

**PROJECT MANUAL**

**VOLUME 2 OF 2  
Technical Specifications**

**WOODBRIIDGE SCHOOL DISTRICT**

**New Woodbridge High School**

Woodbridge Road  
Delaware

PROJECT NO. 11109

CONSTRUCTION MANAGERS  
EDIS  
110 South Poplar Street  
Suite 400  
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(302) 421-5700



**Bid Package A**

**JULY 3, 2012**

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### 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 cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
  - 1. Footings & Piers.
  - 2. Foundation and retaining walls.
  - 3. Slabs-on-grade.
  - 4. Concrete toppings.
- B. Related Sections:
  - 1. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.
  - 2. Section 321313 "Concrete Paving" for concrete pavement and walks.
  - 3. Section 321316 "Decorative Concrete Paving" for decorative concrete pavement and walks.

#### 1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
  - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar

diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

- D. Construction and Control Joint Layout: Indicate proposed construction and control joints required to construct the structure.
  - 1. Location of joints is subject to approval of the Architect.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturer, and testing agency.
- B. Welding certificates.
- C. Material Certificates: For each of the following, signed by manufacturers:
  - 1. Cementitious materials.
  - 2. Admixtures.
  - 3. Form materials and form-release agents.
  - 4. Steel reinforcement and accessories.
  - 5. Waterstops.
  - 6. Curing compounds.
  - 7. Floor and slab treatments.
  - 8. Bonding agents.
  - 9. Adhesives.
  - 10. Vapor retarders.
  - 11. Semirigid joint filler.
  - 12. Joint-filler strips.
  - 13. Repair materials.
- D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
  - 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.
- F. Field quality-control reports.
- G. Minutes of preinstallation conference.

## 1.6 QUALITY ASSURANCE

- A. **Installer Qualifications:** A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. **Manufacturer Qualifications:** A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
  - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. **Testing Agency Qualifications:** An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
  - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
  - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- D. **Source Limitations:** Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- E. **Welding Qualifications:** Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."
- F. **ACI Publications:** Comply with the following unless modified by requirements in the Contract Documents:
  - 1. ACI 301, "Specifications for Structural Concrete,"
  - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- G. **Concrete Testing Service:** Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- H. **Preinstallation Conference:** Conduct conference at Project site.
  - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
    - a. Contractor's superintendent.
    - b. Independent testing agency responsible for concrete design mixtures.
    - c. Ready-mix concrete manufacturer.

- d. Concrete subcontractor.
  - e. Special concrete finish subcontractor.
2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

### PART 2 - PRODUCTS

#### 2.1 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
  - 1. Plywood, metal, or other approved panel materials.
  - 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
    - a. High-density overlay, Class 1 or better.
    - b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
    - c. Structural 1, B-B or better; mill oiled and edge sealed.
    - d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

- E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch minimum.
- G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- H. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
  - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- I. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
  - 1. Furnish units that will leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
  - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
  - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

## 2.2 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- C. Low-Alloy-Steel Reinforcing Bars: ASTM A 706, deformed.
- D. Galvanized Reinforcing Bars: ASTM A 615, Grade 60 deformed bars, ASTM A 767/A 767M, Class I zinc coated after fabrication and bending.
- E. Epoxy-Coated Reinforcing Bars: ASTM A 615, Grade 60 deformed bars, ASTM A 775 or ASTM A 934, epoxy coated, with less than 2 percent damaged coating in each 12-inch (300-mm) bar length.
- F. Steel Bar Mats: ASTM A 184, fabricated from ASTM A 615, Grade 60 deformed bars, assembled with clips.
- G. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
- H. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

## 2.3 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615, Grade 60 plain-steel bars, cut true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
  - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
  - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
  - 3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

## 2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
  - 1. Portland Cement: ASTM C 150, Type I or Type II. May be supplemented with the following:
    - a. Fly Ash: ASTM C 618, Class F.
    - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C 33, coarse aggregate or better, graded. Provide aggregates from a single source.
  - 1. Maximum Coarse-Aggregate Size: 1-1/2 inches for foundations, 1 inch for walls and piers, and 3/4 inch for slabs.
  - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94 and potable.

## 2.5 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
  - 1. Water-Reducing Admixture: ASTM C 494, Type A.

2. Retarding Admixture: ASTM C 494, Type B.
  3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
  4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
  5. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.
- C. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
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. ChemMasters.
    - b. Davis Colors.
    - c. Dayton Superior Corporation.
    - d. Hoover Color Corporation.
    - e. Lambert Corporation.
    - f. QC Construction Products.
    - g. Rockwood Pigments NA, Inc.
    - h. Scofield, L. M. Company.
    - i. Solomon Colors, Inc.
  2. Color: As selected by Architect from manufacturer's full range.

## 2.6 WATERSTOPS

- A. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
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. Greenstreak.
    - b. Meadows, W. R., Inc.
    - c. Vinylex Corp.
  2. Profile: Flat, dumbbell without center bulb.
  3. Dimensions: 6 inches by 3/8 inch thick ; nontapered.
- B. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.
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. Carlisle Coatings & Waterproofing, Inc.; MiraSTOP.
    - b. Concrete Sealants Inc.; Conseal CS-231.

c. Greenstreak; Swellstop.

2.7 VAPOR RETARDERS

- A. See Section 071110: Under Vapor Retarder. Vapor retarders not in compliance with Specification 071110 will not be accepted.

2.8 LIQUID FLOOR TREATMENTS

- A. VOC Content: Liquid floor treatments shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.
1. Apply to all exposed concrete floors (reference architectural drawings).

2.9 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Solventborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A (non-yellowing).
1. Products: Subject to compliance with requirements, acceptable manufacturers but are not limited to, the following]:
- a. BASF Construction Chemicals.
- b. Euclid Chemical Company (The).
- c. L&M Construction Chemicals, Inc.
- d. Meadows, W. R., Inc.
2. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.10 RELATED MATERIALS

- A. Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber for exterior locations and [ASTM D 1752, cork or self-expanding cork for interior locations.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
  - 1. Types I and II, non-load bearing and Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Reglets: Fabricate reglets of not less than 0.022-inch thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- F. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

## 2.11 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
  - 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
  - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
  - 4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
  - 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
  - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.

3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

## 2.12 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
  1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
  1. Use high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
  2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
  3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

## 2.13 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Footings: Proportion normal-weight concrete mixture as follows:
  1. Minimum Compressive Strength: 3000 psi at 28 days.
  2. Maximum Water-Cementitious Materials Ratio: 0.50
  3. Slump Limit: 4 inches, plus or minus 1 inch .
  4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for exterior concrete.
- B. Foundation Piers and Retaining Walls: Proportion normal-weight concrete mixture as follows:
  1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
  2. Maximum Water-Cementitious Materials Ratio: 0.45.
  3. Slump Limit: 4 inches, plus or minus 1 inch.
  4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch.

C. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days. (4,500 psi for concrete subject to de-icing chemicals.)
2. Minimum Cementitious Materials Content: 470 lb/cu. yd. Maximum water-cementitious material ratio: 0.45 in non-air-entrained; 0.40 if air-entrained.
3. Slump Limit: 4 inches plus or minus 1 inch.
4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

D. Concrete Toppings on Metal Deck: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Minimum Cementitious Materials Content: 470 lb/cu. yd.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size for other slabs.
5. Air Content: Do not allow air content of trowel-finished toppings to exceed 3 percent for other slabs.

2.14 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.15 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

### PART 3 - EXECUTION

#### 3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
  - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
  - 2. Class B, 1/4 inch for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
  - 1. Install keyways, reglets, recesses, and the like, for easy removal.
  - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### 3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
  - 2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
  - 3. Install dovetail anchor slots in concrete structures as indicated.

### 3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete and the concrete has achieved at least 75 percent of its 28 day design compressive strength.. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.
  - 1. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

### 3.4 SHORES AND RESHORES

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
  - 1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

### 3.5 VAPOR RETARDERS

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643, manufacturer's written instructions and Specification Section 071110 under slab vapor retarder.

### 3.6 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
  - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
  - 1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- F. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.
- G. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A 780. Use galvanized steel wire ties to fasten zinc-coated steel reinforcement.

