPC - SP11), coat hydrant with three coat Alkyd/Silicone Alkyd system in accordance with Paragraph 2.03.B.2 as for new hydrants. When surface is cleaned to SSPC - SP2 or SSPC - SP3, coat hydrant with Silicone Alkyd Resin Enamel in general conformance with SSPC Paint Specification No. 21. Total dry film thickness of 3 - 6 mils surface is cleaned to bare metal (SSPC - SP11), coat hydrant with three coat Alkyd/Silicone Alkyd system in accordance with Paragraph 2.04.B.2 as for new hydrants.

D. Exterior Below Traffic Flange

1. Surface preparation in accordance with SSPC-SP10 (NACE 2) Near White Blast Cleaned Surface.
2. Primer and intermediate coat: coal tar epoxy in general conformance with SSPC Paint Specification No. 16. Apply two (2) coats with dry film thickness (DFT) of 8 - 10 mils each for total DFT of 16 -20 mils.
3. Finish coat: Water based vinyl acrylic mastic. Apply one coat with dry film thickness of 6 - 8 mils. Color of finish coat to be same as finish coat for exterior above traffic flange.

E. Interior Surfaces Above and Below Water Line Valve

1. Material used for internal coating of hydrant interior ferrous surfaces below water line valve must meet the requirements of local or State standards.
2. Coating shall be liquid or powder epoxy system in accordance with AWWA Standard C-550. Coating may be applied in two or three coats, according to manufacturer's recommendations, for total dry film thickness of 12 -18 mils.

PART 3: EXECUTION

3.01 INSTALLATION

- A. Set fire hydrant plumb and brace at locations and grades as shown on Drawings. When barrel of hydrant passes through concrete slab, place 1-inch-thick piece of standard sidewalk expansion joint material around section of barrel passing through concrete.
- B. Place 12-inch by 12-inch yellow indicators (plastic, sheet metal, plywood, or other material approved by AW Project Manager) on pumper nozzles of new or relocated fire hydrants installed on new water lines not in service. Remove indicators after new water line is tested and approved by Project Manager.
- C. Thrust blocks are required on all hydrant tees. If hydrant lateral is not restrained, contractor shall provide a thrust block behind hydrant shoe. Do not cover drain ports, bolts, or fittings when placing concrete thrust block.
- D. Obtain AW Project Manager's approval in writing prior to installation of hydrants which require changes in bury depth due to obstructions not shown on Drawings. Unit price adjustments will not be allowed for changes in water line flow line or fire hydrant barrel length caused by obstructions.
- E. Plug branch lines to valves and fire hydrants shown on Drawings to be removed. Deliver fire hydrants designated for salvage to AW at their base depot location.
- F. Coating Requirements:
 - 1. Apply coatings in strict accordance with manufacturer's recommendations. No requirements of this specification shall cancel or supersede written directions and recommendations of specific manufacturer so as to jeopardize integrity of applied system.
- G. Furnish affidavit of compliance that coatings furnished complies with requirements of this Specification and referenced standards, as applicable. Per NFPA standards, provide a color code for the hydrant bonnet to indicate the hydrant's available flow at 20 psi according to the following table:

Supply Water Line Flow Characteristics	Bonnet Color
Less than 500 GPM	Red
500-999 GPM	Orange
1000-1499 GPM	Green
1500 GPM & Above	Light Blue

- H. Remove and dispose of unsuitable materials and debris in accordance with local or State requirements.

END OF SECTION 33 12 19

SECTION 33 21 00**DRINKING WATER WELL REQUIREMENTS****PART 1 GENERAL****1.01 DESCRIPTION OF SCOPE**

- A. Construction and installation requirements for drinking water production well.
- B. Contractor shall furnish all equipment, labor, materials and incidentals necessary for the drilling, installation, development and testing of the production well by reverse or direct rotary method.
- C. Contractor shall adhere to all state and local permit and well standard requirements.

1.02 WELL LOCATION

- A. The well shall be drilled in the general location as provided by the Engineer. The Engineer will indicate the exact location in the field with a wooden stake marked "Well #XX".

1.03 ACCESS TO WELL SITE

- A. Contractor shall be responsible for clearing, cutting and providing physical access to the well site.

1.04 WELLHEAD PROTECTION

- A. The well shall be located away from potential sources of contamination in accordance with state or local regulations.
- B. Any well in an area of known contamination or salt water intrusion is required to have doublecased well construction as follows:
 - 1. The outermost well casing shall be constructed into the first significant confining layer which separates the water supply from any such contamination. This casing shall extend at least 20 feet into the confining layer or to the base of the confining layer.
 - 2. The annular space between the casing and the borehole and all subsequent well casings shall be permanently sealed to protect all underlying aquifers as well as the water supply.

3. All wells with casing that extends through salt water into fresh water shall be doublecased.

1.05 SUBMITTALS

A. Submit following Section 01 33 00:

1. Proposed method for disposal of debris
2. The Contractor shall supply as-built drawings or schematics, Manufacturer's operations and maintenance manuals, parts lists and vendor information for all equipment installed for this project. Information shall be compiled into a comprehensive document for the Engineer and Plant personnel use.

B. Submit data following section 01 33 00 for the following:

1. Sand
2. Cement (including ANSI/NSF 61 certification)
3. Well casing and screen
4. Submersible pumps and associated electronics and piping

C. Copies of valid drillers licenses,

D. Copies of valid well drilling, construction, installation, replacement and any other permits required by the state in which the work is being performed.

E. Design calculations for gravel pack, pump size and other calculations as applicable.

F. Results of yield and drawdown tests

G. Results of water quality tests

PART 2 PRODUCTS

2.01 MATERIALS FOR PRODUCTION WELL

A. General

1. Examine all material for defects. Do not install material which is known or thought to be defective.
2. AW reserves the right to inspect all material and to reject all defective material shipped to the job site or stored on the site. Failure of AW to detect damaged material shall not relieve the Contractor from Contractor's total responsibility for the completed work, if it leaks or breaks after installation.
3. All water used in the construction, alteration, and repair or decommissioning of any well shall be of drinking water quality.

4. All well drilling rigs, tools, pipe and other drilling equipment shall be maintained in a clean and operational state to prevent contamination to the well or work site.
5. All steel casing shall be manufactured to conform with the American National Standards Institute (ANSI) dimensions.
6. All materials used for the maintenance, replacement, repair or modification of any well shall meet the following requirements:
 - a. All well casing shall be approved for its intended use by the National Sanitation Foundation (NSF) and either the American Water Works Association (AWWA) or the American Society for Testing and Materials (ASTM)

B. Well Casings

1. All well casings shall be new. They shall be manufactured of steel pipe, ASTM Designation A-53 or A120 or the American Petroleum Institute (API) Specifications 5A or 5L. The casings shall be joined by welding in accordance with the standards of the American Welding Society.
2. Conductor and inner casing shall meet dimension requirements of AWWA Standard Specification A100-90.

C. Well Screen

1. Prior to initiation of work, the Engineer shall notify the Contractor which type of well material and well screen shall be used in the well.
2. Well screen shall be continuous-slot wire-wound screen. Slot size shall be determined based on results of sieve analyses.

D. Gravel Pack

1. The gravel pack material shall consist of clean, insoluble material, properly graded for the aquifer material.
2. Contractor shall provide for the disinfection of the gravel with a 50 mg/l free-chlorine strength solution of potable water during installation.
3. All gravel for packing shall be hard, water-worn gravel washed clean of silt, sand, dirt, and foreign matter. Crushed gravel will not be accepted. All gravel shall be well-rounded, graded, and selected; Colorado silica sand gravel or an engineer equivalent grade will be accepted. Gravel thus furnished shall be subject to approval by the Engineer.

4. Sufficient samples of the proposed gravel shall be delivered to the Engineer by the Contractor at least seven (7) days prior to anticipated placement of the material in the well. The Engineer may elect to have a testing laboratory perform a sieve analysis to verify conformance with the specified gradation. Failure of the sample to meet gradation requirements shall be grounds for rejection.

E. Grout Seal

1. All cement used in the work shall be a standard brand Portland cement conforming to the "Specifications for Portland Cement" ASTM Designation C150 Type II.
2. The grout seal shall be either a neat cement or a sand cement grout:
 - a. Sand Cement Grout - A mixture of Portland Cement (ASTM C150), sand and water in the proportion of not more than two parts by weight of sand to one part of cement with not more than seven (7) gallons of clean water per bag of cement (one cubic foot or 94 pounds) or proportion as per local regulatory requirements, shall be used. The use of special cements, bentonite to reduce shrinkage; or other admixtures (ASTM C494) to reduce permeability, increase fluidity, and/or control time of set, and the composition of the resultant slurry, must be approved in advance by the Engineer.
 - b. Neat Cement Grout - A mixture of Portland Cement (ASTM C150) and not more than seven (7) gallons of clean water per bag (one cubic foot or 94 pounds) of cement or proportion as per local regulatory requirements, shall be used. The use of special cements; bentonite to reduce shrinkage; and other admixtures (ASTM C494) to reduce permeability, increase fluidity, and/or control time of set; and the composition of the resultant slurry, must be approved in advance by the Engineer.
3. Cement shall conform to ANSI/NSF Standard 61.

F. Drilling Fluid and Testing and Handling Facilities

1. Only fresh water from an approved source shall be used in drilling fluids, whether employed alone or in combination with approved drilling additives. Any drilling additives must be approved by the Engineer prior to use and must be NSF approved.
2. The Contractor shall either excavate mud pits or use portable steel pits. The pits shall be equipped with baffles to trap cuttings or settling devices so that no cuttings or fine sand are allowed to recirculate into the hole. The pits shall

be cleaned as needed to provide adequate volume for settling of cuttings and proper fluid circulation.

3. In the event of hole stability problems, acceptable drilling fluid constituents to be used include high-yield bentonite, synthetic polymers, inorganic-phosphate thinning agents, and drilling detergents and foaming agents. Use of weighting materials should be avoided if possible. Lost-circulation materials shall not be used without prior approval of the Engineer. Use of polymer mud without some bentonite to contribute to wall-cake development is not recommended.
4. Drilling fluid discharged from the hole shall flow across a shale shaker equipped with appropriately sized screens to remove all but the finest sand, silt, and clay particles.

G. Test Pump and Accessory Equipment

1. Contractor shall provide a temporary test pump and power source capable of discharging up to 120% of the permanent pump capacity. All equipment shall be reliable for periods of 24 hours of continuous operation at the test rate.
2. An in-line flow meter capable of accurately measuring up to 120% of the permanent pump capacity continuously shall be installed on the test pump discharge line to determine the discharge rate. A control valve shall be installed so that the discharge rate can be controlled and will not vary more than 5 percent from the average rate.

H. Temporary Cap

1. The temporary cap shall be made of at least 1/4-inch thick mild steel.

I. Pump, Discharge Piping and Electrical Equipment

1. Subcontractor shall provide all labor, materials, equipment, machinery and tools necessary to put into satisfactory operation all pump and electrical equipment specified and in accordance with the General Electrical Requirements Standard Specification 26 00 10.
2. All water system piping shall meeting ASTM and NSF standards for drinking water.

- J. For potable water supply wells installed in unconsolidated formations:
1. All well casing shall be no less than four inches in inner diameter and no less than 50 feet in depth, or as per local regulatory requirements.
 2. The diameter of any well screen shall not be less than two inches
 3. All wells shall have a minimum length of 50 feet , or as per local regulatory requirements, of grout seal extending from the top of the gravel pack or top of the well screen to grade.
 4. When used, all well screens shall be properly sized to produce water free of sand and silt at the well head to the extent that the sand and silt will not interfere with the intended use and operation of the well water system.
- K. For potable water supply wells installed in consolidated formations:
1. All well casing shall not be less than six inches in inner diameter
 2. Each well shall have a minimum of 50 feet , or as per local regulatory requirements, of casing and be constructed with a minimum of 20 feet of casing set into unweathered rock.
 3. All wells shall have a minimum length of 50 feet , or as per local regulatory requirements, of grout seal extending from the bottom of the casing above to grade.
 4. If broken rock, mud seams, etc., are encountered when drilling below the base of the permanent casing, the driller shall pull out the permanent casing, ream the hole to below the problem zone and reinstall the well casing.
- L. All well casings shall extend a minimum of 12 inches above grade and shall be equipped with pitless adapters or pitless well units. The pitless adapter or pitless well unit requirement does not apply to wells equipped with a turbine pump. Exceptions to this 12 inch requirement are those well casings located in a well pit or pump house where adequate protection from surface drainage or contamination is provided and those located in driveways as flush mount installations provided with a water tight lid

- M. All wells shall be equipped with a down facing casing vent located at least 12 inches above the flood level. All vents shall be screened to prevent the entry of insects
- N. Any repairs made to existing wells or pump systems, where the well head terminates below ground, shall include extending the well casing above the land surface and installing a pitless adapter. Extending the well casing above grade shall be accomplished by either welding additional casing on the existing casing, or the use of a gasketed, watertight casing adapter

PART 3 EXECUTION

3.01 WELL SITE LOCATION

- A. Well site location shall be approved by the Engineer prior to any work.

3.02 PROVIDE ACCESS

- A. Contractor shall be responsible for any cutting, clearing and disposal of material necessary to gain access and transport all required equipment and materials to each well site.
- B. Any cutting, clearing or other physical disturbance conducted to gain access to the well sites shall be done only as necessary in order to minimize local environmental impact from the work required.

3.03 MOBILIZATION/DEMOBILIZATION

- A. Contractor shall furnish all vehicles, equipment, supplies, labor and incidentals to move his rigs and related equipment and materials to and from the site.

3.04 PRODUCTION WELL CONSTRUCTION

- A. General
 - 1. Contractor shall furnish all equipment, supplies, labor and incidentals required to drill, install and develop the production well.
 - 2. A state licensed well driller shall be onsite to directly supervise the well drilling operation.
 - 3. The work shall be performed with equipment that is adequate to complete all phases of well construction. If, in the opinion of the Engineer, the Contractor's equipment is not capable of satisfactorily performing the work provided

for in these Specifications, the Contractor at his own expense shall substitute equipment satisfactory to the Engineer.

4. Contractor shall dispose of any drilling fluids, cuttings, and discharge waters in accordance with applicable environmental regulations.
5. A well shall not be screened or gravel packed in more than one water bearing unit or across a confining layer.
6. All parts of the well water system shall be properly tested, installed, designed, located and constructed in accordance with all applicable federal, state and local regulations.
7. Adequate protection shall be provided for at the top of the casing to prevent surface contamination from entering the well during the drilling operation and when the driller is not at the drill site.

B. Installation of Conductor Casing

1. Each section of the conductor casing shall be joined to another section by lap welding in the field.
2. Suitable steel guides or spacers similar to casing guides shall be provided in order to center and hold the conductor casing in its proper position until the cement grout has been placed.
3. All field welding shall be performed in accordance with American Welding Society Standards and in such a manner as to avoid any warping. Special care shall be exercised to insure a straight and plumb casing.
4. After the conductor casing has been placed, it shall be sealed off by filling the annular space between the reamed bore wall and the conductor casing with grout.
5. The cement grout shall be pumped under pressure from the bottom of the reamed hole.
6. The seal shall be effective against infiltration of all water from the surface to the bottom of the conductor casing. The cement grout shall reach the surface of the ground around the entire perimeter of the conductor casing.

C. Pilot Bore

1. A pilot borehole, having a minimum diameter of 8-inches, shall be drilled at the well site in order to provide an indication and classification of geologic formations encountered and to allow geophysical logging to the specified depth. The exact depth to which the pilot hole shall be bored will be deter-

mined by the Engineer. The Contractor shall take all measures necessary to protect the top portions of the pilot bore from caving or raveling.