### 3.7 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
4. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
5. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
6. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

### 3.8 WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

### 3.9 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
  - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
  - 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
  - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
  - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
  - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  - 2. Maintain reinforcement in position on chairs during concrete placement.
  - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
  - 4. Slope surfaces uniformly to drains where required.
  - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - 1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

G. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

### 3.10 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

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. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, and to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

### 3.11 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in one direction.
  - 1. Apply scratch finish to surfaces to receive concrete floor toppings or to receive mortar setting beds for bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
  - 1. Apply float finish to surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
  - 1. Apply a trowel finish to surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
  - 2. Finish surfaces to the following tolerances, according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:
    - a. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
  - 3. Finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, 10-ft.- (3.05-m-) long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch (3.2 mm).
- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
- G. Slip-Resistive Finish: Before final floating, apply slip-resistive aluminum granule finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions.

### 3.12 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

### 3.13 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (before and during finishing operations). Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
  2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
    - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
  3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
    - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
  4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

### 3.14 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
  2. Application shall follow manufacturer's instructions.
  3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

### 3.15 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
  3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
  4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
  5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
  7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

### 3.16 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
  1. Steel reinforcement placement.
  2. Steel reinforcement welding.
  3. Headed bolts and studs.
  4. Verification of use of required design mixture.
  5. Concrete placement, including conveying and depositing.
  6. Curing procedures and maintenance of curing temperature.

7. Verification of concrete strength before removal of shores and forms from beams and slabs.
- D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
  2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
  3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
  5. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  6. Compression Test Specimens: ASTM C 31.
    - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
  7. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
    - a. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
  8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
  9. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
  10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
  11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency

may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect.

12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
  13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- E. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 48 hours of finishing.

### 3.17 PROTECTION OF LIQUID FLOOR TREATMENTS

- A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 033000

## SECTION 042200 - CONCRETE UNIT MASONRY

### 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. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry joint reinforcement.
5. Ties and anchors.
6. Miscellaneous masonry accessories.

- B. Related Sections:

1. Section 033000 "Cast-in-Place Concrete".
2. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural-steel frame.

#### 1.3 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
  1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

## 1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
  2. Mortar Test (Property Specification): For each mix required, according to ASTM C 109/C 109M for compressive strength.
  3. Mortar Test (Property Specification): For each mix required, according to ASTM C 780 for compressive strength.
  4. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.
  5. Prism Test: For each type of construction required, according to ASTM C 1314.

## 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For the following:
1. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.

## 1.7 INFORMATIONAL SUBMITTALS

- A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
- B. Qualification Data: For testing agency.
- C. Material Certificates: For each type and size of the following:
1. Masonry units.
    - a. Include material test reports substantiating compliance with requirements.
    - b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include brand, type, and name of manufacturer.
  3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
  4. Grout mixes. Include description of type and proportions of ingredients.
  5. Reinforcing bars.
  6. Joint reinforcement.
  7. Anchors, ties, and metal accessories.
- D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
  2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- E. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
- F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.
- 1.8 QUALITY ASSURANCE
- A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.
  - B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
  - C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.
  - D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.
  - E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."
- 1.9 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 designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and 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.

#### 1.10 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, 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 (600 mm) down both sides of walls and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such 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.
- D. 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 ACI 530.1/ASCE 6/TMS 602.
  - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

## PART 2 - PRODUCTS

### 2.1 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.
- B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

### 2.2 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
  - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
  - 2. Provide bullnose units for outside corners unless otherwise indicated.
- B. CMUs: ASTM C 90.
  - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi Use higher strength masonry as required to meet minimum f'm strength indicated.
  - 2. Density Classification: Normal weight unless otherwise indicated.
  - 3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

### 2.3 CONCRETE AND MASONRY LINTELS

- A. General: Provide one of the following as indicated on the drawings:
- B. Concrete Lintels: ASTM C 1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength not less than CMUs.
- C. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 033000 "Cast-in-Place Concrete," and with reinforcing bars indicated.
- D. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

## 2.4 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, 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 C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Aggregate for Mortar: ASTM C 144.
  - 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 (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
- E. Aggregate for Grout: ASTM C 404.
- F. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
  - 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. Euclid Chemical Company (The); Accelguard 80.
    - b. Grace Construction Products, W. R. Grace & Co. - Conn.; Morset.
    - c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.
- G. Water: Potable.

## 2.5 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).
- B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
  - 1. Interior Walls: Mill-galvanized, carbon steel.
  - 2. Exterior Walls: Hot-dip galvanized, carbon steel.
  - 3. Wire Size for Side Rods: 0.187-inch (4.76-mm) diameter.
  - 4. Wire Size for Cross Rods: 0.148-inch (3.77-mm) diameter.
  - 5. Wire Size for Veneer Ties: 0.187-inch (4.76-mm) diameter.
  - 6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
  - 7. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.

- C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

## 2.6 TIES AND ANCHORS

- A. 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 A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304.
3. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
4. Stainless-Steel Sheet: ASTM A 666, Type 304.
5. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
6. Stainless-Steel Bars: ASTM A 276 or ASTM A 666, Type 304.

- B. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall. Unless noted otherwise on the drawings, provide the following:

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.35-mm-) diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls unless otherwise indicated.
2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.25-inch- (6.35-mm-) diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls, unless otherwise indicated.

- C. Partition Top anchors: 0.105-inch- (2.66-mm-) thick metal plate with 3/8-inch- (9.5-mm-) diameter metal rod 6 inches (152 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel.

- D. Rigid Anchors: Fabricate from steel bars 1-1/2 inches (38 mm) wide by 1/4 inch (6.35 mm) thick bent to configuration indicated.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.

## 2.7 MISCELLANEOUS ANCHORS

- A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.

- B. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

- C. Postinstalled Anchors: Torque-controlled expansion anchors or chemical anchors as indicated on the drawing.
1. Load Capacity: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
  2. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 unless otherwise indicated.
  3. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

## 2.8 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane, or PVC.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
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. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
    - b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
    - c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
    - d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

## 2.9 MORTAR AND GROUT 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. Use portland cement-lime or masonry cement mortar unless otherwise indicated.
  3. For exterior masonry, use portland cement-lime or masonry cement mortar.
  4. For reinforced masonry, use portland cement-lime or masonry cement mortar.
  5. 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 C 270, Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
1. For masonry below grade or in contact with earth, use Type S.
  2. For reinforced masonry, use Type N.
  3. For mortar parge coats, use Type S or Type N.
  4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
  5. For interior non-load-bearing partitions, Type O may be used instead of Type N.
- D. Grout for Unit Masonry: Comply with ASTM C 476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
  2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa).
  3. Provide grout with a slump of 8 to 11 inches (203 to 279 mm) as measured according to ASTM C 143/C 143M.

## 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 work.
  2. Verify that foundations are within tolerances specified.
  3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

- A. Build chases and recesses to accommodate items specified in this and other Sections.
- B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- C. 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.

### 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 (12 mm) or minus 1/4 inch (6 mm).
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) 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 feet (6 mm in 3 m), or 1/2 inch (12 mm) 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 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) 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 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.

#### C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).

2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm).

### 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 (100-mm) horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches (100-mm). Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
  1. Install compressible filler in joint between top of partition and underside of structure above.
  2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch (13-mm) clearance between end of anchor rod and end of tube. Space anchors 48 inches (1200 mm) o.c. unless otherwise indicated.

### 3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
  2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
  3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
  4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. 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.
- C. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
  2. Allow cleaned surfaces to dry before setting.
  3. Wet joint surfaces thoroughly before applying mortar.
- D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

### 3.6 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
1. Space reinforcement not more than 16 inches (406 mm) o.c.
  2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
  3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.

- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

### 3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:
  - 1. Provide an open space not less than 1 inch (25 mm) wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
  - 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
  - 3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 24 inches o.c. horizontally.

### 3.8 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry using one of the following methods:
  - 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
  - 2. Install preformed control-joint gaskets designed to fit standard sash block.
  - 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
  - 4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

### 3.9 LINTELS

- A. Provide concrete or masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.
- B. Provide minimum bearing of 8 inches (200 mm) at each jamb unless otherwise indicated.

### 3.10 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

### 3.11 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.

B. Inspections: Level 1 special inspections according to the "International Building Code."

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area or portion thereof.

E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

G. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.

H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

- I. Prism Test: For each type of construction provided, according to ASTM C 1314 at 7 days and at 28 days.

### 3.12 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 concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

END OF SECTION 042200

## SECTION 051200 - STRUCTURAL STEEL FRAMING

### 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. Structural steel.
- 2. Grout.

- B. Related Sections:

- 1. Section 053100 "Steel Decking" for field installation of shear connectors through deck.
- 2. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and, other metal items not defined as structural steel.
- 3. Section 055100 "Metal Stairs."
- 4. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- 5. Section 055213 "Pipe and Tube Railings."

#### 1.3 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections, moment connections, truss member to member connections, truss to column connections, truss bracing, and braced frames required by the Contract Documents to be selected or completed by structural-steel fabricator. Include comprehensive engineering analysis by a qualified professional engineer registered in Delaware to withstand loads indicated and comply with other information and restrictions indicated, for all trusses, truss bracing, and braced bays.

- 1. Unless otherwise noted on drawings, design connections to support half the total uniform load capacity as tabulated in AISC tables for given member size, span, and grade of steel, and 80% of the total uniform load capacity for composite members.
- 2. See drawings for truss, truss bracing, and braced frame loads.

- B. Moment Connections: Type PR, partially and FR, fully restrained. See details on drawings.
- C. Construction: Moment frame, Braced frame, and Shear wall system.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication of structural-steel components.
  - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
  - 2. Include embedment drawings.
  - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
  - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
  - 5. Identify members and connections of the seismic-load-resisting system.
  - 6. Indicate locations and dimensions of protected zones.
  - 7. Identify demand critical welds.
  - 8. Indicate calculated capacity of all simple shear connections.
  - 9. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer registered in Delaware responsible for their preparation.
- C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:
  - 1. Power source (constant current or constant voltage).
  - 2. Electrode manufacturer and trade name, for demand critical welds.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer, fabricator, professional engineer, and testing agency.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Mill test reports for structural steel, including chemical and physical properties.
- E. Product Test Reports: For the following:
  - 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
  - 2. Direct-tension indicators.

3. Tension-control, high-strength bolt-nut-washer assemblies.
4. Shear stud connectors.
5. Shop primers.
6. Nonshrink grout.

F. Source quality-control reports.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed structural steel work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Fabricator Qualifications: Engage a firm experienced in fabricating structural steel similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to fabricate structural steel without delaying the Work.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.
- D. Comply with applicable provisions of the following specifications and documents:
  1. AISC 303.
  2. AISC 341 and AISC 341s1.
  3. AISC 360.
  4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- E. Preinstallation Conference: Conduct conference at Project site.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
  1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

#### 1.9 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

### PART 2 - PRODUCTS

#### 2.1 STRUCTURAL-STEEL MATERIALS

- A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:
  1. W-Shapes: 60 percent.
  2. Channels, Angles : 60 percent.
  3. Plate and Bar: 25 percent.
  4. Cold-Formed Hollow Structural Sections: 25 percent.
  5. Steel Pipe: 25 percent.
  6. All Other Steel Materials: 25 percent.
- B. W-Shapes: ASTM A 992.
- C. Channels, Angles: ASTM A 36.
- D. Plate and Bar: ASTM A 36 and ASTM A 572, Grade 50.
- E. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
- F. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
  1. Weight Class: As indicated on drawings.
  2. Finish: Black except where indicated to be galvanized.
- G. Steel Castings: ASTM A 216/A 216M, Grade WCB with supplementary requirement S11.

- H. Steel Forgings: ASTM A 668/A 668M.
- I. Welding Electrodes: Comply with AWS requirements.

## 2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C heavy-hex carbon-steel nuts; and ASTM F 436 Type 1, hardened carbon-steel washers; all with plain finish.
  - 1. Direct-Tension Indicators: ASTM F 959, Type 325 compressible-washer type with plain finish.
- B. High-Strength Bolts, Nuts, and Washers: As indicated on the drawings. ASTM A 490 Type 1, heavy-hex steel structural bolts, or tension-control, bolt-nut-washer assemblies with splined ends; ASTM A 563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F 436 Type 1, hardened carbon-steel washers with plain finish.
  - 1. Direct-Tension Indicators: ASTM F 959, Type 490, compressible-washer type with plain finish.
- C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers.
  - 1. Finish: Hot-dip zinc coating.
- D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
  - 1. Finish: Plain.
- E. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- F. Unheaded Anchor Rods: ASTM F 1554, Grade 36. (Unless noted otherwise.)
  - 1. Configuration: Hooked.
  - 2. Nuts: ASTM A 563 heavy-hex carbon steel.
  - 3. Plate Washers: ASTM A 36 carbon steel.
  - 4. Washers: ASTM F 436 Type 1, hardened carbon steel.
  - 5. Finish: Plain unless noted otherwise.
- G. Headed Anchor Rods: ASTM F 1554, Grade 36 straight.
  - 1. Nuts: ASTM A 563 heavy-hex carbon steel.

2. Plate Washers: ASTM A 36 carbon steel.
3. Washers: ASTM F 436, Type 1, hardened carbon steel.
4. Finish: Plain unless noted otherwise.

H. Threaded Rods: ASTM A 36.

1. Nuts: ASTM A 563 heavy-hex carbon steel.
2. Washers: ASTM A 36 carbon steel.
3. Finish: Plain unless noted otherwise.

I. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

J. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.

K. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.

## 2.3 PRIMER

- A. All exposed steel to be painted. Reference architectural drawings and painting specifications.
- B. Primer: (Exposed steel.) Comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting", or if not specified prime with a paint that is compatible with finish paint.
- C. Primer: (Concealed steel.) Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- D. Galvanizing Repair Paint: ASTM A 780.

## 2.4 GROUT

- A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
- B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

## 2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
  1. Camber structural-steel members where indicated.
  2. Fabricate beams with rolling camber up.

3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
  4. Mark and match-mark materials for field assembly.
  5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning."
- F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
- G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.
- H. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches (250 mm) o.c. unless otherwise indicated.
- I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
  2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
  3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

## 2.6 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened and Slip critical (where indicated).

- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
  - 1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

## 2.7 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
  - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
  - 2. Surfaces to be field welded.
  - 3. Surfaces to be high-strength bolted with slip-critical connections.
  - 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
  - 5. Galvanized surfaces.
- B. Painting: (Concealed steel.) Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).
- C. Painting: (Exposed steel.) Comply with Section 099123 "Interior Painting" and 09113 "Exterior Painting."

## 2.8 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123.
  - 1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
  - 2. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.

## 2.9 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
  - 1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

- C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
  - 1. Liquid Penetrant Inspection: ASTM E 165.
  - 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
  - 3. Ultrasonic Inspection: ASTM E 164.
  - 4. Radiographic Inspection: ASTM E 94.
- E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
  - 1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
  - 2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
  - 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

#### 3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

- B. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
  - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
  - 2. Weld plate washers to top of baseplate.
  - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
  - 4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
  - 1. Level and plumb individual members of structure.
  - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
- I. No openings in beams shall be permitted without the written permission of the Architect or the Engineer of record.

### 3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
  - 1. Joint Type: Snug tightened and Slip critical (where indicated).

2. Use minimum  $\frac{3}{4}$ " diameter bolts, nuts, and washer. Furnish proper size bolts, washers, and accessories for use in making field connections. Use a minimum of two bolts for connections.
- B. Weld Connections: Comply with AWS D1.1 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
  2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
  3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
- B. Bolted Connections: Bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.
1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
    - a. Liquid Penetrant Inspection: ASTM E 165.
    - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
    - c. Ultrasonic Inspection: ASTM E 164.
    - d. Radiographic Inspection: ASTM E 94.
- D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
  2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.
- E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
- F. See structural drawings for additional special inspections.

3.6 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.
- B. Touchup Painting for Concealed Steel: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
  - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- C. Touchup Painting for Exposed Steel: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting"Section 099123 "Interior Painting."