2. In order to insure the drilling of the pilot bore to alignment specifications, the Contractor shall furnish and employ a self-checking, mechanical drift indicator to measure hole deflection. The drift from vertical shall be not more than 0.5 degree. Any deviation shall be corrected by the Contractor at Contractor's expense.
3. The Contractor shall collect representative sample of the cuttings at 10-foot depth intervals.
4. The Contractor shall label and preserve each sample. All containers are to be labeled to indicate the depth intervals of the collected sample, and stored in a manner to prevent breakage or loss.
5. A complete lithologic drilling log and shift record of construction activities including drilling rate shall be prepared by the Contractor for the Engineer. Upon completion of the log, copies shall be furnished to the Engineer.
6. A record shall be maintained showing any variation in the addition and amount of approved clays or chemical products or water required during drilling. The depths at which such changes are required shall be shown in the daily reports.
7. Permanent records of all drilling and related operations shall be made by the Contractor in accordance with State or local laws.

D. Downhole Geophysical Survey

1. Upon completion of the pilot hole, the Contractor shall conduct the geophysical logging of the pilot borehole. The Contractor shall allow for log interpretations after logging has been completed prior to proceeding with any additional work.
2. The Contractor shall perform, or have performed (logging firm shall be approved by the Engineer), the following logs for the pilot borehole:
 - a. Spontaneous Potential and Resistivity Log (Electric Log)
 - b. Acoustic Log
 - c. Gamma Log
 - d. Caliper Survey
 - e. Neutron Log.
3. The interval to be logged shall be the total depth of the borehole, subject to satisfactory borehole conditions, the limitations of the logging technique, and/or other directives from the Engineer.

4. The well log header shall include:

- a. well location and elevation
- b. owner's name
- c. OSE permit file number
- d. type, weight, resistivity, and temperature of drilling fluid
- e. resistivity of the filtrate and any other information necessary for proper interpretation of the logs.

5. Copies of each log, including a digital copy, shall be furnished to the Engineer.

6. The sampling interval shall be no greater than 0.5 feet.

E. Reaming Pilot Bore for Well Casing

1. The pilot hole shall be reamed based on well design after the pilot hole is completed and logs interpreted.
2. A record shall be kept showing any variation in the addition and amount of water, and other additives required during the reaming operation. The depths at which such changes are observed shall be shown in the daily reports.

F. Caliper Survey

1. Upon completion of the drilling operations, the Contractor shall conduct or arrange for the borehole to be surveyed for the hole cross-section.
2. If the caliper survey indicates that the hole is smaller than the specified diameter by more than one inch at any point, the hole shall be re-reamed and resurveyed. If corrective measures are required, the Contractor shall provide and pay for all corrective measures and additional surveys.
3. After the caliper survey has been made, and the survey approved by the Engineer, installation of the well casing shall commence.

G. Installation of Well Casing

1. When the drilling operation has been completed to the satisfaction of the Engineer, the blank and screen casing shall be installed. The lengths and intervals of each casing type shall be determined by the Engineer.
2. The casing shall be centered in the hole. All field joints shall be properly lap-welded during installation with a continuous 1/2-inch fillet weld. Bar holes in the casing are prohibited and shall not be used.

3. The bottom of the casing shall be at a sufficient distance above the bottom of the bore hole to ensure that the casing will not be supported by the bottom of the boring.
4. If, for any reason, the casing cannot be landed in the correct position or at a depth acceptable to the Engineer, the Contractor shall remove the casing from the borehole and correct problems at the Contractor's expense.
5. If the Contractor is not successful at constructing the well to specification, Contractor shall construct another well on the site at the direction of the Engineer and complete this well in accordance with the specifications and drawings at no additional cost.
6. If the casing should collapse prior to well completion, it shall be withdrawn and replaced at the Contractor's expense.
7. All work required to be repeated, and all additional materials, labor and equipment required, shall be furnished at the expense of the Contractor, and no claim for additional compensation shall be made or be allowed therefore.
8. Centralizing guides shall be installed by the Contractor immediately above and below the perforated section of the casing and every 60 feet thereafter. The guides shall be welded to the casing at the top and bottom with 2-inches minimum standoff from the casing.

H. Well Screen

1. The location of the sections of well screen shall be determined by the Engineer after a study of the driller's log and the drilling cuttings.
2. Prior to initiation of work, the Engineer shall notify the Contractor which type of well screen shall be used in the well.

I. Installation of Gravel Pack

1. Gravel, as specified by the Engineer, shall be installed in the annular space between the bore hole and the casing. The gravel shall be carefully installed to insure complete filling of the annular space from the bottom of the bore hole to the bottom of the grout seal..
2. Contractor shall provide for the disinfection of the gravel during its placement as detailed in Section 2.01 -D-2 of these specifications.
3. The gravel pack shall not extend into any confining layer above the screen:

- a. For well screens less than or equal to 20 feet in length, the filter pack shall not extend more than 10 feet above the top of the well screen.
 - b. For well screens greater than 20 feet in length, the filter pack shall not extend more than 50 percent of the length of the well screen itself above the top of the well screen. The filter pack shall not extend more than 50 feet above the top of any well screen.
4. During the entire gravel packing operation, clean water shall be circulated through the perforated casing and up the annular space outside of the casing. When the gravel has been placed, a swab shall be carefully worked opposite all perforated sections of casing while circulating with clean water. As the gravel settles, more shall be added. This operation shall be continued until there is no further measurable settlement of the gravel, and the gravel has been washed clean.
5. A gravel refill pipe shall be installed and terminate above the ground surface, are sealed in place, are provided with water tight caps and the well casings are eight inches or greater in diameter. Upon completion of the well development the annulus shall be refilled with gravel.
6. The volume of gravel used shall be no less than the calculated volume of the annular space between the casing and the wall of the hole based upon the caliper survey. The Contractor shall supply the devices required to measure the gravel.
7. A cement seal shall be placed on top of the gravel pack.

J. Alignment of Well

1. Tests to determine the plumbness and alignment of the screen and casing shall be made by the Contractor after the well has been completed, but prior to its being accepted.
2. The wells shall be constructed sufficiently round, straight and plumb so that the maximum size pump can be installed without difficulty.
3. The standard for plumbness shall be that the axis of the well casing not deviate from the vertical in excess of one half the inside diameter of the casing per 100 feet of depth.
4. If Engineer determines that the plumbness or alignment is outside the specifications, it will be corrected by the Contractor at Contractor's expense.

K. Placement of Cement Grout

1. Installation of the grout shall be carried out by pumping with hydraulic or pneumatic pressure in a continuous operation through a feed line inserted between the casing and the wall of the hole.
2. The feed line shall be lowered to within two feet of the bottom of the zone to be grouted. The line shall be slowly withdrawn as the annulus fills with grout, but care shall be taken to insure that the discharge end of the feed line remains submerged a minimum of five feet in the grout at all times while grouting operations are in progress. After any section of grout has been placed, it shall be allowed to set for a period of 24 hours, or longer as directed by the Engineer, before further operations are undertaken.

3.05 DEVELOPMENT OF THE WELL

- A. Contractor shall develop the well in order to remove native silt and clay, drilling fluid residue, and the finer fraction of the gravel pack and aquifer material. The objective of the development process is to assure maximum specific capacity and sand free water.
- B. Well Development by Bailing and Swabbing
 1. Development by bailing and swabbing to clean the gravel pack and remove wall-cake material shall begin immediately after the gravel pack is in place. The Contractor shall initiate development with a bailer equipped with a foot valve suitable for removing fill material from the bottom of the well. The Contractor shall proceed with care to bail fluid from the well, starting at the top of the fluid column.
 2. The Contractor shall bail the well until the fluid level is at static head. The Contractor shall then lower the bailer into the perforated section of the well, gently raising and lowering the bailer through the perforated section to initiate flow through the perforated casing. After the Contractor has sufficiently shown that unrestricted flow through the perforated casing is occurring, he shall bail any fill from the bottom of the well to within 3-feet of the shoe.
 3. After the initial bailing is performed, the Contractor shall develop the well by line swabbing. Development by line swabbing shall be performed with a rubber-flanged swab of a diameter no more than 1/2-inch smaller than the inside diameter of the casing and screen. The swab shall be equipped with a valve that will open to allow rapid fall of the swab but will close when being pulled upward through the perforated casing. The Contractor shall take care not to exert undue differential pressure on the well casing and perforated casing while swabbing.
 4. After initial development by swabbing is performed, the Contractor shall treat the well with an NSF approved solution of sodium phosphate (SAPP). Treatment shall be per manufacturer's specifications.

5. The Contractor may be required to periodically interrupt development by swabbing to bail fill material from the well. Development by swabbing shall continue until the Engineer is satisfied that the well is adequately developed and there is no movement of the gravel pack level over a period of one-hour of swabbing.

6. At the conclusion of swabbing, the Contractor shall remove any fill material from the bottom of the well within 3-feet from the shoe.

C. Development by Pumping and Surging

1. The Contractor shall furnish, disinfect, install, operate, and remove a deep-well turbine pump for developing the well.
2. The prime mover shall be a variable speed type. The Contractor shall furnish and install discharge piping for the pumping unit of sufficient size and length to conduct water to the discharge point selected and identified by the Engineer.
3. The Contractor shall furnish and install a device to measure instantaneous flow total flow. Water levels shall be measured by an electric-line probe calibrated to 0.01 ft. increments.
4. The initial pumping rate shall be restricted and, as the water clears, shall be gradually increased until the maximum rate is reached.
5. At proper intervals as determined by the Owner's Representative, the pump shall be stopped and the water in the pump column shall be allowed to surge back through the pump bowls and through the casing perforations.
6. The cycle of pumping and surging shall be repeated until the discharged water is clean of sand, silt, and mud and until there is no increase in specific capacity during at least 12 hours of continuous pumping and surging.
7. The Contractor shall continue development until the following conditions have been met:
 - a. Sand production is less than 15 ppm within 20 minutes after commencement of pumping at the maximum rate.
 - b. Average sand production does not exceed 5 ppm for a two-hour cycle after commencement of pumping at the maximum rate.
 - c. Specific capacity of the well is essentially stable for a minimum of 2 hours and the specific capacity is the same for all of the different flow-rate steps after equal amounts of time.
8. The Contractor shall keep independent records of pumping time, flow rate, pumping level, sand production, and other discharge characteristics.

3.06 8-HOUR PRELIMINARY PUMPING TEST

- A. Contractor shall furnish all equipment, labor, supplies and incidentals required to conduct an 8 hour step drawdown pumping test on the production well, including all pipelines, meters, orifices, gages and temporary utilities.
- B. The pumping test shall be conducted under the supervision of the Engineer.
- C. Contractor shall provide a temporary test pump with a capability of discharging up to 120% of the rated capacity of the permanent production pump. The temporary pump shall have sufficient throttling devices so that the rate of discharge may be controlled. The permanent production pump shall not be used for the pumping test.
- D. The flow from the test shall not cause significant erosion at the discharge point. There shall be no trace of chlorine residual at the start of the pump test.
- E. Pump rates will be conducted using a step method. Data obtained from this test shall be used to design the permanent pumping equipment. The Contractor shall gather enough information to be able to determine the setting for the new pump, and prepare a plan for the 24-hour pump test.

3.07 24-HOUR PUMPING TEST

- A. Contractor shall furnish all equipment, labor, supplies and incidentals required to conduct a 24 hour constant rate pumping test on the production well, including all pipelines, meters, orifices, gages and temporary utilities.
- B. The pumping test shall be conducted under the supervision of the Engineer. If the test is less than 24 hours, the Contractor will be paid by unit price as specified in the Bid Section.
- C. Contractor shall provide a temporary test pump with a capability of discharging up to 120% of the rated capacity of the permanent pump. The temporary pump shall have sufficient throttling devices so that the rate of discharge may be controlled. The permanent production pump shall not be used for the pumping test.
- D. The flow from the test shall not cause significant erosion at the discharge point. There shall be no trace of chlorine residual at the start of the pump test.
- E. The 24 hour pump test shall be conducted in accordance with the following guidelines:
 - 1. Static water levels must be measured and recorded in the pumping well immediately before the start of the test.

2. The time intervals for reading water levels are suggested as in Table 1 given below and they should be followed as close as possible during the 24-hour draw-down pump test and subsequent recovery test. There should be at least 90% recovery in the pumped well.

Table 1

TIME INTERVALS FOR WATER LEVEL
MEASUREMENTS DURING 24-HOUR PUMPING TEST

<u>Time into Test</u>	<u>Measurement Interval</u>
0 to 5 minutes	Every 1/2 minute
5 to 15 minutes	Every 1 minute
15 to 60 minutes	Every 5 minutes
60 to 120 minutes	Every 10 minutes
120 to 480 minutes	Every 30 minutes
480 to 1440 minutes	Every 60 minutes

3. Pumping rate should be recorded at least every 10 minutes for the first hour and every half hour thereafter. Necessary adjustments should be made to keep the pump rate constant throughout the test.
4. The selected pumping rate for the pump test should exceed the design pumping rate by 20%.
5. After the pump is stopped, measure and record recovery water levels following the above schedule.
6. Contractor must submit a pumping test plan for review and approval prior to conducting the test. This shall include a sketch of the well field with dimensions between wells, anticipated flow rates, means of discharge, equipment to be used, method of reading water levels, and all other pertinent information. Analysis of data with conclusions must be submitted by the Contractor to the Engineer.
7. The 24 hour pumping test is a continuous test, no partial payments will be made to the Contractor for test interruptions that are caused by the Contractor.

3.08 DISINFECTING THE WELL

- A. Following the conclusion of the development pumping, Contractor shall disinfect the well according to the procedures established by local, state or federal regulatory agencies.
- B. The well shall be thoroughly clean of all foreign substances before disinfection. Oil, grease, or joint dope shall be removed by swabbing the casing with an alkaline solution if necessary.

- C. The well shall be disinfected with a chlorine solution using a calcium hypochlorite compound with 70 percent solution available chlorine. The hypochlorite shall be dissolved in a solution at the ground surface and applied so that a concentration of at least 50 ppm of available chlorine is available in all parts of the well.
- D. The disinfecting solution shall be allowed to stand in the well for at least one hour and then pumped until the discharge contains no residual chlorine.
- E. Chlorinated water shall be disposed in accordance with state and/or local regulations by the Contractor

3.09 DISPOSAL OF DRILLING WASTES

- A. The Contractor shall provide all facilities, equipment, and materials required for the removal of drilling wastes and excess development materials from the well site.

3.10 DISPOSAL OF DEVELOPMENT AND TEST WATER

- A. The Contractor shall provide all pipeline and facilities for discharging pumped water from the well site. The Contractor shall so design his system that no erosion results from the discharge.

3.11 INSTALLATION OF TEMPORARY CAP

- A. Contractor shall furnish all equipment, labor, supplies and incidents to install a temporary cap on the production well.

4.0 WELL HOUSE

- A. The Contractor shall provide all equipment, labor, supplies and incidents to install a well house for the production well and associated piping and electrical equipment.
- B. The Contractor shall construct the well house in accordance with design requirements specified by the Engineer. The building shall be designed and installed to permit access for the removal and repair of the pump and related appurtenances.
- C. The building shall meet all building codes and shall be constructed to properly secure the well and all components of the pumping system against vandalism, flooding and other identified hazards.
- D. The area surrounding the well house shall be fenced and locked. Chain link and barb wire fencing shall be used.