END OF SECTION 051200

## SECTION 052100 - STEEL JOIST FRAMING

### 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. K-series steel joists.
2. KCS-type K-series steel joists.
3. K-series steel joist substitutes.
4. LH-series long-span steel joists.
5. Joist accessories.

- B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete".
2. Section 042000 "Unit Masonry".
3. Section 051200 "Structural Steel Framing".
4. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and, other metal items not defined as structural steel.
5. Section 055100 "Metal Stairs."
6. Section 055213 "Pipe and Tube Railings."
7. Section 099113 "Exterior Painting" for repair painting of primed deck and finish painting of deck.
8. Section 099123 "Interior Painting" for repair painting of primed deck and finish painting of deck.

#### 1.3 DEFINITIONS

- A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."
- B. Special Joists: Steel joists requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of joist, accessory, and product.
- B. Shop Drawings:
  - 1. Include layout, designation, number, type, location, and spacing of joists.
  - 2. Include joining and anchorage details, bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
  - 3. Indicate locations and details of bearing plates to be embedded in other construction.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and professional engineer.
- B. Welding certificates.
- C. Manufacturer certificates.
- D. Mill Certificates: For each type of bolt.

#### 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."
  - 1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.
- B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle joists as recommended in SJI's "Specifications."
- B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

#### 1.8 SEQUENCING

- A. Deliver steel bearing plates to be built into masonry construction (if required).

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.
  - 1. Use ASD; data are given at service-load level.
  - 2. Design special joists to withstand design loads with live-load deflections no greater than the following:
    - a. Floor Joists: Vertical deflection of 1/360 of the span.
    - b. Roof Joists: Vertical deflection of 1/360 of the span.
    - c. Roof joists to be designed for uplift loads indicated on drawings.
- B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

### 2.2 K-SERIES STEEL JOISTS

- A. Manufacture steel joists of type indicated according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
  - 1. Joist Type: K-series steel joists and KCS-type K-series joist as indicated on plan.
- B. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.
- C. Provide holes in chord members for connecting and securing other construction to joists.
- D. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated, complying with SJI's "Specifications."
- E. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."
- F. Manufacturer's standard camber as recommended by SJI.
- G. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

### 2.3 LONG-SPAN STEEL JOISTS

- A. Manufacture steel joists according to "Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements as indicated.

1. Joist Type: LH-series steel joists.
2. End Arrangement: Underslung.
3. Top-Chord Arrangement: See drawings.

- B. Provide holes in chord members for connecting and securing other construction to joists.
- C. Camber long-span steel joists according to SJI's "Specifications."
- D. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

#### 2.4 PRIMERS

- A. All exposed joists will be painted. Reference architectural drawings and painting specifications.
- B. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15 for all joists above ceiling.
- C. Primer: Provide shop primer that complies with Section 099113 "Exterior Painting" and Section 099123 Interior Painting for all exposed joists.

#### 2.5 JOIST ACCESSORIES

- A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
- B. Bridging: Detail and fabricate according to SJI's "Specifications."Furnish additional erection bridging if required for stability.
- C. Fabricate steel bearing plates from ASTM A 36 steel with integral anchorages of sizes and thicknesses indicated. Shop prime paint.
- D. Steel bearing plates with integral anchorages as shown.
- E. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch (13 mm) of finished wall surface unless otherwise indicated.
- F. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A, carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.
  1. Finish: Plain, uncoated.
- G. High-Strength Bolts, Nuts, and Washers: ASTM A 325 Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
  1. Finish: Plain.

- H. Welding Electrodes: Comply with AWS standards.
- I. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

## 2.6 CLEANING AND SHOP PAINTING

- A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.
- B. Do not prime paint joists and accessories to receive sprayed fire-resistive materials.
- C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil (0.025 mm) thick.
- D. Shop priming of joists and joist accessories is specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting", or if not specified, prime with a paint that is compatible with finish paint.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Do not install joists until supporting construction is in place and secured.
- B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.
  - 1. Before installation, splice joists delivered to Project site in more than one piece.
  - 2. Space, adjust, and align joists accurately in location before permanently fastening.
  - 3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
  - 4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.
- C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and

procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

- D. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with Research Council on Structural Connection's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" for high-strength structural bolt installation and tightening requirements.
- E. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

### 3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.
- B. Visually inspect field welds according to AWS D1.1/D1.1M.
  - 1. In addition to visual inspection, test field welds according to AWS D1.1/D1.1M and the following procedures, as applicable:
    - a. Liquid Penetrant Inspection: ASTM E 165.
    - b. Magnetic Particle Inspection: ASTM E 709.
    - c. Ultrasonic Testing: ASTM E 164.
    - d. Radiographic Testing: ASTM E 94.
- C. Visually inspect bolted connections.
- D. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.
- E. Perform additional testing to determine compliance of corrected Work with specified requirements.

### 3.4 PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.
  - 1. Clean and prepare surfaces by hand-tool cleaning according to SSPC-SP 2, or power-tool cleaning according to SSPC-SP 3.

2. Apply a compatible primer of same type as primer used on adjacent surfaces.
- C. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- D. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that joists and accessories are without damage or deterioration at time of Substantial Completion.

END OF SECTION 052100

## SECTION 053100 - STEEL DECKING

### 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. Roof deck.
2. Acoustical roof deck.
3. Acoustical cellular roof deck.
4. Composite floor deck.

- B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for normal-weight structural concrete fill over steel deck.
2. Section 051200 "Structural Steel Framing."
3. Section 099113 "Exterior Painting" for repair painting of primed deck and finish painting of deck.
4. Section 099123 "Interior Painting" for repair painting of primed deck and finish painting of deck.
5. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and, other metal items not defined as structural steel.
6. Section 055213 "Pipe and Tube Railings."

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.

- B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Product Certificates: For each type of steel deck.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
  - 1. Power-actuated mechanical fasteners.
  - 2. Acoustical roof deck.
- D. Evaluation Reports: For steel deck.
- E. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."
- C. Installer Qualifications: An experienced installer who has completed steel deck similar in material, design, and extent to that indicated for this project and whose work has resulted in construction with a record of successful in-service performance.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
  - 1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.
- C. Rusty or mud spattered decking shall not be erected.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
- B. Fasten deck to resist uplift loads indicated on drawings. Provide additional fasteners to those specified as required.
- C. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
- D. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

### 2.2 ROOF DECK

- 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. Canam United States; Canam Group Inc.
  - 2. CMC Joist & Deck.
  - 3. Consolidated Systems, Inc.; Metal Dek Group.
  - 4. Epic Metals Corporation.
  - 5. New Millennium Building Systems, LLC.
  - 6. Nucor Corp.; Vulcraft Group.
  - 7. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
- B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
  - 1. Galvanized-Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 33 G60 zinc coating.
  - 2. Deck Profile: As indicated.
  - 3. Profile Depth: As indicated.
  - 4. Design Uncoated-Steel Thickness: As indicated.
  - 5. Span Condition: Triple span or more.
  - 6. Side Laps: Overlapped or interlocking seam at contractor option.

### 2.3 ACOUSTICAL ROOF DECK

- A. Manufacturers: Subject to compliance with requirements.

- B. Acoustical Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
1. Galvanized-Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 40 G60 zinc coating.
  2. Deck Profile: As indicated.
  3. Cellular Deck Profile: As indicated.
  4. Profile Depth: As indicated.
  5. Design Uncoated-Steel Thickness: As indicated.
  6. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated.
  7. Span Condition: Three span minimum.
  8. Side Laps: Overlapped or interlocking seam at Contractor's option.
  9. Acoustical Perforations: Cellular deck units with manufacturer's standard perforated flat-bottom plate welded to ribbed deck.
  10. Sound-Absorbing Insulation: Manufacturer's standard premolded roll or strip of glass or mineral fiber.
  11. Acoustical Performance: 0.90 tested according to ASTM C 423.
  12. Accessories:
    - a. Spacer mesh of profile to fit void space between vertical ribs beneath insulation.
    - b. Closure plate of the same thickness as the roof deck, as required to provide solid bearing paint for roof insulation.

#### 2.4 COMPOSITE FLOOR DECK

- 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. Canam United States; Canam Group Inc.
  2. CMC Joist & Deck.
  3. Consolidated Systems, Inc.; Metal Dek Group.
  4. New Millennium Building Systems, LLC.
  5. Nucor Corp.; Vulcraft Group.
  6. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
- B. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
1. Galvanized-Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 40 G60 zinc coating.
  2. Profile Depth: 1-1/2 inches (38 mm).
  3. Design Uncoated-Steel Thickness: 0.0358 inch or as indicated on the drawings.
  4. Span Condition: Triple span or more.

## 2.5 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.
- G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.
- H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
- I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0747 inch thick, with factory-punched hole of 3/8-inch minimum diameter.
- J. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.
- K. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch- wide flanges and level recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.
- L. Galvanizing Repair Paint: ASTM A 780

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.
- B. Install temporary shoring before placing deck panels if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
  - 1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions. Mechanical fasteners shall provide equal or greater diaphragm strength as specified welds.
- J. All openings greater than 12 inches shall be reinforced with angle framing according to details on structural drawings.

### 3.3 ROOF-DECK INSTALLATION

- A. Unless indicated otherwise on plan, fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches (38 mm) long, and as follows:
  - 1. Weld Diameter: 5/8 inch, nominal.
  - 2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds 12 inches apart in the field of roof and 6 inches apart in roof corners and perimeter, based on roof-area definitions in FMG Loss Prevention Data Sheet 1-28 or as indicated.
  - 3. Weld Washers: Install weld washers at each weld location.

- B. Unless indicated otherwise on plan, Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 36 inches, and as follows:
  - 1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
  - 2. Mechanically clinch or button punch.
  - 3. Fasten with a minimum of 1-1/2-inch long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
  - 1. End Joints: Lapped 2 inches minimum unless otherwise indicated or necessary due to deck type.
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld flanges to top of deck. Space welds not more than 12 inches apart with at least one weld at each corner.
  - 1. Install reinforcing channels or zees in ribs to span between supports and weld.
- E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
  - 1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.
- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.
- G. Sound-Absorbing Insulation: Installation into topside ribs of deck as specified in manufacturer's literature.

#### 3.4 FLOOR-DECK INSTALLATION

- A. Unless indicated otherwise indicated on plan, fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
  - 1. Weld Diameter: 5/8 inch , nominal.
  - 2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart or as indicated on drawings.
  - 3. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 18 inches , and as follows:
  - 1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.

2. Mechanically clinch or button punch.
  3. Fasten with a minimum of 1-1/2-inch-long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches with end joints as follows:
1. End Joints: Lapped.
- D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.
- E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Field welds will be subject to inspection.
- C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.
- D. Remove and replace work that does not comply with specified requirements.
- E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.
- F. Refer to structural drawings for additional special inspections and testing.

### 3.6 PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 053100

DIVISION 21 SECTION 210500  
COMMON WORK RESULTS FOR FIRE PROTECTION  
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SECTION 210500 COMMON WORK RESULTS FOR FIRE PROTECTION

PART 1. GENERAL

1.1. SUMMARY

- A. All work under Division 21 is subject to the Division 01, *General Conditions* and Special Requirements for the entire contract.
- B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all mechanical work.
- C. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange piping, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with *Submittals* specified below. The right is reserved to make reasonable changes in location of equipment, and piping up to the time of rough-in or fabrication.
- D. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.
- E. Coordinate the work under Division 21 with the work of all other construction trades.
- F. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.

1.2. EXAMINATION OF SITE

- A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for contractors failure to do so.
- B. Examine and verify specific conditions described in individual specifications sections.
- C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.3. MATERIALS AND EQUIPMENT

- A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.
- B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable

for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.

- C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.
- D. Substitution will not be permitted for specified items of material or equipment where noted.
- E. All items of equipment furnished shall have a service record of at least five (5) years.

#### 1.4. FIRE SAFE MATERIALS

- A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

#### 1.5. REFERENCED STANDARDS, CODES AND SPECIFICATIONS

- A. Specifications, Codes and Standards listed below are included as part of this specification, latest edition.
- B. ASTM - American Society for Testing and Materials
- C. FM - Factory Mutual
- D. IBC - International Building Code
- E. MSSP - Manufacturers Standards Society of the Valve and Fittings Industry
- F. NFPA - National Fire Protection Association
- G. UL - Underwriters' Laboratories
- H. All equipment materials, piping and installation shall comply with the codes and standards listed in the enforceable edition of the Applicable National Fire Protection Association Pamphlets.

#### 1.6. SHOP DRAWINGS/SUBMITTALS

- A. Prepare and submit shop drawings for all mechanical equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from that shown on contract drawings.
- B. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.

C. Items and Systems

Exterior Equipment/Piping Supports  
Material and Equipment List  
Pipe Materials Including Itemized Schedule

1.7. EXCAVATION AND BACKFILLING

A. General

1. Perform all necessary excavation, or installation of work under Division 21, in whatever materials or conditions encountered, using suitable methods and equipment.
2. Accurately establish required lines and grades and properly locate the work.
3. Determine the locations of all existing utilities before commencing the work.

B. Excavation: (Refer also to other portions of the specifications)

1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.
2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, and OSHA Guidelines.
3. Keep excavations dry. Protect excavations from freezing.

C. Backfilling: (Refer also to other portions of the specifications)

1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.
2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.
3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.
4. Do not backfill against frozen material. Do not use frozen material for backfill.

1.8. DEFINITIONS

- A. *Approve* - to permit use of material, equipment or methods conditional upon compliance with contract documents requirements.
- B. *Furnish and install* or *provide* means to supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.

- C. *Contractor* means the mechanical contractor and any of his subcontractors, vendors, suppliers, or fabricators.
- D. *Piping* includes pipe, all fittings, valves, hangers, insulation, identification, and other accessories relative to such piping.
- E. *Concealed* means hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction or in crawl space.
- F. *Exposed* means not installed underground or *concealed* as defined above.
- G. *Invert Elevation* means the elevation of the inside bottom of pipe.
- H. *Finished Spaces*: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.
- I. *Review* - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.
- J. *Building Line*: Exterior wall of building.

## PART 2. ELECTRICAL REQUIREMENTS – NOT USED

## PART 3. EXECUTION

### 3.1. SUPPORTS, HANGERS AND FOUNDATIONS

- A. Provide supports, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.

### 3.2. PROTECTION OF WORK

- A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.
- B. Cover temporary openings in piping and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver pipes and tubes with factory applied end caps.
- C. Cover or otherwise protect all finishes.
- D. Replace damaged materials, devices, finishes and equipment.
- E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.3. WALL AND FLOOR PENETRATION

- A. All penetrations of floors by piping or conduit under Division 26 shall be sleeved, sealed, and caulked airtight for sound and air transfer control.
- B. Where piping extends through below grade walls provide waterproof pipe penetration seals, as specified in another division of these specifications.
- C. Piping sleeves:
  - 1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
  - 2. Twenty-two (22) gauge galvanized steel elsewhere.

3.4. PIPING SYSTEM TESTING

- A. All fire protection piping shall be pressure tested per NFPA-13 and the Fire Marshal requirements. Fire protection piping system shall be proven tight under the following gauge pressure for a duration of 4 hours.

SYSTEM	TEST PRESSURE
Fire Protection	200 psig

3.5. PIPE IDENTIFICATION

- A. Furnish and install detectable metallic tape above all direct buried piping.

END OF SECTION

DIVISION 21 SECTION 210505  
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SECTION 210505 - FIRE PROTECTION PIPING, FITTINGS AND VALVES

## PART 1. GENERAL

### 1.1. SUMMARY

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

### 1.2. SYSTEM DESCRIPTION CONDITIONS

- A. Provide all labor and materials necessary to furnish and install all piping systems on this project as herein specified and/or shown on the drawings.
- B. All piping and insulation installed in ceiling plenums must be plenum rated and comply with NFPA and the authority having jurisdiction.
- C. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- D. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- E. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- F. Provide pipe hangers and supports in accordance with ASTM B31.9, MSS SP69 and NFPA-13 unless indicated otherwise.