5.0 PUMPS AND ASSOCIATED ELECTRICAL AND PIPING

- A. Pumps and electrical equipment in remote areas shall be protected against electrical surge and, where necessary, lighting strikes.
- B. Pumps shall be designed based on required demand and well capability.
- C. Well pumps and appurtenant equipment shall be designed and installed to ensure adequate protection of the water supply and protection against freezing of the water
- D. Each well pump shall have a check valve
- E. In a screened well, the well pump setting and suction inlet shall be located so that the pumping level of the water cannot be drawn below the top of the screen
- F. Each pump shall be mounted so as to minimize vibration and noise and to minimize damage to the pump.
- G. A pressure switch and a thermal overload switch shall be included on all pump installations.
- H. A pressure switch is required on all positive displacement pumping systems.
- I. Pump controls or accessories shall either be housed in a secured building or be enclosed in a weatherproof, locked cabinet.
- J. All well systems shall be connected to the facilities SCADA system as specified by the Engineer.

6.0 WELL ABANDONMENT

- A. All boreholes and completed wells that require abandonment shall be abandoned in accordance with State and local requirements
- B. Contractor shall furnish all equipment, labor, supplies and incidentals required to properly abandon the borehole or well and shall include:
 - 1. Concrete, cement grout, bentonite, or sealing clay shall be used as primary sealing materials and shall be placed from the bottom upward by methods that will avoid segregation or dilution of material.
 - 2. Complete, accurate records shall be kept of the entire decommissioning procedure.
 - 3. The depth of each layer of all sealing and backfilling materials shall be recorded.
 - 4. The quantity of sealing materials shall be recorded.

5. Any changes in the well made during the sealing, such as perforating casing, shall be recorded in detail..

7.0 EXCEPTIONS

- A. Any exceptions from this standard to the material or material standard specification, installation, well or pump design, well development or testing shall be at the discretion of the Engineer and only with Engineer's written approval.

8.0 SAFETY DURING CONSTRUCTION

- A. All equipment shall be maintained in a safe manner during construction. The work area shall at all times be kept neat and free from hazards.

END OF SECTION

DIVISION 43
GAS, LIQUID, AND STORAGE

**SECTION 43 20 10
PUMPS, GENERAL**

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide all pumps and pumping appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated in the Contract Documents.
- C. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the Work and for coordination of design, assembly, testing, and installation of the Work of each pump Section; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each pump Section. Unless otherwise indicated, the single Manufacturer shall be the Manufacturer of the pump.
- D. Single Manufacturer: Where two or more pump systems of the same type or size are required, the pumps shall all be produced by the same Manufacturer.

1.2 CONTRACTOR SUBMITTALS

- A. General: Submittals shall be furnished in accordance with Section 01 33 20 - Contractor Submittals.
- B. Shop Drawings: Shop drawings shall contain the following information:
 - 1. Pump name, identification number, and specification Section number.
 - 2. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump. The equipment Manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions. A family of performance curves at intervals of 100 rpm from minimum speed to maximum speed shall be provided for each centrifugal pump equipped with a variable frequency drive.
 - 3. The Contractor shall require the Manufacturer to indicate on the performance curves the limits recommended for stable operation without surge, without cavitation, and without vibration (except vibration within specified allowable limits). The stable operating range shall be as wide as possible based on actual hydraulic and mechanical measurements taken during the factory performance tests of the pumps.
 - 4. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.
 - 5. Data, in accordance with Section 26 20 00 Low Voltage AC Induction Motors OR, for the electric motor proposed for each pump.
 - 6. Elevation of proposed Local Control Panel showing panel-mounted devices, details of enclosure type, single line diagram of power distribution, and current draw of panel,

- and list of all terminals required to receive inputs or to transmit outputs from the Local Control Panel.
7. Wiring diagram of field connections with identification of terminations between Local Control Panels, junction terminal boxes, and equipment items.
 8. Complete electrical schematic diagram.
- C. Operation and Maintenance Manual: The Manual shall contain the required information for each pump Section.
- D. Spare Parts List: A Spare Parts List shall contain the required information for each pump Section.
- E. Factory Test Data: Signed, dated, and certified factory test data for each pump system which requires factory testing, submitted before shipment of equipment.
- F. Certifications
1. Manufacturer's certification of proper installation.
 2. Contractor's certification of satisfactory field testing.

1.3 QUALITY ASSURANCE

- A. Factory Testing: The following tests shall be conducted on each indicated pump system:
1. Motors: All motors of sizes 100 hp and larger shall be assembled, tested, and certified at the motor factory and the working clearances checked to insure that all parts are properly fitted. The tests shall be in accordance with ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators, and ANSI/IEEE 115 - Test Procedure for Synchronous Machines, including heat run and efficiency tests. All computations shall be recorded and certified and dated copies of the test results shall be furnished.
 2. Pump Systems: All centrifugal pump systems 100 hp and larger shall be tested at the pump factory in accordance with the Test Code for Centrifugal Pumps of the Standards of the Hydraulic Institute, Inc., Performance Acceptance Test Grade 1B. Tests shall be performed using the complete pump system to be furnished, including the motor.
 3. For motors smaller than 100 hp, the Manufacturer's certified test motor shall be acceptable. Testing of prototype models will not be acceptable. The following minimum test data shall be submitted:
 - a. Hydrostatic test data
 - b. A minimum of five hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute.
 - c. Pump curves showing head, flow, bhp, efficiency, and NPSH requirements.
 - d. Certification that the pump horsepower demand did not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve. not change unless the style definition is changed.
 4. Factory Witnessed Tests: Witness Tests are not required.
- B. Warranty: Unless otherwise specified, each pump shall be supplied with manufacturer's standard warranty of one (1) year from substantial completion.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Compliance with the requirements of the individual pump Sections may necessitate modifications to the Manufacturer's standard equipment.
- B. Performance Curves: All centrifugal pumps shall have a continuously rising curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or engine, or encroach on the service factor.
- C. No cavitation shall be allowed in pumps operating within the stable operating range for the specified operating conditions. For the purposes of this provision, cavitation shall be recognized and accepted as being present in a pumping unit if cavitation noise can be perceived either by the human ear or by acoustic instruments or devices. The presence or absence of cavitation noise shall be verified by the Owner during both the factory performance tests of the pumps and during operation of the pumps up to the end of the warranty period. To assist in revealing potential cavitation during the factory performance tests, in addition to all other required tests, the Manufacturer shall force the pumps to operate at the specified minimum net positive suction head available for each of the following conditions: minimum flow rate, design flow rate and head, and maximum flow rate.
- D. All components of each pump system provided under the pump Sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors, variable frequency controls if required, necessary mountings, and appurtenances.

2.2 MATERIALS OF CONSTRUCTION

- A. All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:
 - 1. Cast iron pump casings and bowls shall be of austenitic ductile iron, conforming to ASTM A 439 - Specification for Austenitic Ductile Iron Castings, or equal.
 - 2. Bronze pump impellers shall conform to ASTM B 62 - Specification for Composition Bronze or Ounce Metal Castings, or B 584 - Specification for Copper Alloy Sand Castings for General Applications, where dezincification does not exist.
 - 3. Stainless steel pump shafts shall be Type 416 or 316. Miscellaneous stainless steel parts shall be of Type 316.
 - 4. All anchor bolts, nuts, and washers that are not buried or submerged shall be hot-dip galvanized, unless otherwise specified in individual pump Sections. Buried or submerged bolts, nuts, and washers shall be stainless steel in accordance with Section 05 50 00 - Metal Fabrications.

2.3 PUMP COMPONENTS

- A. Flanges: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 or B16.5 - Pipe Flanges and Flanged Fittings Dimensions.
- B. Lubrication: Vertical pump shafts of clean water pumps shall be product water-lubricated, unless otherwise specified. Deep-well pumps and pumps with dry barrels shall have water- or oil-lubricated bearings and seals and enclosed lineshafts. Pumps for other process fluids shall be lubricated as indicated.
- C. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.
- D. Vortex Suppressors: Vertical pumps with marginal submergence shall be provided with vortex suppressors.
- E. Drains: All gland seals, air valves, cooling water drains, and drains from variable frequency drive equipment shall be piped to the nearest floor sink, or drain, with galvanized steel pipe or copper tube, properly supported with brackets.
- F. Grease Lubrication: For all vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10-inches and larger, the Contractor shall provide a stainless steel tube attached to the column for grease lubrication of the bottom bearing.
- G. Stuffing Boxes: Where stuffing boxes are indicated for the pump seal, they shall be of the best quality, using the Manufacturer's suggested materials best suited for the specific application. For drainage and liquids containing sediments, the seals shall be fresh-water flushed, using lantern rings.
1. Unless otherwise specified, the packing material shall be interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following:
 - a. Shaft speeds - up to 2500 rpm
 - b. Temperature - up to 500 degrees F
 - c. pH range - 0 to 14.
 2. If fresh water is not available, the seal shall be flushed with product water cleaned by a solids separator as manufactured by John Crane Co., Lakos (Claude Laval Corp.), or equal.
- H. Mechanical Seals: Mechanical seals shall be fresh water-flushed unless indicated otherwise; in which case product water cleaned by a solids separator as above shall be used. Mechanical seals shall be as manufactured by the following, or equal:

Type	Manufacturer
Wastewater Pumps	Double seals: John Crane Type L Double; Borg-Warner Type L Double; Chesterton

Abrasives, Grit, or Lime Slurry Pumps	Double seals: John Crane Type I (hard faces); Borg-Warner Type L (hard faces); Chesterton
Chemicals or Corrosive Liquid Pumps	Single seals: John Crane Type 8-1, 9; Borg-Warner Type Q, QB; Chesterton
Water Pumps Hot and Cold	Single seals: John Crane, Type I, 21; Borg-Warner Type L; Chesterton

- I. Where indicated, a buffer fluid must be circulated a minimum 20 psi above discharge pressure, or as required by the Manufacturer, in order to maintain reliable seal performance.
- J. Mechanical seals for all services other than chemicals and corrosives shall be equipped with nonclogging, single coil springs and nonsliding, internal, secondary elastomers. Metal parts shall be Type 316 stainless steel, Alloy 20, or Hastelloy B or C.

2.4 PUMP APPURTENANCES

- A. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed, and Manufacturer's name and model number. Dimension and flow information shall be in metric units, followed by English units in parentheses.
- B. Solenoid Valves: The pump Manufacturer shall provide solenoid valves on the water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical ratings shall be compatible with the motor control voltage.
- C. Gauges: all pumps (except sample pumps, sump pumps, and hot water circulating pumps) shall be equipped with pressure gauges installed at pump discharge lines. Pump suction lines shall be provided with compound gauges. Gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.
 - 1. Where subject to shock or vibrations, the gauges shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.
 - 2. Pressure and compound gauges shall be provided in accordance with Section 17205 – Pressure Gauges.

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

- A. Inspection, Startup, and Field Adjustment: Where required by the individual pump Sections, an authorized service representative of the Manufacturer shall visit the site for the number of days indicated in those Sections to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.
 - 1. Installation of the equipment.

2. Inspection, checking, and adjusting the equipment.
3. Startup and field testing for proper operation.
4. Performing field adjustments to ensure that the equipment installation and operation comply with the specified requirements.

B. Instruction of the Owner's Personnel

1. Where required by the individual pump Sections, an authorized training representative of the Manufacturer shall visit the site for the number of days indicated in those Sections to instruct the Owner's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.
2. The representative shall have at least two years' experience in training. A resume for the representative shall be submitted.
3. Training shall be scheduled a minimum of three weeks in advance of the first session.
4. Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the material.
5. The training materials shall remain with the trainees.
6. The Owner may videotape the training for later use with the Owner personnel.

3.2 INSTALLATION

- A. General: Pumping equipment shall be installed in accordance with the Manufacturer's written recommendations.
- B. Alignment: All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.
- C. Lubricants: The Contractor shall provide the necessary oil and grease for initial operation.

3.3 PROTECTIVE COATING

- A. Materials and equipment shall be coated as required in Section 09 90 00 – Painting and Coating.

3.4 FIELD TESTS

- A. Where required by the individual pump Sections, each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating of bearings.
- B. The following field testing shall be conducted:
1. Startup, check, and operate the pump system over its entire speed range. Vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the Engineer.
 2. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.

3. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test, unless insufficient liquid volume is available.
 4. Electrical and instrumentation tests shall conform to the requirements of the Sections under which that equipment is indicated.
- C. Field testing will be witnessed by the Engineer. The Contractor shall furnish 5 days advance notice of field testing.
- D. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.
- E. After each pumping system has satisfied the requirements, the Contractor shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests, a listing of all persons present during the tests, and the test data.
- F. The Contractor shall bear all costs of field tests, including related services of the Manufacturer's representative, except for power and water which the Owner will bear. If available, the Owner's operating personnel will provide assistance in field testing.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

SECTION 43 25 10
SUBMERSIBLE WELL PUMPS AND MOTORS

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide and install submersible non-clog pumps and appurtenances, complete and operable, in accordance with the Contract Documents. Furnish and install guide rails and supports to remove pumps from wet well installations.
- B. The requirements of Section 43 20 10 – Pumps and Section 11 00 00 – Equipment General apply to this Section.
- C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump which will best satisfy the indicated requirements.

1.2 CONTRACTOR SUBMITTALS

- A. Shop Drawings: Submittals shall be made in accordance with Section 01 33 20 – Contractor Submittals and Section 43 20 10 – Pumps, General. At a minimum, submit the following information:
 - 1. Pump performance curves;
 - 2. Pump outline drawing and typical installation guides;
 - 3. Electric motor data;
 - 4. List of spare parts.
- B. Spare Parts List: The Contractor shall obtain from the manufacturer and submit at the same time as Shop Drawings a list of manufacturer suggested spare parts for each piece of equipment specified. The Contractor shall also furnish the name, address and telephone number for the nearest distributor for each piece of equipment.
- C. Operation and Maintenance Manual: Provide technical operation and maintenance manuals in accordance with Section 01 33 20 – Contractor Submittals.

1.3 QUALITY ASSURANCE

- A. Firms regularly engaged in manufacture of pumping equipment of types required, whose equipment has been in satisfactory use in similar service for not less than five years.
- B. Warranty: Provide pump manufacturer's standard warranty in accordance with Section 43 20 10 – Pumps, General.
- C. The Contractor shall correct defects in the pumping system upon notification from the Owner within 5 years from the date of Substantial Completion. Corrections shall be completed within 60 days after notification

PART 2 - GENERAL

2.1 GENERAL

- A. Pump seals shall be designed for complete water tightness at 65-ft submergence for 30 minutes and data on factory testing and quality control shall be submitted with the Shop Drawings.