### 1.3. QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.

### 1.4. DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to site under as hereinbefore specified.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed systems.

### 1.5. ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

#### 1.6. ALTERNATES

- A. Refer to Division 01 - *Alternates* for description of work under this section affected by alternates.

### PART 2. PRODUCTS

#### 2.1. PIPE MATERIALS

- A. All materials, unless otherwise specified, shall be new and of the best quality of their respective kinds, and shall conform to the requirements and ordinances of local, state and insurance authorities having jurisdiction.

- 1. Fire Protection Piping (NFPA-13):

- a). Piping Underground: Steel, schedule 40, ASTM A53, black pipe with ASME C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape, or listed ductile iron pipe.
    - b). Wet Pipe Fittings: Steel fittings shall be ASME B16.9, wrought steel, butt welded. Mechanical grooved couplings shall be malleable iron housing clamps to engage and lock C shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe. Mechanical formed fittings shall be carbon steel housing with integral pipe stop and O-ring and O-ring uniformity compressed into permanent mechanical engagement onto pipe.
    - c). Special Requirements: All fire protection piping, valves, fittings and joints shall comply with applicable National Fire Protection Pamphlets (NFPA) local codes, building codes, Fire Marshal, Owner's Insurance Underwriter, and the authority having jurisdiction.

- B. Steel pipe shall be similar and equal to National Tube Company, Grinnell, Republic, or Bethlehem black or zinc-coated (galvanized) as hereinafter specified. Pipe shall be free from all defects which may affect the durability for the intended use. Each length of pipe shall be stamped with the manufacturer's name.

- C. Welding fittings for steel pipe shall meet the requirements of ASTM Standard A-23 and shall be standard catalog products. Fittings fabricated by metering and notching pipe will not be accepted.

#### 2.2. SLEEVES

- A. Sleeves shall be provided around all pipes through walls, floors, or other building parts. Sleeves shall be standard weight galvanized iron pipe two sizes larger than the pipe or insulation so that pipe or insulation shall pass through masonry or concrete walls or floors. Provide 20 gauge galvanized steel sheet or galvanized pipe sleeves for all piping passing

through frame walls.

- B. Sleeves through floors shall be flush with the floor except for sleeves passing through Equipment Rooms which shall extend ¾-inch above the floor. Space between the pipe and sleeve shall be caulked. Escutcheon plates shall be constructed to conceal the ends of sleeves. Each trade shall be responsible for drilling existing floors and walls for necessary sleeve holes. Drilling methods and tools shall be as hereinbefore specified.
- C. Sleeves through walls and floors shall be sealed with a waterproof caulking compound.

### 2.3. WATER PROOF PIPE PENETRATION SEALS

- A. Provide and install waterproof pipe penetration seals at all pipes that enter the building below grade or through exterior wall.
- B. Link seals are to be Metraflex Metraseals, Model MS, Linkseal, or approved equal, black EPDM seal material, glass reinforced plastic pressure plates, zinc plated nuts and bolts, seals are to be resistant to sunlight and ozone, pressure rated to make a hydrostatic seal of up to 20 psig and up to 40 feet of head, temperature rated from -40 degrees F to 250 degrees F.

## PART 3. EXECUTION

### 3.1. GENERAL PIPING INSTALLATION REQUIREMENTS

- A. All pipes shall be cut accurately to measurements established at the building, and shall be worked into place without springing or forcing, properly clearing all other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted. All pipes shall be so installed as to permit free expansion and contraction without causing damage. All open ends of pipe lines, equipment, etc., shall be properly capped or plugged during installation to keep dirt or other foreign material out of the system. All pipes shall be run parallel with the lines of the building and as close to walls, columns and ceilings as may be practical, with proper pitch. All piping shall be arranged so as not to interfere with removal of other equipment on devices not to block access to doors, windows, manholes, or other access openings. Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment, and installed so that there will be no interference with the installation of the equipment. All valves and specialties shall be placed to permit easy operation and access and all valves shall be regulated, packed and glands adjusted at the completion of the work before final acceptance. All piping shall be installed so as to avoid air or liquid pockets throughout the work. Ends of pipe shall be reamed so as to remove all burrs.
- B. Where pipe support members are welded to structural building framing, scrape, brush clean, weld and apply one coat of zinc rich primer.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

### 3.2. PIPE JOINTS INSTALLATION REQUIREMENTS

- A. Screwed Joints: All screwed joints shall be made with tapered threads properly cut.

Screwed joints shall be made perfectly tight with a stiff mixture of graphite and oil, applied with a brush to the male threads on the fittings.

- B. Prohibited Connections: No direct weld, soldered, or brazed connections, without unions or flanges, shall be made to valves, strainers, apparatus, or related equipment. Right and left couplings, long threads, or caulking of pipe threads or gasket joints will not be permitted.

### 3.3. SUPPORTS INSTALLATION REQUIREMENTS

- A. General: All hangers shall be of an approved type arranged to maintain the required grading and pitching of lines to prevent vibration and to provide for expansion and contraction. Saddles shall be Grinnells Figure 173/273 or approved equal. Provide approved spacers between saddles and pipe where flexible insulation is specified. Provide insulation protection shields for insulated piping without saddles. Shield shall be Grinnell Figure 167 or as approved equal. Comply with NFPA-13.
- B. Spacing: Regardless of spacing, hangers shall be provided at or near all changes in direction, both vertical and horizontal, for all piping.
- C. Vertical Lines: Shall be supported at their bases, using either a suitable hanger placed in a horizontal line near the riser, or a base type fitting set on a pedestal, foundation or support. All vertical lines extending through more than one floor level shall be supported at each floor with a riser clamp. Riser clamp shall be Grinnell Co.'s Figure 261, or approved equal. All vertical drops to pump suction elbows shall be supported by floor posts.
- D. Racks and Brackets: All horizontal piping on vertical walls shall be properly supported by suitable racks securely anchored into the wall construction. Where not practical to obtain ceiling anchorage, all piping near walls shall be supported by approved brackets securely anchored into the wall construction. Washer plates (Fib. 60, 60L) and other miscellaneous attachments, fasteners, etc., shall be Grinnell or as approved equal. All exterior hanger and bracket systems in their entirety shall be galvanized.
- E. Support of horizontal piping shall allow for vertical adjustment after installation of piping.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.
- G. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

END OF SECTION

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## SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

### PART 1. GENERAL

#### 1.1. SUMMARY

- A. All work under Division 22 is subject to the Division 01, *General Requirements, the General Conditions and Supplementary Conditions*.
- B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all plumbing work.
- C. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange piping, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with *Submittals* specified below. The right is reserved to make reasonable changes in location of equipment, piping, up to the time of rough-in or fabrication.
- D. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.
- E. Coordinate the work under Division 22 with the work of all other construction trades.
- F. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.

#### 1.2. EXAMINATION OF SITE

- A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for contractors failure to do so.
- B. Examine and verify specific conditions described in individual specifications sections.
- C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

#### 1.3. MATERIALS AND EQUIPMENT

- A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.
- B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer.

Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.

- C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.
- D. Substitution will not be permitted for specified items of material or equipment where noted.
- E. All items of equipment furnished shall have a service record of at least five (5) years.

#### 1.4. FIRE SAFE MATERIALS

- A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

#### 1.5. REFERENCED STANDARDS, CODES AND SPECIFICATIONS

- A. Specifications, Codes and Standards listed below are included as part of this specification, latest edition.
- B. ASME - American Society of Mechanical Engineers
- C. ASPE - American Society of Plumbing Engineers
- D. ASTM - American Society for Testing and Materials
- E. AWWA - American Water Works Association
- F. EPA - Environmental Protection Agency
- G. IBC - International Building Code
- H. NSF - National Sanitation Foundation
- I. UL - Underwriters' Laboratories
- J. All plumbing equipment and materials shall comply with the codes and standards listed in the latest edition of ASHRAE HVAC Applications Handbook, Chapter entitled *Codes and Standards*.

#### 1.6. SHOP DRAWINGS/SUBMITTALS

- A. Prepare and submit shop drawings for all plumbing equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from that shown on contract drawings.
- B. Submit data and shop drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item

and system and the applicable specification paragraph number and drawing number.