B. Pump Identification:

Pump Name	Sage Well II R Submersible Pump
Equipment number	See Drawing M-03
Location	Sage Well II R

2.2 OPERATING CONDITIONS

- A. The Work of this Section shall be suitable for long term operation under the following conditions:

Parameter	Units	Value
Drive		Variable Speed
Ambient environment		Submersible
Ambient temperature	Deg F	35 to 100
Fluid service		Potable Water
Fluid temperature	Deg F	50 to 70
Fluid pH range		6 to 8
Fluid specific gravity		1.0
Project site elevation	ft, msl	300
Minimum available NPSH	ft	10
Power supply		480-volt, 3-phase, 60 Hz

2.3 PERFORMANCE REQUIREMENTS

Parameter	Units	Value
Maximum shutoff head	ft	550
Design flow capacity	gpm	1200
Design flow pump head, TDH	ft	425
Design flow minimum pump Hydraulic efficiency	%	80
Design flow NPSH available	ft	25
Pump Setting depth	ft	470 below ground surface
Maximum pump speed	rpm	1760
Maximum motor speed	rpm	1760
Maximum motor size	HP	250
Size of column pipe	inches	8

2.4 PUMP REQUIREMENTS

- A. Construction: Construction of submersible well pumps shall conform to the following requirements:

Pump casing	Class 30 Cast Iron
Impeller	Enclosed B584 Bronze
Bearings	Liquid Lubricated
Shaft	Stainless steel
Mounting Method	In pitless unit
Pump Connection	NPT

- B. The pump bowls shall be of close grained, cast iron ASTM A48 Class 30. The water passages on bowl sizes 4" through 20" shall be lined with porcelain enamel and larger sizes shall be Heresite or fusion epoxy-lined to reduce friction losses; shall be free of blow holes, sand holes and other detrimental defects, and shall be accurately machined and fitted. The impellers shall be of bronze ASTM B584C86500 Manganese bronze or 416 Stainless Steel and statically and dynamically balanced. Impellers shall be securely fastened to the shaft with taper split bushings of steel. The pump shaft shall be of A276GR416 stainless steel, turned, ground and polished. It shall be supported by bronze bearings of ASTM B505C84400 above and below each impeller. The size of the shaft shall be no less than that determined by ANSI/AWWA Specifications E101, Section A4.3 paragraph 4.3.3. The pump assembly shall be NSF-61 materials.
- C. PITLESS UNIT: A complete pitless unit shall be supplied and installed by the contractor including all required pump and appurtenances in pitless unit. The pump supplier or licensed well driller shall make all modifications to the existing well casing to provide and install the pitless unit. See Drawing M-03.
- D. SOUNDER TUBE: Two (2) PVC sounder tubes shall be installed with the column. The sounder tubes shall be a minimum of 1.25" schedule 80 flush thread PVC pipe. Threads shall conform to ASTM F480. The sounder tubes shall extend from the top of the pump assembly through the pitless unit and to the surface. The bottom of the sounder tubes shall be capped. The bottom 10 feet and the top 10 feet of the sounder tubes shall be slotted, in accordance with ASTM F-480. The slot size shall be 0.050". The sounder tubes shall be strapped to the discharge column with stainless steel bands.
- E. WATER LEVEL INDICATION. A complete water level indication system for the water well shall be provided. The system shall consist of two components. A submersible analog transmitter and a digital indicator.
1. The level transmitter shall be a two-wire type, 0.84 inches in diameter. The transmitter shall produce a 4 to 20 milliamp signal proportionate to the span range of the transmitter. The span range shall exceed the static water level of the water well. An integral electrical cable shall suspend the transmitter. The cable shall include a Kevlar standing capable of supporting 200 pounds. The transmitter shall be an INW model PS98i or approved equal.
 2. The digital indicator shall receive the analog signal, display the level, provide local alarm to the pump controls, and retransmit the analog signal to a telemetry system provided by others. The indicator shall be housed in a fiberglass enclosure. The

indicator shall be a Moore model 330 with an enclosure made by Hoffman or approved equal.

- F. Pump, with its cable and appurtenances, shall be able to withstand continuous submergence to a minimum depth of 400 feet, whether running or off, without leakage.
- G. Motor: The motor shall be a squirrel cage induction motor designed for continuous underwater operation in conformance with NEMA standards. A Kingsbury type thrust bearing shall be used to carry the pump downthrust load. The bearing shall be rated for a minimum of 130% of the maximum pump down thrust load. Motor shall be filled with a water & propylene glycol solution for cooling and lubrication. No oils or grease lubrication shall be used. A flexible diaphragm shall be provided to permit expansion of internal motor fluid. The shaft seal shall be a Nitrile Rubber lip seal or a Nitrile, Carbon, Carbide and/or Ceramic face seal. The assembled pump and motor system shall be furnished as a complete unit. The pump motor shall be NSF-61 materials. Motor shall be 90% minimum efficiency.
- H. Electrical Cable: The motor lead to electrical cable splice shall conform to IEEE and NEC standards. The electrical wire shall be annealed bare 19 stranded copper conductors insulated with PVC. All power conductors plus a ground conductor shall be jacketed in a flat heavy duty PVC jacketing. All cable shall be UL listed per UL83 Type TW Construction A, as Deep Well Submersible Cable. Power conductors shall be sized to allow no more than 5% of voltage loss in the entire length. Grounding conductor shall be sized per Table 24.3 of UL83. The electrical cable shall be strapped to the discharge column with stainless steel bands. Electrical cable shall be sealed pressure tight through the discharge head as required to meet the conditions indicated herein.
- I. Discharge Column: The discharge column shall be Schedule 40 wall thickness ASTM A53 black steel pipe w/ threaded ends and couplings. Intermediate check valves shall be placed at intervals no greater than 250 feet. Intermediate check valves shall be of ductile iron construction and shall include a stainless break off plug. One check valve shall be located at the first joint above the pump.
- J. Moisture Sensor: Provide moisture sensor in seal oil chamber to detect moisture leakage through the outer shaft seal. The moisture sensor shall be wired to the pump control system to provide seal failure protection indication for the pump. Coordinate supply of a moisture detection relay for each pump suitable for connection to SCADA for seal chamber moisture detection.
- K. Thermal Sensors: Each phase of the motor shall contain a bi-metallic temperature switch in the upper portion of the stator windings. These thermal switches shall be connected in series and set to open at 140C +/- 5C. The temperature sensors shall be wired to the pump control system to provide high temperature protection indication for the pump. Coordinate supply of a high temperature detection relay for each pump suitable for connection to SCADA for windings high temperature detection.

2.5 MANUFACTURERS, OR EQUAL

- A. Flowserve
- B. National Pump Company

C. Goulds

2.6 PUMP CONTROLS

- A. Pump controls shall be purchased and installed by the CONTRACTOR in coordination with the well pump supplier and coordinated with the control drawings and requirements, and Owner SCADA integrator.
- B. The pump shall be controlled by an electronic Variable Frequency Drive as noted on the design drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General installation requirements shall conform to the requirements of Section 43 20 10 – Pumps, General.
- B. Pumping equipment shall be installed in accordance with manufacturer shop drawings and as indicated in the drawings.

3.2 SERVICES OF MANUFACTURER

- A. Inspection, Startup, and Field Adjustment: The service representative of the Manufacturer shall be present at the site for three work days minimum, to furnish the services required by Section 43 20 10 - Pumps, General. The ENGINEER may require that the inspection, startup, and field adjustment services above be furnished in three separate trips. The Contractor shall obtain and pay for the factory representative start-up service.
- B. Instruction of OWNER'S Personnel: The training representative of the Manufacturer shall be present at the site for one work day to furnish the services required by Section 43 20 10 - Pumps, General. This time is in addition to that required under item A above.
- C. A "Day on Site" is defined as a conventional 8-hour workday excluding travel time. A "Trip to Site" is defined as complete round trip travel from the Manufacturer's factory. All expenses including salary, local/long distance travel, lodging, meals and any other per diem or miscellaneous expenses of the authorized service representative shall be the responsibility of the Contractor.

END OF SECTION

APPENDIX A
GEOTECHNICAL INVESTIGATION

Geotechnical Engineering Services

JBLM ISDC 21 - Sage Well 2 Replacement
Joint Base Lewis-McChord, Washington

for

Bowen Collins & Associates, Inc.

March 31, 2023



GEOENGINEERS 
Earth Science + Technology

Geotechnical Engineering Services

JBLM ISDC 21 - Sage Well 2 Replacement
Joint Base Lewis-McChord, Washington

for

Bowen Collins & Associates, Inc.

March 31, 2023



1101 South Fawcett Avenue, Suite 200
Tacoma, Washington 98402
253.383.4940

Geotechnical Engineering Services
JBLM ISDC 21 - Sage Well 2 Replacement
Joint Base Lewis-McChord, Washington

File No. 0371-218-02

March 31, 2023

Prepared for:

Bowen Collins & Associates, Inc.
154 East 14075 South
Draper, Utah 84020

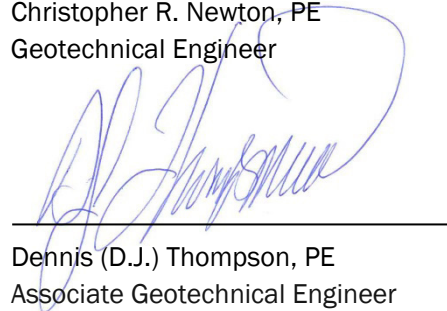
Attention: Jon Oldham, PE

Prepared by:

GeoEngineers, Inc.
1101 South Fawcett Avenue, Suite 200
Tacoma, Washington 98402
253.383.4940



Christopher R. Newton, PE
Geotechnical Engineer



Dennis (D.J.) Thompson, PE
Associate Geotechnical Engineer

CRN:DJT:leh



Disclaimer: Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Table of Contents

1.0 INTRODUCTION AND PROJECT UNDERSTANDING.....	1
2.0 SCOPE OF SERVICES.....	1
3.0 SITE CONDITIONS.....	1
3.1. Surface Conditions.....	1
3.2. Literature Review	2
3.2.1. Geologic Maps	2
3.3. Subsurface Conditions	2
3.3.1. Subsurface Explorations and Laboratory Testing.....	2
3.3.2. Soil and Groundwater Conditions.....	2
4.0 CONCLUSIONS AND RECOMMENDATIONS	3
4.1. Primary Geotechnical Considerations	3
4.2. Seismic Design Considerations.....	4
4.2.1. Seismic Design Parameters.....	4
4.2.2. Liquefaction	4
4.2.3. Lateral Spreading Potential	5
4.2.4. Surface Rupture Potential	5
4.3. Site Development and Earthwork	5
4.3.1. General.....	5
4.3.2. Clearing and Stripping.....	5
4.3.3. Erosion and Sedimentation Control	5
4.3.4. Temporary Excavations and Cut Slopes.....	6
4.3.5. Permanent Cut and Fill Slopes	6
4.3.6. Groundwater Handling Considerations	7
4.3.7. Surface Drainage.....	7
4.3.8. Subgrade Preparation	7
4.3.9. Subgrade Protection and Wet Weather Considerations	7
4.4. Fill Materials.....	8
4.4.1. Structural Fill.....	8
4.4.2. Select Granular Fill	8
4.4.3. Pipe Bedding.....	9
4.4.4. Trench Backfill	9
4.4.5. On-Site Soil.....	9
4.5. Fill Placement and Compaction	9
4.5.1. General.....	9
4.5.2. Area Fills and Pavement Bases	10
4.5.3. Backfill Behind Retaining Walls and Below-Grade Structures.....	10
4.5.4. Trench Backfill	10
4.6. Foundation Support.....	10
4.6.1. Mat Foundations, Spread Footings, and Slabs-on-Grade	10
4.7. Retaining Walls and Below-Grade Structures	12
4.7.1. Design Parameters.....	12
4.7.2. Drainage.....	13

4.8. Stormwater Infiltration.....	14
4.8.1. General.....	14
4.8.2. Soil Grain-Size Analysis Methods and Results.....	14
4.8.3. Recommended Design Infiltration Rate.....	15
4.8.4. Discussion and Construction Considerations.....	15
4.9. Pavement Recommendations.....	16
4.9.1. General.....	16
4.9.2. Asphalt Concrete Pavement Sections.....	16
4.9.3. Portland Cement Concrete Pavement Design.....	17
5.0 LIMITATIONS	17

LIST OF FIGURES

Figure 1. Vicinity Map

Figure 2. Site Plan

APPENDICES

Appendix A. Subsurface Explorations and Laboratory Testing

 Figure A-1 – Key to Exploration Logs

 Figures A-2 through A-5 – Logs of Test Pits

 Figure A-6 – Sieve Analysis Results

 Figure A-7 – DIPRA 10-Point Test Results

Appendix B. Report Limitations and Guidelines for Use

1.0 INTRODUCTION AND PROJECT UNDERSTANDING

This report presents the results of our geotechnical engineering services for the Sage Well 2 Replacement project. The project site is located directly north of Evergreen Way SW at Joint Base Lewis-McChord (JBLM), Washington, as shown on the Vicinity Map, Figure 1.

Our understanding of this project is based on conversations with you (Bowen Collins & Associates) and review of your “JBLM ISDC 21 – Sage Well 2 Replacement Preliminary Design” Technical Memorandum (Memo) dated October 7, 2022. The Memo summarizes 30 percent design information for the near grade improvements and facilities to be associated with the Sage 2 Well Replacement (SG2R).

We understand the existing Sage Well 2 (SG2) has not been operational since 2018. This project will include the design and permitting for a replacement drinking water supply well at McChord Field with a target production rate of 1,000 gallons per minute (gpm). The new drinking water supply well, SG2R, will replace the lost capacity from SG2 being inoperable, and add additional capacity. Based on the “Hydrogeologic Report SAGE II Replacement Well” dated December 9, 2022 prepared by GeoEngineers, Inc. (Hydrogeologic Report), it is anticipated that SG2R will be completed in a deep aquifer at a depth of approximately 800 feet below the project site surface. The actual final depth will depend on soil and groundwater conditions observed during well drilling.

As part of the overall well site development, the project will also include a single-story well house, roughly 22 by 23 feet in dimension supported on conventional shallow foundations. Other improvements include foundations for associated well facility equipment, water and electrical utility lines, gravel and/or asphalt paving for parking, driveways, and the well house yard.

No specific stormwater management facilities have been planned during preparation of this report. A shallow discharge pond is being considered for the “pump-to-waste cycle” operation of SG2R. The pump-to-waste cycle operation removes stagnant water from inside the well. This process will occur up to once a day and for as long as 5 minutes. It was reported that the estimated total volumetric discharge during this operation is about 668 cubic feet. The discharge pond and any stormwater management facilities will be designed and constructed in general accordance with the criteria outlined in the 2019 Department of Ecology Stormwater Management Manual for Western Washington (SWMMWW).

2.0 SCOPE OF SERVICES

Our services for this project have been provided in general accordance with our Signed Agreement with Bowen Collins executed on March 22, 2022 and as indicated in our proposal dated January 27, 2022. A complete list of our scope of services is provided in our proposal and can also be provided upon request.

3.0 SITE CONDITIONS

3.1. Surface Conditions

The proposed SG2R site is rectangular and situated within a vacant field with scattered trees, as shown on the Site Plan, Figure 2. Evergreen Way SW and 150th Street SW bound the site to the south while further vacant fields with scattered trees surround the site on all other sides. Site topography is generally flat with a ground surface elevation of approximately Elevation 280 feet. Elevations referenced in this report refer to the North American Vertical Datum of 1988 (NAVD88). Elevations should be considered approximate.

3.2. Literature Review

3.2.1. Geologic Maps

Our understanding of the site geology is based on review of the *Geologic Map of the Tacoma 1:100,000-scale Quadrangle, Washington* (Schuster, et al. 2015). The geologic map indicates the site is underlain by “Recessional Outwash, Steilacoom gravel” (Qgo_{sg}). Steilacoom gravel deposits are described as loose to dense, poorly- to well-sorted sand and gravel that were deposited during glacial lake outburst floods. Based on our experience in the project vicinity, Steilacoom gravel soils are typically medium dense to dense and can contain cobbles and boulders. These soils were not glacially consolidated after deposition.

“Vashon Till” (Qgt) is mapped approximately a tenth mile to the northwest of the project site. Vashon Till is glacially consolidated and is described as a low permeability, highly compact mixture of sand, gravel, silt, and clay, and can sometimes be called “hardpan”. Vashon Till can contain cobbles and boulders dispersed throughout.

3.3. Subsurface Conditions

3.3.1. Subsurface Explorations and Laboratory Testing

We explored subsurface conditions at the site by excavating four test pits (TP-1 through TP-4) at the approximate locations shown in the attached Site Plan, Figure 2. Test pit depths ranged from 9 to 10 feet below the ground surface (bgs). A description of our subsurface exploration program and summary exploration logs are provided in Appendix A.

Selected samples collected from our test pits were tested in our laboratory to confirm field classifications and to evaluate pertinent engineering properties. Our laboratory testing program included grain-size distribution analyses, moisture content determinations, and a Ductile Iron Pipe Research Association (DIPRA) 10-Point test. A summary of our laboratory testing program and the test results are provided in Appendix A.

As a part of our scope of services, we had proposed to complete a Proctor test (ASTM International [ASTM] D 1557) on a sample, or a composite, of materials obtained at shallower depths in our test pits. As a part of the test requirement, the sample is supposed to have less than 30 percent retained on the ¾-inch sieve (by weight). Our sample had nearly 50 percent retained on the ¾-inch sieve, and as such, we were unable to complete the Proctor test. In general, this indicates that there is some relatively larger sized gravel, and even cobble sized materials, at this project site.

3.3.2. Soil and Groundwater Conditions

Test pit explorations were advanced through approximately 2 inches of sod. Underlying the sod, we observed what we interpret to be fill overlying recessional outwash deposits (Steilacoom gravel). Fill typically consisted of loose to medium dense silty sand with gravel and extended to between about ½ and 2¼ feet bgs. The recessional outwash typically consisted of medium dense to dense gravel with sand, recorded to the depths explored (9 to 10 feet bgs). Occasional cobbles and organics were observed and noted in the fill and recessional outwash deposits. Minor to moderate sidewall caving was typically observed from about 4 feet bgs to the termination depth in the explorations.

We did not observe a static groundwater or perched groundwater condition in our explorations. Although not encountered, perched groundwater could be present in other areas or depths at the site. The interface

between more permeable and less permeable zones within the fill and/or between weathered and unweathered materials are likely locations for accumulation of perched groundwater. Perched groundwater levels can depend on rainfall amounts, irrigation activities, and other factors. We anticipate that perched groundwater levels will generally be highest during the wet season, typically October through May.

Static groundwater conditions and overall assessments of groundwater are included in our Hydrogeologic Report. For general civil construction design, and the purposes of this report, a design static groundwater can be assumed to be at a depth of 20 feet bgs (approximate Elevation 260 feet). The actual static groundwater depth is deeper. If excavations are needed to extend to depths of about 20 feet, or a design requires exact measurements, we should be contacted to re-assess and refine the design groundwater depth.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1. Primary Geotechnical Considerations

Based on our understanding of the project, the explorations performed for this study and our experience, it is our opinion that the proposed improvements can be designed and constructed generally as envisioned with regard to geotechnical considerations. Geotechnical recommendations provided in this report have been developed in general accordance with the guidelines presented in the Unified Facilities Criteria (UFC) 3-220-01 "Geotechnical Engineering" (U.S. Department of Defense, November 2012), which was updated in November 2021 to reference the International Building Code 2018 (IBC 2018). A summary of key geotechnical considerations for the project is provided below and is followed by our detailed recommendations.

- Proposed structures at the site can be supported using shallow foundations and slabs-on-grade, provided that the foundation bearing surfaces are prepared as recommended. We do not anticipate that significant overexcavation will be required, unless isolated areas of loose, or otherwise unsuitable areas are encountered near foundation grade.
- In our opinion, the risk of liquefaction occurring at this site is low.
- Based on our field observations and laboratory testing, stormwater infiltration at this site is feasible. We recommend a long-term design infiltration rate of 30 inches per hour.
- Clearing and stripping depths at the site for sod and associated root network will typically be on the order of about 3 to 6 inches.
- The existing site fill contains a significant quantity of fines, and, therefore, could be difficult or impossible to work with when wet or become easily disturbed if exposed to wet weather. Depending on the intended use of the material and the moisture/weather conditions, it may be difficult to re-use the fill as structural fill.
- The native recessional outwash deposits encountered below the fill consists of clean gravel with sand and will typically be more resilient to moisture and wet weather conditions. We expect the recessional outwash deposits to be appropriate for use as a general structural fill for most applications and almost any time of the year.

4.2. Seismic Design Considerations

4.2.1. Seismic Design Parameters

In accordance with requirements in the 2018 IBC, we performed a preliminary evaluation of seismic design parameters per American Society of Civil Engineers (ASCE) 7-16. Based on our explorations completed for this study and our experience in areas with similar soil conditions, it is our opinion that the site can be characterized as Site Class D.

Further, per ASCE 7-16 Section 11.4.8, a ground motion hazard analysis is required for structures on Site Class D with S_1 greater than or equal to 0.2. As shown in Table 1 below, S_1 is greater than 0.2 for this site; therefore, this provision applies. Alternatively, per ASCE 7-16 Supplement 3 Section 11.4.8, a ground motion hazard analysis is not required where the value of S_{M1} is increased by 50 percent for all applications of S_{M1} and the resulting value of S_{D1} is used for all applications of S_{D1} . This exception was incorporated in the seismic design parameters provided in Table 1 below; however, we can perform ground motion hazard analysis, if preferred by the design team.

TABLE 1. SEISMIC DESIGN CRITERIA

2018 IBC Parameters ¹	Value
Site Class	D
Mapped MCE _R Spectral Response Acceleration at Short Period, S_s (g)	1.332
Mapped MCE _R Spectral Response Acceleration at 1-second period, S_1 (g)	0.466
Site Modified Peak Ground Acceleration, PGA_M	0.55
Short Period Site Coefficient, F_a	1.000
Long Period Site Coefficient, F_v	1.834
Design Spectral Acceleration at 0.2-second period, S_{Ds} (g)	0.888
Design Spectral Acceleration at 1.0-second period, S_{D1} (g)	0.855 ²
Site Modified Earthquake Spectral Response Acceleration at Short Periods, S_{Ms} (g)	1.332
Site Modified Considered Earthquake Spectral Response Acceleration at 1-Second Periods, S_{M1} (g)	1.282 ²

Notes:

¹ Parameters developed based on latitude 47.1214804 and longitude -122.5104297 using the Applied Technology Council (ATC) Hazards online tool (<https://hazards.atcouncil.org/>).

² Per ASCE 7-16 Supplement 3 Section 11.4.8 Item 1, parameter has been increased 50 percent or has increased by 50 percent as a result of the adjusted S_{M1} value.

4.2.2. Liquefaction

Liquefaction refers to a condition where vibration or shaking of the ground, usually from earthquake forces, results in development of excess pore pressures in loose, saturated soils and subsequent loss of strength. In general, soils that are susceptible to liquefaction include loose to medium dense sands to silty sands that are below the water table. The Department of Natural Resources Geologic Information Portal (DNR Geologic Portal) available online and accessed on January 23, 2023, indicates the site soils have a “very low to low” liquefaction potential. Based on the soil and groundwater conditions observed in our explorations, it is our opinion that the potential for liquefaction at the site is low.

4.2.3. Lateral Spreading Potential

Lateral spreading related to seismic activity typically involves lateral displacement of large, surficial blocks of non-liquefied soil when a layer of underlying soil loses strength during seismic shaking. Lateral spreading usually develops in areas where sloping ground or large grade changes (including retaining walls) are present. Based on our understanding of the liquefaction risk at the site and the proposed improvements, it is our opinion that the risk of lateral spreading is low.

4.2.4. Surface Rupture Potential

According to the DNR Geologic Portal (accessed January 23, 2023), there are no mapped faults or other seismogenic features within about 7.2 miles of the site. Based on the proximity of the site to the nearest mapped fault or seismogenic feature, it is our opinion the risk for surface rupture at this site is low.

4.3. Site Development and Earthwork

4.3.1. General

We anticipate that site development and earthwork will include grading, removal of pavement and hardscape, excavating for shallow foundations, utilities, and other improvements, establishing subgrades for foundations and roadways and placing and compacting fill and backfill materials. We expect that site grading and earthwork can be accomplished with conventional earthmoving equipment. The following sections provide specific recommendations for site development and earthwork.

4.3.2. Clearing and Stripping

During stripping operations, excessive disturbance of surficial soils can occur, especially if occurring in, and/or left exposed to wet conditions. Disturbed soils may require additional remediation during final site grading and construction. We anticipate that clearing and stripping depths at the site will typically be on the order of about 3 to 6 inches to remove sod and the associated root network at the surface. It is likely that greater stripping depths will be required in areas of heavier vegetation, lower lying areas or in areas containing trees.

We encountered cobbles in our explorations. Boulders can also be present in the recessional outwash and glacial till soils in the project vicinity. As such, the contractor should be prepared to remove cobbles and boulders, if encountered during grading or excavation. Boulders may be removed from the site or used in landscape areas. Voids caused by boulder removal should be backfilled with compacted structural fill.

4.3.3. Erosion and Sedimentation Control

Erosion and sedimentation rates and quantities can be influenced by construction methods, slope length and gradient, amount of soil exposed and/or disturbed, soil type, construction sequencing and weather. Implementing an Erosion and Sedimentation Control Plan will reduce impacts to the project where erosion-prone areas are present. The plan should be designed in accordance with applicable JBLM, county and/or state standards. The plan should incorporate basic planning principles, including:

- Scheduling grading and construction to reduce soil exposure;
- Re-vegetating or mulching denuded areas;
- Directing runoff away from exposed soils;

- Reducing the length and steepness of slopes with exposed soils;
- Decreasing runoff velocities;
- Preparing drainage ways and outlets to handle concentrated or increased runoff;
- Confining sediment to the project site; and
- Inspecting and maintaining control measures frequently.

Temporary erosion protection should be used and maintained in areas with exposed or disturbed soils to help reduce erosion and reduce transport of sediment to adjacent areas and receiving waters. Permanent erosion protection should be provided by paving, structure construction or landscape planting.

Until the permanent erosion protection is established, and the site is stabilized, site monitoring may be required by qualified personnel to evaluate the effectiveness of the erosion control measures and to repair and/or modify them as appropriate. Provisions for modifications to the erosion control system based on monitoring observations should be included in the erosion and sedimentation control plan. Where sloped areas are present, some sloughing and raveling of exposed or disturbed soil on slopes should be expected. We recommend that disturbed soil be restored promptly so that surface runoff does not become channeled.

4.3.4. Temporary Excavations and Cut Slopes

Based on observations made during excavation of our test pits and our experience with other projects in similar soil conditions, we anticipate that shallow excavations could experience minor to moderate caving. Excavations deeper than 4 feet should be shored or laid back at a stable slope if workers are required to enter. Shoring and temporary slope inclinations must conform to the provisions of Title 296 Washington Administrative Code (WAC), Part N, "Excavation, Trenching and Shoring." Regardless of the soil type encountered in the excavation shoring, trench boxes or sloped sidewalls will be required under Washington Industrial Safety and Health Act (WISHA). We recommend contract documents specify that the contractor is responsible for selecting excavation and dewatering methods, monitoring the excavations for safety and providing shoring, as required, to protect personnel and structures.

In general, we recommend that for planning purposes all temporary cut slopes be inclined no steeper than about 1½H to 1V (horizontal to vertical). This guideline assumes all surface loads are kept at a minimum distance of at least one-half the depth of the cut away from the top of the slope and that seepage is not present on the slope face. Flatter cut slopes will be necessary where seepage occurs or if surface surcharge loads are anticipated. Temporary covering with heavy plastic sheeting should be used to protect these slopes during periods of wet weather.

4.3.5. Permanent Cut and Fill Slopes

We recommend permanent slopes be constructed at a maximum inclination of 2H:1V to manage erosion. Where 2H:1V permanent slopes are not feasible, protective facings and/or retaining structures should be considered.

To achieve uniform compaction, we recommend fill slopes be overbuilt and subsequently cut back to expose well-compacted fill. Fill placement on existing slopes steeper than 5H:1V should be benched into the slope face. The configuration of benches depends on the equipment being used and the inclination of

the existing slope. Bench excavations should be level and extend into the slope face at least half the width of the compaction equipment used.

Exposed areas should be re-vegetated as soon as practical to reduce surface erosion and sloughing. Temporary protection should be used until permanent protection is established.

4.3.6. Groundwater Handling Considerations

Based on our understanding of the proposed site improvements we do not anticipate that the regional groundwater table will be encountered during excavations at the site. For design purposes, and as described above, we recommend that static groundwater be considered at a depth of 20 feet below grade (approximate Elevation 260 feet).

Areas of perched groundwater could be encountered at the site depending on the time of year and other factors previously described. Groundwater handling needs will typically be lower during the summer and early fall months. We anticipate that shallow perched groundwater can be handled adequately with sumps, pumps, and/or diversion ditches, as necessary. Ultimately, we recommend that the contractor performing the work be made responsible for controlling and collecting groundwater encountered.

4.3.7. Surface Drainage

Surface water from roof downspouts, driveways and landscape areas should be collected and controlled. Curbs or other appropriate measures such as sloping pavements, sidewalks and landscape areas should be used to direct surface flow away from buildings, erosion sensitive areas and from behind retaining structures. Roof and catchment drains should not be connected to wall or foundation drains.

4.3.8. Subgrade Preparation

Subgrades that will support pavements and gravel-surfaced areas (i.e., well house yard and driveways) should be thoroughly compacted to a uniformly firm and unyielding condition on completion of stripping and before placing structural fill. We recommend that subgrades for pavements and gravel-surfaced areas be evaluated to identify areas of yielding or soft soil. Probing with a steel probe rod or proof-rolling with a heavy piece of wheeled construction equipment are appropriate methods of evaluation.

If soft or otherwise unsuitable subgrade areas are revealed during evaluation that cannot be compacted to a stable and uniformly firm condition, we recommend that: (1) the unsuitable soils be scarified (e.g., with a ripper or farmer's disc), aerated and recompacted, if practical; or (2) the unsuitable soils be removed and replaced with compacted structural fill, as needed.

4.3.9. Subgrade Protection and Wet Weather Considerations

The wet weather season generally begins in October and continues through May in western Washington; however, periods of wet weather can occur during any month of the year. Near surface soils (silty sand fill) observed in our explorations were recorded up to depths of about 2¼ feet and contain a significant quantity of fines and will be susceptible to disturbance during periods of wet weather. Expect that this zone of soil at the near surface will become easily disturbed and difficult to manage when wet. The Steilacoom gravel at depth contains less fines and will be more resilient to wet weather and as such, it may be more practical to conduct earthwork at this site, even during relatively extended wet weather months, provided appropriate

measures are implemented to protect exposed soil. If earthwork is scheduled during the wet weather months, we offer the following recommendations:

- Measures should be implemented to remove or eliminate the accumulation of surface water from work areas. The ground surface in and around the work area should be sloped so that surface water is directed away and graded so that areas of ponded water do not develop. Measures should be taken by the contractor to prevent surface water from collecting in excavations and trenches.
- Earthwork activities should not take place during periods of heavy precipitation.
- Slopes with exposed soils should be covered with plastic sheeting.
- The contractor should take necessary measures to prevent on-site soils and other soils to be used as fill from becoming wet or unstable. These measures may include the use of plastic sheeting, sumps with pumps and grading. The site soils should not be left uncompacted and exposed to moisture. Sealing exposed soils by rolling with a smooth-drum roller prior to periods of precipitation will help reduce the extent to which these soils become wet or unstable.
- Construction traffic should be restricted to specific areas of the site, preferably areas that are surfaced with working pad materials not susceptible to wet weather disturbance.
- Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practical.
- Protective surfacing such as placing asphalt-treated base (ATB) or haul roads made of quarry spalls or a layer of free-draining material such as well-graded pit-run sand and gravel may be considered to limit disturbance to completed areas. Minimum quarry spall thicknesses should be on the order of 12 to 18 inches. Typically, minimum gravel thicknesses on the order of 24 inches are necessary to provide adequate subgrade protection.

4.4. Fill Materials

4.4.1. Structural Fill

The workability of material for use as structural fill will depend on the gradation and moisture content of the soil. Material used for structural fill should be free of debris, organic contaminants, and rock fragments larger than 6 inches. For most applications, structural fill consisting of material similar to “Select Borrow” or “Gravel Borrow” as described in Section 9-03.14 of the Washington State Department of Transportation (WSDOT) Standard Specifications will be appropriate.

Weather and site conditions should be considered when determining the type of import fill materials purchased and brought to the site for use as structural fill. If earthwork activities are scheduled during the wet weather months or during prolonged periods of wet weather, we recommend that washed crushed rock or select granular fill, as described below, be used for structural fill.