- C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.

- D. Items and Systems

- Direct Buried Piping
- Exterior Equipment/Piping Supports
- Floor Drains
- Grease Interceptor
- Material and Equipment List
- Pipe Materials Including Itemized Schedule
- Test Certificates
- Trap Priming Lines
- Floor Cleanouts

#### 1.7. PENETRATION OF WATERPROOF CONSTRUCTION

- A. Coordinate the work to minimize penetration of waterproof construction, including exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

#### 1.8. CONCRETE AND MASONRY WORK

- A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 22. Perform work in accordance with requirements of other applicable Divisions of these specifications.
- B. Concrete shall test not less than 3,000 psi compressive strength after 28 days.
- C. Grout shall be non-shrink, high strength mortar, free of iron of chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.

#### 1.9. EXCAVATION AND BACKFILLING

- A. GENERAL

- 1. Perform all necessary excavation, or installation of work under Division 22, in whatever materials or conditions encountered, using suitable methods and equipment.
- 2. Accurately establish required lines and grades and properly locate the work.
- 3. Determine the locations of all existing utilities before commencing the work.

- B. Excavation: (Refer also to other portions of the specifications)

1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.
  2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, and OSHA Guidelines.
  3. Keep excavations dry. Protect excavations from freezing.
- C. Backfilling: (Refer also to other portions of the specifications)
1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.
  2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.
  3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.
  4. Do not backfill against frozen material. Do not use frozen material for backfill.

#### 1.10. DEFINITIONS

- A. *Approve* - to permit use of material, equipment or methods conditional upon compliance with contract documents requirements.
- B. *Furnish and install or provide* means to supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.
- C. *Contractor* means the mechanical contractor and any of his subcontractors, vendors, suppliers, or fabricators.
- D. *Piping* includes pipe, all fittings, valves, hangers, insulation, identification, and other accessories relative to such piping.
- E. *Concealed* means hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction or in crawl space.
- F. *Exposed* means not installed underground or *concealed* as defined above.
- G. *Invert Elevation* means the elevation of the inside bottom of pipe.
- H. *Finished Spaces*: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.
- I. *Review* - limited observation or checking to ascertain general conformance with design

concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

- J. *Building Line:* Exterior wall of building.

## PART 2. ELECTRICAL REQUIREMENTS – NOT USED

## PART 3. EXECUTION

### 3.1. EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment according to approved submittal data. Portions of the work are shown only in diagrammatic form. Refer conflicts to Architect.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

### 3.2. SUPPORTS, HANGERS AND FOUNDATIONS

- A. Provide supports, attachments, and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.

### 3.3. PROTECTION OF WORK

- A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.
- B. Cover temporary openings in piping and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver pipes and tubes with factory applied end caps.
- C. Cover or otherwise protect all finishes.
- D. Replace damaged materials, devices, finishes and equipment.
- E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

### 3.4. WALL AND FLOOR PENETRATION

- A. All penetrations of floors by piping or conduit under Division 22 shall be sleeved, sealed, and caulked airtight for sound and air transfer control.
- B. Where piping extends through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these specifications.
- C. Piping sleeves:
  - 1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and

concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.

2. Twenty-two (22) gauge galvanized steel elsewhere.

### 3.5. PIPING SYSTEMS TESTING

- A. All gas piping shall be pressure tested in accordance with NFPA-54. Gas piping systems shall be proven tight under the following gauge pressures for a duration of four(4) hours:

<b>SYSTEM</b>	<b>TEST PRESSURE</b>
Gas Piping	100 psig

- B. All storm and waste piping shall be tested by the Contractor and approved by the Engineer before acceptance. All storm, soil, and waste piping, located underground, shall be tested before backfilling. The costs of all equipment required for tests are to be included in the contract price.
- C. The entire new drainage system shall have all necessary openings plugged and filled with water to the level of the highest stack above. The system shall hold this water for thirty (30) minutes without showing a drop greater than 1inch. Where a portion of the system is to be tested, the test shall be conducted in the same manner as described for the entire system, except a vertical stack 10 feet above the highest horizontal line to be tested may be installed and filled with water to maintain sufficient pressure, or a pump may be used to supply the required pressure. The pressure shall be maintained for thirty (30) minutes. All testing shall be in accordance with the local Plumbing Code and witnessed by the Plumbing Inspector or authority having jurisdiction.
- D. Testing and acceptance thereof shall be in accordance with local requirements and shall meet approval of authority having jurisdiction. Submit certificates and approved permits and insert one (1) copy in the *Operations and Maintenance Manuals*.

### 3.6. PIPE IDENTIFICATION

- A. Furnish and install detectable metallic tape above all direct buried piping.

END OF SECTION

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SECTION 220505 - PLUMBING PIPING, FITTINGS AND VALVES

## PART 1. GENERAL

### 1.1. SUMMARY

- A. The conditions of the contract and other general requirements apply to the work specified in this section. All work under this section shall also be subject to the requirements of Division 22 Section, Common Work Results for Plumbing and Division 01, *General Requirements*.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2. SYSTEM DESCRIPTION CONDITIONS

- A. Provide all labor and materials necessary to furnish and install all piping systems on this project as herein specified and/or shown on the drawings. Final connections to equipment furnished in other sections of the specifications shall be included under this section.
- B. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- C. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- D. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- E. Provide pipe hangers and supports in accordance with ASTM B31.9 and MSS SP69 unless indicated otherwise.

### 1.3. QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulation. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.
- C. Welders Certification: In accordance with ASME Section 9.
- D. Maintain one copy of each document on site.

### 1.4. DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to site under as hereinbefore specified.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed systems.

#### 1.5. ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

#### 1.6. EXTRA MATERIALS

- A. Provide one (1) repacking kit for each size valve.

### PART 2. PRODUCTS

#### 2.1. PIPE MATERIALS

- A. All materials, unless otherwise specified, shall be new and of the best quality of their respective kinds, and shall conform to the requirements and ordinances of local, state and insurance authorities having jurisdiction.
  - 1. Sanitary Underground - Within Building to 5 Feet Outside of Foundation Wall:
    - a). PVC Pipe: Schedule 40 DWV or cellular core. Fittings: Schedule 40 PVC, ASTM D 2665 or ASTM F891 socket fittings. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
  - 2. Storm Water Below Grade or Under Building to Point 5 Feet from Building Line:
    - a) PVC Pipe: Schedule 40 DWV or cellular core. Fittings: Schedule 40 PVC, ASTM D 2665 or ASTM F891 socket fittings. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
  - 3. Domestic Cold Water Outside of Building Below Ground or Under Building to Point 5 Feet from Building Line:
    - a). Pipe: 2-1/2 inches & smaller, soft temper type K. ASTM B88 - No joints below grade except as approved by the Engineer. Below grade trap priming piping shall be soft temper type K or Pex piping at contractor's option.  
  
3 inches & larger, ductile iron pipe for water, ANSI 21.50 & 21.51 with double thickness cement mortar lining, ANSI 21.4.
    - b). Fittings & Joints: wrought copper solder joint fittings, ANSI B16.22. Joints for copper piping shall be ASTM B32, SOLDER, grade 95TA.

Cast iron pressure fittings, ANSI 21.10, Class 250. Mechanical specification for mechanical joint for cast iron pressure pipe & fittings ANSI A21.11. Joints for ductile iron pipe shall be AWWA C111, rubber gasket with 3/4 inch diameter rods.

4. Gas Piping:

- a). Outside Building, Below Ground: Copper type *L* tubing, ASTM B88 Below Ground
- b). Fittings & Joints: 150 lb. screwed galvanized malleable iron ASTM B16.3 with joints sealed with litharge and glycerin. Piping 2 ½ inches and larger and any concealed piping within walls must be welded, ASTM A24 forged steel welded type joints shall be threaded or welded to ANSI B31.1 or ASME Sec. 1.
- c). Finish: All gas piping downstream of regulator shall be primed and finished with two coats of rust resistant paint with pewter gray finish. Paint shall be two part epoxy-exterior paint as manufactured by Pittsburgh Paint, Themeco, or approved equal. Painting shall be provided under another Section of these Specifications.