If prolonged dry weather prevails during the earthwork phase of construction, materials with a somewhat higher fines content may be acceptable.

4.4.2. Select Granular Fill

Select granular fill should consist of well-graded sand and gravel or crushed rock with a maximum particle size of 6 inches and less than 5 percent fines by weight based on the minus ¾-inch fraction. Organic matter,

debris or other deleterious material should not be present. In our opinion, material with gradation characteristics similar to WSDOT Specification 9-03.9 (Aggregates for Ballast and Crushed Surfacing), or 9-03.14 (Borrow) is suitable for use as select granular fill, provided that the fines content is less than 5 percent (based on the minus 3/4-inch fraction) and the maximum particle size does not exceed 6 inches.

4.4.3. Pipe Bedding

Trench backfill for the bedding and pipe zone should consist of well-graded granular material similar to “Gravel Backfill for Pipe Zone Bedding” described in Section 9-03.12(3) of the WSDOT Standard Specifications. The material must be free of roots, debris, organic matter, and other deleterious material. Other materials may be appropriate depending on manufacturer specifications and/or local jurisdiction requirements.

4.4.4. Trench Backfill

Trench backfill must be free of debris, organic material, and rock fragments larger than 6 inches. We recommend that trench backfill material consist of material similar to “Select Borrow” or “Gravel Borrow” as described in Section 9-03.14 of the WSDOT Standard Specifications.

4.4.5. On-Site Soil

Based on our subsurface explorations and experience, it is our opinion that existing site soils, excluding the sod, may be considered for use as structural fill and trench backfill, provided that they can be adequately moisture conditioned, placed and compacted as recommended and does not contain organic or other deleterious material. The fill soil (SM on the test pit logs) and other siltier soil types (i.e., SP-SM, GM, GP-GM) are moisture sensitive and may be difficult to work with when wet. The lower fines content Steilacoom gravel (soils typically classified as GP on the test pit logs) will be more resilient to changes in moisture content and will likely remain workable during periods of wet weather.

The moisture contents were tested at between 12 and 16 percent in the existing fill/upper 2 to 3 feet and approximately 2 percent in the Steilacoom gravel soil below this. Based on our experience, we anticipate that the upper 2 to 3 feet of soil will be at or slightly above the optimum moisture content (OMC) in its current condition. Additional rain or wet weather construction will increase this. Conversely, it is possible that the Steilacoom gravel may require additional moisture or adding water during placement to achieve adequate compaction. In some cases, the particle sizes in the Steilacoom gravel may be too large (greater than 6 inches in diameter) to be able to use this material appropriately and some segregation could be required.

4.5. Fill Placement and Compaction

4.5.1. General

To obtain proper compaction, fill and backfill soil should be compacted near the OMC and in uniform horizontal lifts. Lift thickness and compaction procedures will depend on the moisture content and gradation characteristics of the soil and the type of equipment used. The maximum allowable moisture content varies with the soil gradation and should be evaluated during construction. Generally, 8- to 12-inch loose lifts are appropriate for steel-drum vibratory roller compaction equipment. Compaction should be achieved by mechanical means. During fill and backfill placement, sufficient testing of in-place density should be conducted to check that adequate compaction is being achieved.

4.5.2. Area Fills and Pavement Bases

Fill placed to raise site grades and materials under pavements, gravel-surfaced areas and structural areas should be placed on subgrades prepared as previously recommended. Fill material placed below structures and footings should be compacted to at least 95 percent of the theoretical maximum dry density (MDD) per ASTM D 1557. Fill material placed less than 2 feet below subgrades for driveways and gravel-surfaced areas should be compacted to at least 95 percent of the MDD. Fill placed deeper than 2 feet below subgrade in these areas should be compacted to at least 90 percent of the MDD. Fill material placed in landscaping areas should be compacted to a firm condition that will support construction equipment, as necessary, typically around 85 to 90 percent of the MDD.

4.5.3. Backfill Behind Retaining Walls and Below-Grade Structures

Backfill behind retaining walls or below-grade structures should be compacted to between 90 and 92 percent of the MDD. Overcompaction of fill placed directly behind retaining walls or below-grade structures should be avoided. We recommend use of hand-operated compaction equipment and maximum 6-inch loose lift thickness when compacting fill within about 5 feet behind retaining walls or below-grade structures.

4.5.4. Trench Backfill

For utility excavations, we recommend that the initial lift of fill over the pipe be thick enough to reduce the potential for damage during compaction, but generally should not be greater than about 18 inches above the pipe. In addition, rock fragments greater than about 1 inch in maximum dimension should be excluded from this lift.

Trench backfill material placed below structures and footings should be compacted to at least 95 percent of the MDD. In paved areas, trench backfill should be uniformly compacted in horizontal lifts to at least 95 percent of the MDD in the upper 2 feet below subgrade. Fill placed below a depth of 2 feet from subgrade in paved areas must be compacted to at least 90 percent of the MDD. In non-structural areas, trench backfill should be compacted to a firm condition that will support construction equipment as necessary.

4.6. Foundation Support

4.6.1. Mat Foundations, Spread Footings, and Slabs-on-Grade

4.6.1.1. General

The proposed structures at the site can be satisfactorily supported on mat foundations and spread footings. Mat foundations and spread footings should be established at least 18 inches below the lowest adjacent grade, primarily for frost protection. Isolated spread footings should have a minimum width of 24 inches. Continuous spread footings for walls should be at least 18 inches wide.

Based on the groundwater conditions observed in our explorations and our understanding that foundations will be established within a few feet of existing site grade, it is our opinion footing drains are not necessary to maintain bearing support as provided in this report.

The sections below provide our recommendations for foundation bearing surface preparation and foundation design parameters. Slab-on-grade subgrades should be prepared in accordance with the “Subgrade Preparation” and/or “Area Fills and Bases” sections of this report.

4.6.1.2. Foundation Bearing Surface Preparation

Mat foundations and spread footings can bear on existing site fill, recessional outwash deposits (Steilacoom gravel), or on structural fill extending to these soils. Foundation excavations should be performed using a smooth-edged bucket to limit bearing disturbance. Any roots/organics should be completely removed from below proposed foundation areas.

Loose or disturbed materials present at the base of foundation excavations should be removed or compacted. If relatively looser fill soil is present at or below foundation grades, we recommend it be either overexcavated and replaced with compacted structural fill, or scarified, dried, and recompacted at near the OMC. The bearing surface should be compacted as necessary to a firm, unyielding condition.

If structural fill is placed below foundations as either replacement of overexcavated soils or to establish a bearing pad, we recommend the structural fill extend laterally beyond the foundation perimeter a distance equal to the depth of fill (measured from the base of the footing), or 3 feet, whichever is less.

Foundation bearing surfaces should not be exposed to standing water. If water is present in the excavation, it must be removed before placing formwork and reinforcing steel. Where protection is needed, a 6-inch-thick layer of crushed rock or a 3- to 4-inch-thick layer of lean-mix concrete could be considered at the base of excavations. This will also limit disturbance to bearing surfaces from construction traffic.

Prepared foundation bearing surfaces should be evaluated by a member of our firm prior to placement of formwork or reinforcing steel to verify that the bearing surface has been prepared in accordance with our recommendations or to provide recommendations for remediating unsuitable bearing soils.

4.6.1.3. Allowable Soil Bearing Pressure for Spread Footings

Spread footings bearing on subgrades prepared as recommended may be designed using an allowable soil bearing pressure of 3,000 pounds per square foot (psf). This bearing pressure applies to the total of dead and long-term live loads and may be increased by one-third when considering total loads, including earthquake or wind loads. This is a net bearing pressure. The weight of the foundation and overlying backfill can be ignored in calculating foundation sizes.

4.6.1.4. Modulus of Subgrade Reaction (Mat Foundations and Slabs-on-Grade)

A modulus of subgrade reaction of 250 pounds per cubic inch (pci) may be used for structural design of mat foundations and slabs-on-grade, provided that the bearing surface has been prepared as recommended and consists of thoroughly compacted existing site soil or structural fill extending to such soil. This value is for a 1-foot by 1-foot square plate. The modulus of subgrade reaction for a foundation varies based on its minimum width and is computed according to the following equation:

$$k_s = k_{s1}[(B+1)/2B]^2$$

Where k_s is the computed modulus of subgrade reaction, k_{s1} is the modulus of subgrade reaction for a 1- foot by 1-foot square plate, and B is the minimum width or lateral dimension of the mat or slab. For mats and slabs-on-grade designed and constructed as recommended, we estimate settlements as described below.

4.6.1.5. Static Foundation Settlement (Mats Foundations and Spread Footings)

To limit foundation settlement, disturbed soil must be removed from the base of foundation excavations and the bearing surface should be prepared as recommended. Provided these measures are taken, we

estimate the total static settlement of mat foundations and spread footings will be on the order of 1 inch or less for the bearing pressures and/or modulus values presented above. Differential settlements could be on the order of ¼ to ½ inch between similarly loaded foundations or over a distance of about 20 feet across a foundation dimension. The settlements should occur rapidly, essentially as loads are applied. Settlements could be greater than estimated if disturbed or saturated soil conditions are present below foundations.

4.6.1.6. Slab-on-Grade Settlement and Capillary Break and Underslab Drainage

We recommend the slab-on-grade floors be underlain by a minimum 6-inch-thick capillary break layer consisting of clean sand and gravel, crushed rock, or washed rock. The capillary break material should contain less than 3 percent fines material based on the minus ¾-inch sieve size fraction. WSDOT Specification 9-03.9 (Aggregates for Ballast and Crushed Surfacing; i.e., crushed surfacing base course [CSBC]) can also be considered for use as a capillary break material.

We estimate that settlement for slabs-on-grade constructed as recommended will be less than ¾ inch for a floor load of up to 500 psf.

Based on our understanding of soil and groundwater conditions at the site and proposed construction, it is our opinion that an underslab drain system is not necessary. If dry slabs are required (e.g., where adhesives are used to anchor carpet or tile to slab), a waterproof liner may be placed as a vapor barrier below the slab.

4.6.1.7. Lateral Resistance

The ability of the soil to resist lateral loads is a function of the base friction, which develops on the base of foundations, mats and slabs, and the passive resistance, which develops on the face of below-grade elements of the structure as these elements move into the soil. For cast-in-place foundations supported in accordance with the recommendations presented above, the allowable frictional resistance on the base of the foundation may be computed using a coefficient of friction of 0.40 applied to the vertical dead-load forces. If precast foundations are included as part of project plans, we can provide specific recommendations for base friction resistance for precast foundations. The allowable passive resistance on the face of the foundation or other embedded foundation elements may be computed using an equivalent fluid density of 275 pounds per cubic foot (pcf).

These values include a factor of safety of about 1.5. The passive earth pressure and friction components may be combined provided that the passive component does not exceed two-thirds of the total. The top foot of soil should be neglected when calculating passive lateral earth pressure unless the area adjacent to the foundation is covered with pavement or a slab-on-grade.

4.7. Retaining Walls and Below-Grade Structures

4.7.1. Design Parameters

We recommend the following lateral earth pressures be used for design of conventional retaining walls and below-grade structures. Our design pressures assume that the ground surface around the retaining structures will be level or near level. If drained design parameters are used, drainage systems must be included in the design in accordance with the recommendations presented in the “Drainage” section below.

- Active soil pressure may be estimated using an equivalent fluid density of 35 pcf for the drained condition.
- Active soil pressure may be estimated using an equivalent fluid density of 80 pcf for the undrained condition; this value includes hydrostatic pressure.
- At-rest soil pressure may be estimated using an equivalent fluid density of 55 pcf for the drained condition.
- At-rest soil pressure may be estimated using an equivalent fluid density of 90 pcf for the undrained condition; this value includes hydrostatic pressure.
- For seismic considerations, a uniform lateral pressure of $12 \cdot H$ psf (where H is the height of the retaining structure or the depth of a structure below ground surface) should be added to the lateral earth pressure.
- A typical traffic surcharge of 250 psf should be included if vehicles are allowed to operate within $\frac{1}{2}$ the height of the retaining walls. This surcharge may be represented by an additional 2 feet of soil. Other surcharge loads should be considered on a case-by-case basis.

The active soil pressure condition assumes the wall is free to move laterally $0.001 H$, where H is the wall height. The at-rest condition is applicable where walls are restrained from movement. The above recommended lateral soil pressures do not include the effects of sloping backfill surfaces or surcharge loads, except as described. Overcompaction of fill placed directly behind retaining walls or below-grade structures must be avoided to limit lateral pressures placed on the wall. We recommend use of hand-operated compaction equipment and maximum 6-inch loose lift thickness when compacting fill within about 5 feet of retaining walls and below-grade structures.

Retaining wall or below-grade structure foundation bearing surfaces should be prepared following the “Foundation Bearing Surface Preparation” section of this report. Provided bearing surfaces are prepared as recommended, retaining wall or below-grade structure foundations may be designed using the allowable soil bearing pressure and lateral resistance values presented above for structure foundation design. We estimate settlement of retaining structures will be similar to the values previously presented for structure foundations.

4.7.2. Drainage

If retaining walls or below-grade structures are designed using drained parameters, a drainage system behind the structure must be constructed to collect water and prevent the buildup of hydrostatic pressure against the structure. We recommend the drainage system include a zone of free-draining backfill a minimum of 18 inches in width against the back of the wall. The drainage material should consist of coarse sand and gravel containing less than 5 percent fines by weight based on the fraction of material passing the $\frac{3}{4}$ -inch sieve. A perforated, rigid, smooth-walled drainpipe with a minimum diameter of 4 inches should be placed along the base of the structure within the free-draining backfill and extend for the entire wall length. The drainpipe should be metal or rigid polyvinyl chloride (PVC) pipe and be sloped to drain by gravity. Discharge should be routed to appropriate discharge areas and to reduce erosion potential. Cleanouts should be provided to allow routine maintenance. We recommend roof downspouts or other types of drainage systems not be connected to retaining wall drainage systems.

Other systems may also be considered, where appropriate and as approved by the project engineer. Weep holes and other thorough wall drainage systems may be considered. Typically, the minimum 18 inches we recommend as a drainage zone can be reduced to about 12 inches, with the use of a woven geotextile fabric for separation, that is placed between the natural soil cut and the drainage zone. There are also other products, such as waffle-type plastic drain board systems.

4.8. Stormwater Infiltration

4.8.1. General

No specific stormwater management facilities are currently planned besides the shallow pond described previously for discharging stagnant water removed from the inside of the well. Based on the subsurface conditions observed in the explorations and our experience, it is our opinion that stormwater infiltration is feasible at the project site.

According to the 2019 SWMMWW, the infiltration rate of on-site soils can be determined by either in-situ testing (e.g., pilot infiltration tests) or correlation to soil grain-size distribution. Per the SWMMWW, grain-size analysis methods are only appropriate for soils unconsolidated by glacial advance (i.e., the recessional outwash [Steilacoom gravel] deposits encountered in our explorations). Therefore, it is our opinion the grain-size analysis method is appropriate for determining the long-term design infiltration rates at this site.

4.8.2. Soil Grain-Size Analysis Methods and Results

Using the recommended procedures in the 2019 SWMMWW, we estimated initial saturated hydraulic conductivity ($K_{sat,initial}$) of selected soil samples based on grain-size analysis method. Calculated $K_{sat,initial}$ was then reduced by appropriate correction factors to determine the long-term design infiltration rate ($K_{sat,design}$). $K_{sat,design}$ is a term used by the SWMMWW. Our final recommendations for a design infiltration rate is presented below.

Correction factors in the SWMMWW are based on site variability and number of tests conducted (CF_v), uncertainty of the test method (CF_t), and the potential for long-term clogging due to siltation and bio-buildup (CF_m). Recommended correction factors are outlined in Section V-5.4 of the SWMMWW.

Table 2 below summarizes the partial and total correction factor(s) that, in our opinion, are suitable for design.

TABLE 2. GRAIN-SIZE ANALYSIS CORRECTION FACTOR SUMMARY

Issue	Partial Correction Factor
Site Variability and Number of Locations Tested (CF_v)	0.40
Test Method (CF_t)	0.40
Siltation and Bio-Buildup (CF_m)	0.90
Total Correction Factor = $CF_v \times CF_t \times CF_m$	$CF_T = 0.144$

Table 3 below summarizes the calculated initial ($K_{sat,initial}$) and long-term ($K_{sat,design}$) infiltration rates based on grain-size analysis methods for the samples tested. The $K_{sat,design}$ values include the total correction factor applied from Table 2 above.

TABLE 3. ESTIMATED INFILTRATION RATE SUMMARY

Exploration	Depth (feet)	Elevation (feet)	Geologic Unit	USCS Soil Type	Percent Fines	$K_{sat,initial}$ (in/hr)	$K_{sat,design}$ (in/hr)
TP-2	5	275	Steilacoom gravel	GP	3	248.4	35.8
TP-3	5.5	274.5	Steilacoom gravel	GP	3	459.1	66.1

4.8.3. Recommended Design Infiltration Rate

The calculated long-term design infiltration rates in Table 3 exceeds 30 inches per hour. The 2019 SWMMWW does not specifically provide a limit for the long-term design infiltration rate. However, the project site is located in Pierce County. Guidance provided in the 2015 Pierce County Stormwater Management & Site Development Manual (SWMSDM) does limit the long-term design rate to 30 inches per hour. Additionally, The City of Lakewood 2021 *Engineering Standards Manual* (ESM), section 7.0 also recommends that the long-term design infiltration rate of Steilacoom gravels be limited to 30 inches per hour. As such, we also recommend a maximum long-term design value of 30 inches per hour.

4.8.4. Discussion and Construction Considerations

Based on our observations and experience, Steilacoom gravel deposits typically have moderate to high infiltration potential. Soils encountered in the test pits at depth were relatively uniform across the site and no clear demarcation was observed between high or low permeable layers.

We did not observe groundwater in our explorations. As such, it is our opinion that maintaining vertical separation between the bottom of facilities and groundwater will likely not be necessary if facilities are established within 5 feet of existing site grade.

Further, we did not observe significant soil layering nor presence of underlying impermeable layers in our explorations. Other guidance for facility vertical separations, locations, set-backs, treatments, or other requirements presented in the SWMMWW, or other appropriate code documents, should also be considered in the design.

Because of the high rate of infiltration potential, some stormwater treatment (bio-swales, galleries, trenches, etc.) may be required, prior to final infiltration. We expect that the Steilacoom gravel will have a relatively low cation exchange capacity (CEC) and organic contents, and likely not meet the SWMMWW requirements necessary for treatment. As such, some additional treatment medium design may be necessary.

We recommend that GeoEngineers review the proposed stormwater infiltration facility design to confirm that the anticipated performance can be achieved based on the soil conditions encountered. We also recommend that we observe soil conditions at the base of the infiltration facilities during construction, obtain samples, conduct sieve analysis laboratory testing, and verify that soil conditions present are as anticipated for the proposed design.

Equipment should not be permitted in the infiltration areas after they are excavated to grade because of the potential for compaction of the subgrade that could reduce the infiltration rate. To help reduce clogging of infiltration facilities, we recommend they be protected during construction with siltation control facilities

such as temporary settling basins, silt fences, and hay bales. Suspended solids can clog the soil and reduce the infiltration rate. Periodic sweeping of paved areas, during and following construction, will help extend the life of the infiltration facilities.

4.9. Pavement Recommendations

4.9.1. General

Paved areas are expected to include driveways and well house yard areas. Based on our experience, we provide recommended conventional asphalt concrete pavement (ACP) and Portland cement concrete (PCC) sections below. These pavement sections may not be adequate for heavy construction traffic loads such as those imposed by concrete transit mixers, dump trucks or cranes. Additional pavement thickness may be necessary to prevent pavement damage during construction if other loading types are planned. The recommended sections assume that final improvements surrounding the pavements will be designed and constructed such that stormwater or excess irrigation water from landscape areas does not accumulate below the pavement section or pond on pavement surfaces. If pavements in parking areas slope inward (toward the center of the parking area) full depth curbs or other measures should be used to prevent water from entering and ponding on the subgrade and within the base section.

Existing pavements, hardscaping or other structural elements should be removed prior to placement of new pavement sections. Pavement subgrade should be prepared as recommended in the “Subgrade Preparation” and/or “Area Fills and Pavement Bases” sections of this report. Crushed surfacing base course and subbase, if used, should be moisture conditioned to near optimum moisture content and compacted to at least 95 percent of the theoretical MDD per ASTM D 1557.

CSBC and crushed surfacing top course (CSTC) should conform to applicable sections of 4-04 and 9-03.9(3) of the WSDOT Standard Specifications. The top approximate 2 inches of the CSBC sections provided may consist of CSTC as a leveling layer and for more precise grade development.

Hot mix asphalt should conform to applicable sections of 5-04, 9-02 and 9-03 of the WSDOT Standard Specifications.

PCC mix design should conform with Section 5-05.3(1) of the WSDOT Standard Specifications. Aggregates for PCC should conform to applicable sections of 9-03.1 of the WSDOT Standard Specifications.

Some areas of pavement may exhibit settlement and subsequent cracking over time. Cracks in the pavement will allow water to infiltrate to the underlying base course, which could increase the amount of pavement damage caused by traffic loads. To prolong the effective life of the pavement, cracks should be sealed as soon as possible.

4.9.2. Asphalt Concrete Pavement Sections

Recommended minimum ACP sections are provided below.

4.9.2.1. Standard-Duty ACP – Automobile Driveways and Parking Areas

- 2 inches of hot mix asphalt, class ½ inch, PG 58-22
- 4 inches of compacted CSBC
- Subgrade consisting of Steilacoom gravel, prepared as recommended in the “Subgrade Preparation” and/or “Area Fills and Pavement Bases” sections of this report. Where siltier subgrade is encountered, some removal may be necessary.

4.9.2.2. Heavy-Duty ACP – Areas Subject to Occasional Heavy Truck Traffic

- 3 inches of hot mix asphalt, class ½ inch, PG 58-22
- 6 inches of compacted CSBC
- Subgrade consisting of Steilacoom gravel, prepared as recommended in the “Subgrade Preparation” and/or “Area Fills and Pavement Bases” sections of this report. Where siltier subgrade is encountered, some removal may be necessary.

4.9.3. Portland Cement Concrete Pavement Design

Recommended minimum PCC pavement sections are provided below. Reinforcement could be considered to reduce the potential for cracking in areas where the concrete slabs have irregular shapes or where new slabs abut existing concrete slabs, and the joint layout between the slabs cannot be matched. If reinforcement is considered, we are available to discuss typical steel reinforcement volumes with the project structural engineer, who ultimately designs the location, size, and layout of reinforcement.

4.9.3.1. Standard PCC Pavement – Automobile Driveways and Parking Areas

- 6 inches of PCC with a minimum 14-day flexural strength of 650 psi
- 4 inches of compacted CSBC
- Subgrade consisting of Steilacoom gravel, prepared as recommended in the “Subgrade Preparation” and/or “Area Fills and Pavement Bases” sections of this report. Where siltier subgrade is encountered, some removal may be necessary.

4.9.3.2. Heavy Duty PCC Pavement – Areas Subject to Heavy Truck Traffic

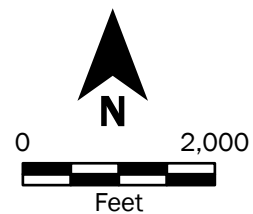
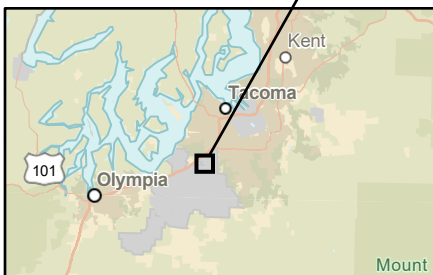
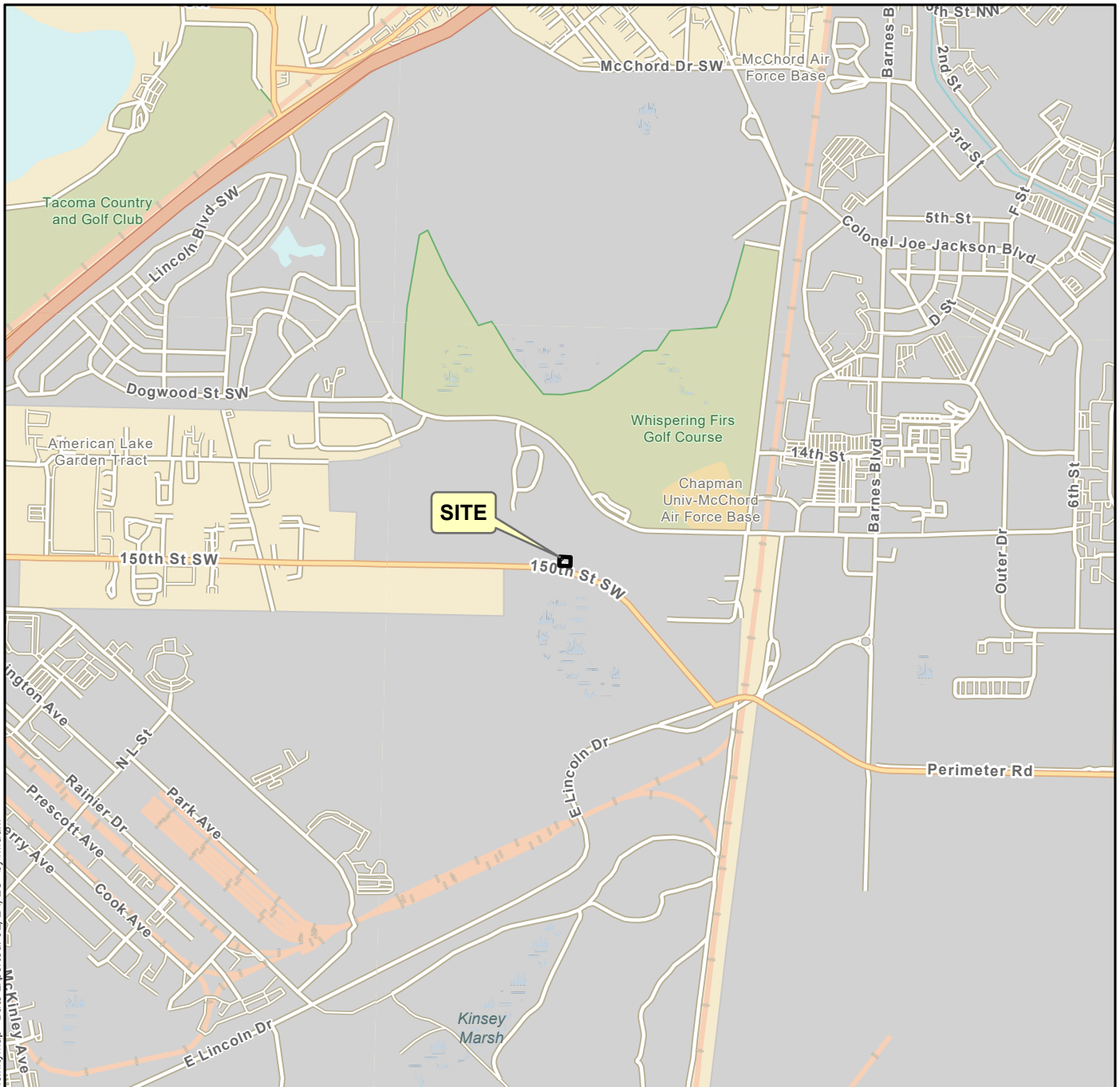
- 9 inches (minimum) of PCC with a minimum 14-day flexural strength of 650 psi
- 5 inches of compacted CSBC
- Subgrade consisting of Steilacoom gravel, prepared as recommended in the “Subgrade Preparation” and/or “Area Fills and Pavement Bases” sections of this report. Where siltier subgrade is encountered, some removal may be necessary.

5.0 LIMITATIONS

We have prepared this report for Bowen Collins for the Sage Well 2 Replacement project located at Joint Base Lewis-McChord, Washington. Bowen Collins may distribute copies of this report to owner’s authorized agents and regulatory agencies as may be required for the Project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices for geotechnical engineering in this area at the time this report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment, and experience. No warranty, express or implied, applies to the services or this report.

Please refer to Appendix B titled “Report Limitations and Guidelines for Use” for additional information pertaining to use of this report.



Vicinity Map

JBLM ISDC 21 - Sage Well 2 Replacement
Joint Base Lewis-McChord, Washington



Figure 1

Source(s):
• ESRI


Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers. The locations of features shown may be approximate. GeoEngineers makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

P:\0371218\CAD\02\Geotech Report\037121802_F02_Site Plan.dwg F02 Date Exported:3/29/2023 12:11 PM - by Kyle M. Cook

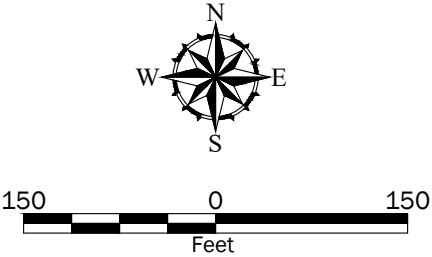



Legend

- x—x—x— Proposed Fence Area
- TP-1  Test Pit by GeoEngineers, 2022

- Notes:**
1. The locations of all features shown are approximate.
 2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Aerial from Microsoft Bing.
Projection: WA State Plane, South Zone, NAD83, US Foot



Site Plan	
JBLM ISDC 21 - Sage Well 2 Replacement Joint Base Lewis-McChord, Washington	
	Figure 2

APPENDIX A

Subsurface Explorations and Laboratory Testing

APPENDIX A

SUBSURFACE EXPLORATIONS AND LABORATORY TESTING

Subsurface Explorations

Subsurface conditions for the proposed Sage Well 2 Replacement project were explored by excavating four test pits on November 21, 2022 at the approximate locations shown in Figure 2. The test pits were excavated to depths between about 9 and 10 feet below ground surface (bgs) using an excavator and operator provided by Kelly's Excavating under subcontract to GeoEngineers. After each test pit was completed, the excavation was backfilled using the generated material and compacted in lifts by tamping with the excavator bucket.

Our field representative obtained samples, classified the soils encountered, and maintained a detailed log of each exploration. The relative densities noted on the test pit logs are based on the difficulty of excavation and our experience and judgment. The soils were classified visually in general accordance with the system described in Figure A-1, which includes a key to the exploration logs. Summary logs of the explorations are included as Figures A-2 through A-5.

The locations of the test pits were determined using an electronic tablet with global positioning system (GPS) software. The locations of the explorations should be considered approximate.

Laboratory Testing

Soil samples obtained from the explorations were transported to GeoEngineers' laboratory. Representative soil samples were selected for laboratory tests to evaluate the pertinent geotechnical engineering characteristics of the site soils and to confirm our field classifications.

Our testing program consisted of the following:

- Two grain-size distribution analyses (sieve analyses [SA])
- Three moisture content determinations (MC)
- One Ductile Iron Pipe Research Association (DIPRA) 10-point test

Tests were performed in general accordance with test methods of ASTM International (ASTM) or other applicable procedures. The following sections provide a general description of the tests performed.

Sieve Analysis (SA)

Grain-size distribution analyses were completed on selected samples in general accordance with ASTM Test Method C 136. This test method covers the quantitative determination of the distribution of particle sizes in soils. Typically, the distribution of particle sizes larger than 75 micrometers (μm) is determined by sieving. The results of the tests were used to verify field soil classifications and determine pertinent engineering characteristics. Figure A-6 presents the results of our sieve analyses.

Moisture Content (MC)

The moisture content of selected samples was determined in general accordance with ASTM Test Method D 2216. The test results are used to aid in soil classification and correlation with other pertinent engineering soil properties. The results are presented on the test pit logs at the depths tested.

DIPRA 10-Point Test

A DIPRA 10-point test was performed on a sample collected from TP-4 in general accordance with ANSI/ANSW C105/A21.5. The test results are typically used to evaluate corrosivity to ductile iron pipe; the potential for corrosion may differ for thin-walled steel pipe. The test results are provided in Figure A-7.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
HIGHLY ORGANIC SOILS				MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

Sampler Symbol Descriptions

	2.4-inch I.D. split barrel / Dames & Moore (D&M)
	Standard Penetration Test (SPT)
	Shelby tube
	Piston
	Direct-Push
	Bulk or grab
	Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS		TYPICAL DESCRIPTIONS
GRAPH	LETTER	
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact



Measured groundwater level in exploration, well, or piezometer



Measured free product in well or piezometer

Graphic Log Contact



Distinct contact between soil strata



Approximate contact between soil strata

Material Description Contact



Contact between geologic units



Contact between soil of the same geologic unit

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PL	Point lead test
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
UU	Unconsolidated undrained triaxial compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

Key to Exploration Logs



Figure A-1

Date Excavated	11/21/2022	Total Depth (ft)	10	Logged By	OA	Excavator	Kelly's Excavating, Inc.	Groundwater not observed
				Checked By	CRN	Equipment	Takeuchi TB138 Mini Excavator	See "Remarks" section for caving observed
Surface Elevation (ft)	280	Easting (X)	1140067	Coordinate System	WA State Plane South			
Vertical Datum	NAVD88	Northing (Y)	658451	Horizontal Datum	NAD83 (feet)			

Elevation (feet)	Depth (feet)	SAMPLE		Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
		Testing Sample	Sample Name Testing						
279	1	1	MC		SOD	Approximately 2 inches of sod	12		Occasional cobbles from surface to bottom of test pit
					SM	Dark brown silty fine to medium sand with gravel and occasional organic matter (fine roots) (loose, moist) (fill)			
278	2		2		GP	Tan with minor oxidation staining fine to coarse gravel with sand, trace silt and occasional organic matter (fine roots) (medium dense, moist) (Steilacoom gravel)			Minor caving observed between 7 and 10 feet
277	3					Grades to dense			
276	4								
275	5		3						
274	6								
273	7								
272	8								
271	9								
270	10		4						

Notes: See Figure A-1 for explanation of symbols.

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Google Earth.

Log of Test Pit TP-1



Project: JBLM ISDC 21 - Sage Well 2 Replacement
Project Location: Joint Base Lewis-McChord, Washington
Project Number: 0371-218-02

Figure A-2
Sheet 1 of 1

Date Excavated	11/21/2022	Total Depth (ft)	10	Logged By	OA	Excavator	Kelly's Excavating, Inc.	Groundwater not observed
				Checked By	CRN	Equipment	Takeuchi TB138 Mini Excavator	See "Remarks" section for caving observed
Surface Elevation (ft)	280	Easting (X)	1139989	Coordinate System	WA State Plane South			
Vertical Datum	NAVD88	Northing (Y)	658444	Horizontal Datum	NAD83 (feet)			

Elevation (feet)	Depth (feet)	SAMPLE		Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
		Testing Sample	Sample Name Testing						
279	1		1 MC		SOD	Approximately 2 inches of sod	13		Occasional cobbles from surface to bottom of test pit
278	2				SM	Dark brown silty fine to medium sand with gravel and occasional organic matter (fine roots) (loose to medium dense, moist) (fill)			
277	3		2		GP	Tan with occasional iron oxidation staining fine to coarse gravel with sand, trace silt and occasional organic matter (fine roots) (medium dense to dense, moist) (Steilacoom gravel)			Minor caving observed from 7 to 10 feet
276	4								
275	5		3 SA			Grades to without iron oxidation staining	2	3	
274	6								
273	7					Grades to without occasional organic matter			
272	8		4						
271	9								
270	10								

Notes: See Figure A-1 for explanation of symbols.

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Google Earth.

Log of Test Pit TP-2



Project: JBLM ISDC 21 - Sage Well 2 Replacement
Project Location: Joint Base Lewis-McChord, Washington
Project Number: 0371-218-02

Figure A-3
Sheet 1 of 1

Date Excavated	11/21/2022	Total Depth (ft)	10	Logged By	OA	Excavator	Kelly's Excavating, Inc.	Groundwater not observed
				Checked By	CRN	Equipment	Takeuchi TB138 Mini Excavator	See "Remarks" section for caving observed
Surface Elevation (ft)	280	Easting (X)	1140074	Coordinate System	WA State Plane South			
Vertical Datum	NAVD88	Northing (Y)	658502	Horizontal Datum	NAD83 (feet)			

Elevation (feet)	Depth (feet)	SAMPLE		Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
		Testing Sample	Sample Name Testing						
279	1		1 MC		SOD	Approximately 2 inches of sod	16		Occasional cobbles observed from surface to bottom of test pit
					SM	Dark brown silty fine to medium sand with gravel and occasional organic matter (fine roots) (loose, moist) (fill)			
278	2				GP	Tan with minor oxidation staining fine to coarse gravel with sand, trace silt and occasional organic matter (fine to medium roots) (dense, moist) (Steilacoom gravel)			Medium roots up to approximately ¼ inch diameter between 3 and 4 feet
277	3								
276	4								
275	5								
274	6		2 SA				2	3	Minor caving observed between 5 and 10 feet
273	7								
272	8								
271	9		3						
270	10								

Notes: See Figure A-1 for explanation of symbols.

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Google Earth.

Log of Test Pit TP-3













Project: JBLM ISDC 21 - Sage Well 2 Replacement
Project Location: Joint Base Lewis-McChord, Washington
Project Number: 0371-218-02

Figure A-4
Sheet 1 of 1

Date: 2/24/23 Path: \\GEOENGINEERS.COM\WORK\PROJECTS\0\0371-218-02.GPJ DBLibrary\Library\GEOENGINEERS_DF_STD_US_JUNE_2017.GLB\GER_TESTPIT_1P_GEOTEC_SF

Date Excavated	11/21/2022	Total Depth (ft)	9	Logged By	OA	Excavator	Kelly's Excavating, Inc.	Groundwater not observed
				Checked By	CRN	Equipment	Takeuchi TB138 Mini Excavator	See "Remarks" section for caving observed
Surface Elevation (ft)	280	Easting (X)	1140012	Coordinate System	WA State Plane South			
Vertical Datum	NAVD88	Northing (Y)	658529	Horizontal Datum	NAD83 (feet)			

Elevation (feet)	Depth (feet)	SAMPLE		Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
		Testing Sample	Sample Name Testing						
279	1				SOD	Approximately 2 inches of sod			Occasional cobbles observed from surface to bottom of test pit
					SM	Dark brown silty fine to medium sand with gravel and occasional organic matter (fine roots) (loose, moist) (fill)			
278	2				GP	Tan with minor oxidation staining fine to coarse gravel with sand, trace silt and occasional organic matter (fine roots) (dense, moist) (Steilacoom gravel)			
277	3					Grades to without oxidation staining and without organic matter			Grab sample collected at 4 feet bgs for 10-pt. DIPRA test. See Figure A-7 for results. Moderate caving observed between 4 and 10 feet
276	4		1						
275	5								
274	6								
273	7		2						
272	8								
271	9								

Notes: See Figure A-1 for explanation of symbols.

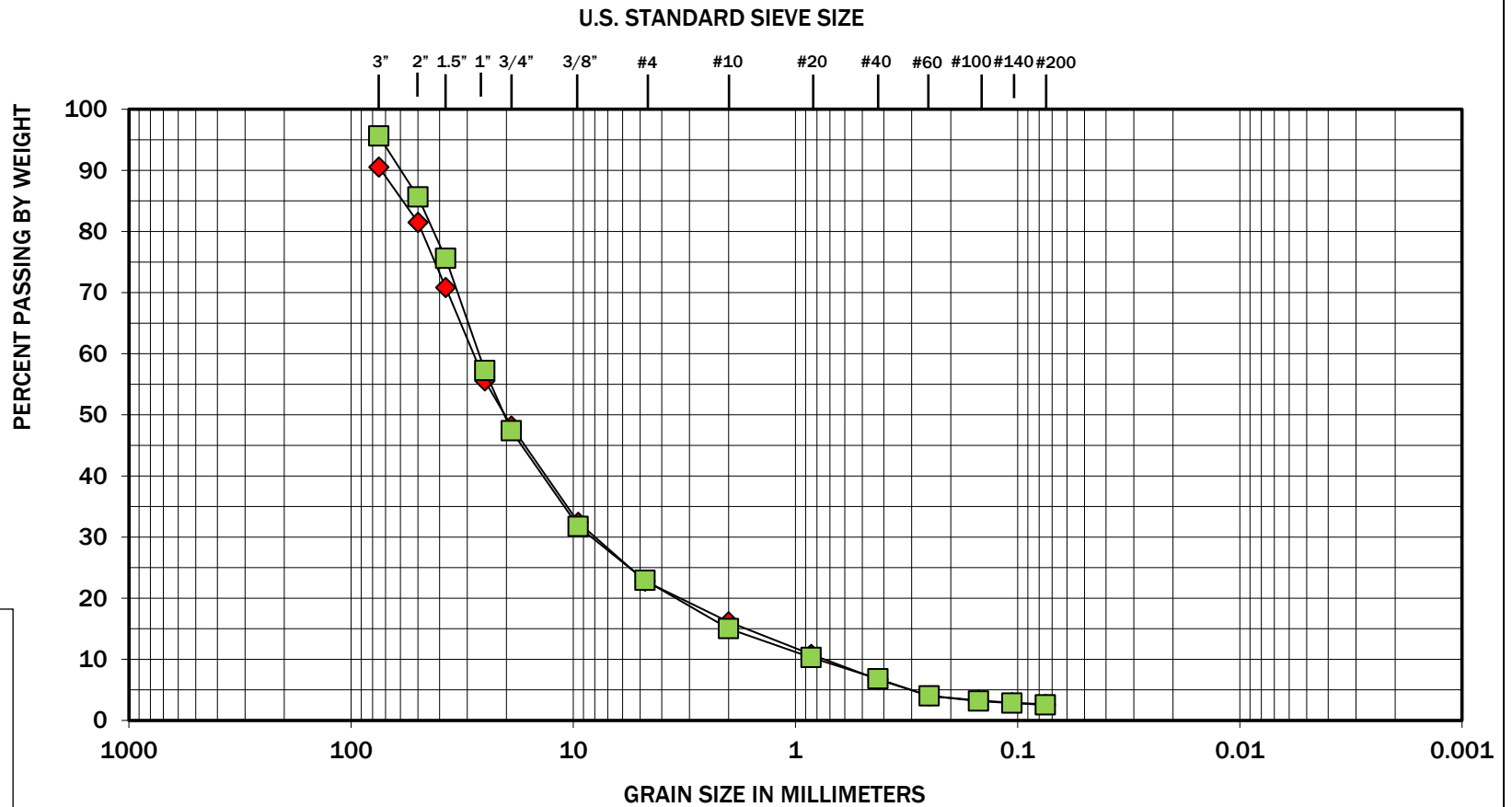
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Google Earth.

Log of Test Pit TP-4



Project: JBLM ISDC 21 - Sage Well 2 Replacement
Project Location: Joint Base Lewis-McChord, Washington
Project Number: 0371-218-02

Figure A-5
Sheet 1 of 1



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Boring Number	Depth (feet)	Moisture (%)	Soil Description
◆	TP-2	5	2	Poorly graded gravel with sand (GP)
■	TP-3	5.5	2	Poorly graded gravel with sand (GP)



Note: This report may not be reproduced, except in full, without written approval of GeoEngineers, Inc. Test results are applicable only to the specific sample on which they were performed, and should not be interpreted as representative of any other samples obtained at other times, depths or locations, or generated by separate operations or processes.

The grain size analysis results were obtained in general accordance with ASTM C 136. GeoEngineers 17425 NE Union Hill Road Ste 250, Redmond, WA 98052

GEOENGINEERS



Figure A-6

JBLM ISDC 21 - Sage Well 2 Replacement
Joint Base Lewis-McChord, Washington

Sieve Analysis Results

DIPRA
(Ductile Iron Pipe Research Association)
10 Point Soil Evaluation

Job Name: McChord Sage Well 2		Job #: 0371-218-02	
Date: 12/28/22		Tested by: JJS	
Boring #: TP-4		DIPRA Pts.	
Sample #: 1		Resistivity :	25,000 0
Depth: 4		pH :	5.94 0
Soil Description:	Gravel with sand and trace silt (GP)	Redox Potential :	295 0
		Sulfides :	NEG 0
		Moisture :	Fair 1
		Total DIPRA Points:	

DIPRA Point Scale

Resistivity (ohm-cm)

0 - 1500	10 pts
1500 - 1800	8 pts
1800 - 2100	5 pts
2100 - 2500	2 pts
2500 - 3000	1 pt
> 3000	0 pts

pH

0.0 - 2.0	5 pts.
2.0 - 4.0	3 pts.
4.0 - 8.5	0 pts
8.5 - 14.0	3 pts.

Redox Potential (millivolts)

>+100(mv)	0 pts
+50 to +100(mv)	3.5 pts
0 to +50(mv)	4 pts
Negative	5 pts

Sulfides

Positive	3.5 pts
Trace	2 pts
Negative	0 pts

Moisture

Poor (wet)	2 pts
Fair (moist)	1 pts
Good (dry)	0 pts

pH and Redox meters calibrated by: Cal Cert

Date: 10/10/2022

DIPRA 10-Point Results

JBLM ISDC 21 - Sage Well 2 Replacement
Joint Base Lewis-McChord, Washington



Figure A-7

Note: This report may not be reproduced, except in full, without written approval of GeoEngineers, Inc. Test results are applicable only to the specific sample on which they were performed, and should not be interpreted as representative of any other samples obtained at other times, depths or locations, or generated by separate operations or processes.

APPENDIX B

Report Limitations and Guidelines for Use

APPENDIX B

REPORT LIMITATIONS AND GUIDELINES FOR USE¹

This appendix provides information to help you manage your risks with respect to the use of this report.

Read These Provisions Closely

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory “limitations” provisions in its reports. Please confer with GeoEngineers if you need to know more how these “Report Limitations and Guidelines for Use” apply to your project or site.

Geotechnical Services are Performed for Specific Purposes, Persons and Projects

This report has been prepared for Bowen Collins & Associates, Inc. and for the Project(s) specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project, and its schedule and budget, our services have been executed in accordance with our Signed Agreement with Bowen Collins & Associates, Inc. dated March 22, 2022 and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A Geotechnical Engineering or Geologic Report is based on a Unique Set of Project-Specific Factors

This report has been prepared for the Sage Well 2 Replacement project at Joint Base Lewis-McChord, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,
- Not prepared for the specific site explored, or
- Completed before important project changes were made.

¹ Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed structure;
- Elevation, configuration, location, orientation or weight of the proposed structure;
- Composition of the design team; or
- Project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

Environmental Concerns are Not Covered

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

Information Provided by Others

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Information Provided by Others

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

Geotechnical and Geologic Findings are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data

and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

Geotechnical Engineering Report Recommendations are Not Final

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable, but separating logs from the report can create a risk of misinterpretation.

Give Contractors a Complete Report and Guidance

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these "Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- Advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- Encourages contractors to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

Contractors are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