- B. Steel pipe shall be similar and equal to National Tube Company, Grinnell, Republic, or Bethlehem black or zinc-coated (galvanized) as hereinafter specified. Pipe shall be free from all defects which may affect the durability for the intended use. Each length of pipe shall be stamped with the manufacturer's name.
- C. Copper pipe shall be Revere, Anaconda or Chase with approved solder fittings.
- D. Welding fittings for steel pipe shall meet the requirements of ASTM Standard A-23 and shall be standard catalog products. Fittings fabricated by metering and notching pipe will not be accepted.

2.2. UNIONS, FLANGES, AND COUPLINGS

- A. Unions in steel pipe 2-inches and smaller shall be malleable iron with brass inserted seats designed for a working pressure of 150 psig.
- B. Unions in copper pipe 2-inches and smaller shall be sweat fittings with bronze seats designed for a working pressure of 125 psig.
- C. Flanges for steel pipe over 2 inches shall be 150 psig, forged steel, slip on. Gaskets shall be 1/16 inch thick pre-formed neoprene.
- D. Flanges for copper pipe over 2 inches shall be bronze. Gaskets shall be 1/16 inch thick preformed neoprene.

2.3. SLEEVES

- A. Sleeves shall be provided around all pipes through walls, floors, ceilings, partitions, roof

structure members or other building parts. Sleeves shall be standard weight galvanized iron pipe two sizes larger than the pipe or insulation so that pipe or insulation shall pass through masonry or concrete walls or floors. Provide 20 gauge galvanized steel sheet or galvanized pipe sleeves for all piping passing through frame walls.

- B. Sleeves through floors shall be flush with the floor except for sleeves passing through Equipment Rooms which shall extend ¾-inch above the floor. Refer to Division 23 Section, *Vibration Controls for HVAC, Plumbing and Fire Protection Equipment* for mechanical equipment room penetrations additional requirements. Space between the pipe and sleeve shall be caulked. Escutcheon plates shall be constructed to conceal the ends of sleeves. Each trade shall be responsible for drilling existing floors and walls for necessary sleeve holes. Drilling methods and tools shall be as hereinbefore specified.
- C. Sleeves through walls and floors shall be sealed with a waterproof caulking compound.

#### 2.4. WATER PROOF PIPE PENETRATION SEALS

- A. Provide and install waterproof pipe penetration seals at all pipes that enter the building below grade or through exterior wall.
- B. Link seals are to be Metraflex Metraseals, Model MS, Linkseal, or approved equal, black EPDM seal material, glass reinforced plastic pressure plates, zinc plated nuts and bolts, seals are to be resistant to sunlight and ozone, pressure rated to make a hydrostatic seal of up to 20 psig and up to 40 feet of head, temperature rated from -40 degrees F to 250 degrees F.

#### 2.5. TRANSITION FITTINGS

- A. General Requirements:
  - 1. Same size as pipes to be joined.
  - 2. Pressure rating at least equal to pipes to be joined.
  - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Plastic-to-Metal Transition Fittings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a). Charlotte Pipe and Foundry Company.
    - b). Harvel Plastics, Inc.
    - c). Spears Manufacturing Company.
  - 2. Description: PVC or CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket end.

- D. Plastic-to-Metal Transition Unions:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a). Colonial Engineering, Inc.
    - b). NIBCO INC.
    - c). Spears Manufacturing Company.
  2. Description: PVC or CPVC four-part union. Include brass threaded end, solvent-cement-joint plastic end, rubber O-ring, and union nut.

### PART 3. EXECUTION

#### 3.1. GENERAL PIPING INSTALLATION REQUIREMENTS

- A. All pipes shall be cut accurately to measurements established at the building, and shall be worked into place without springing or forcing, properly clearing all openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted. All pipes shall be so installed as to permit free expansion and contraction without causing damage. All open ends of pipe lines, equipment, etc., shall be properly capped or plugged during installation to keep dirt or other foreign material out of the system. All pipes shall be run parallel with the lines of the building and as close to walls, columns as may be practical, with proper pitch. All piping shall be arranged so as not to interfere with removal of other equipment on devices not to block access to openings. Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment, coils, etc., and installed so that there will be no interference with the installation of the equipment, ducts, etc. All piping shall be installed so as to avoid air or liquid pockets throughout the work. Ends of pipe shall be reamed so as to remove all burrs.
- B. All piping shall be graded to convey entrained air to high points where automatic air vents shall be provided. The size of supply and return pipes for each piece of equipment shall in no case be smaller than the outlets in the equipment.
- C. All piping shall be run to provide a minimum clearance of 2-inches between finished covering on such piping and all adjacent work. Group piping wherever practical at common elevations.
- D. Rough-in is required to all equipment and fixtures provided under this Contract.
- E. Spring clamp plates (escutcheons) shall be provided where pipes are exposed in the building and run through walls, floors, or ceilings. Plates shall be chrome plated spun brass of plain pattern, and shall be set tight on the pipe and to the building surface.
- F. If the size of any piping is not clearly evident in the drawings, the Contractor shall request instructions for the Engineer as to the proper sizing. Any changes resulting from the Contractor's failure to request clarification shall be at his expense. Where pipe size discrepancies or conflicts exist in the drawings, the larger pipe size shall govern.

- G. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

### 3.2. WASTE PIPING INSTALLATION REQUIREMENTS

- A. Each pipe shall be laid true to line and grade and in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flow line. All pipe when laid shall rest on the full length of the barrel and bell holes shall be dug in trench bottoms to make joints. Pipe shall not be adjusted to grade by use of block or wedges. Where rock or old foundations are encountered, trenches shall be excavated 6-inches below grade and crusher run limestone shall be used as a bedding material to support barrel of pipe.
- B. As the work progresses, the interior of the sewer shall be cleared of all dirt and superfluous materials of every description.
- C. Trenches shall be kept free from water until the pipe jointing material has set and pipe shall not be laid when the conditions of the trench or the weather is unsuitable for such work. At all times, when work is not in progress, all open ends of pipe and fittings shall be securely closed to the satisfaction of the Engineer, so that no trench water, earth or other substance will enter the pipe or fittings.
- D. Slip joints will be permitted only in trap seals or on the inlet side of the trap. Unions on the sewer side of the trap shall be ground faced, and shall not be concealed or enclosed. Install bell and spigot pipe with bell end upstream.
- E. Threaded joints shall be American Standard taper screw threads with permacel joint compound applied to the male thread. Connections between threaded pipe and cast iron pipe shall have a ring or half coupling screwed on to form a spigot end on the threaded pipe.
- F. Establish invert elevations, slopes for drainage to 1/8 inch per foot. Maintain gradients.

### 3.3. PIPE JOINTS INSTALLATION REQUIREMENTS

- A. **Welded Joints:** Joints in piping 2-1/2-inches and larger shall be fusion welded. Welding shall be in accordance with recommendations of the American Welding Society. Welding fittings shall conform in physical and chemical properties to the latest revisions of the American Society for Testing Materials.
- B. **Qualify welding procedures, welders and operators** in accordance with ASME B31.1, or ASME B31.9 as applicable, for shop and project site welding of piping work. Certify welding of piping work using Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB). Submit welders qualifications for approval.
- C. **Screwed Joints:** All screwed joints shall be made with tapered threads properly cut. Screwed joints shall be made perfectly tight with a stiff mixture of graphite and oil, applied with a brush to the male threads on the fittings.
- D. **Soldered Joints and Copper Piping:** Joints in copper piping shall conform to the following

minimum standards.

1. The pipes shall be cut to a length making certain that the ends are square, using a fine hacksaw blade or tube cutter. The ends of all pipes shall be reamed and all burrs removed.
  2. The outside end of the pipe and the cut end of the fitting shall be cleaned with steel wool, sand cloth, or steel wire brush. All dark spots shall be removed.
  3. The flux shall be applied evenly and sparingly to the outside end of the pipe and the inside of the outer end of the fitting until all surfaces to be jointed are completely covered. The piping and fitting shall be slipped together and reworked several times to insure an even distribution of the flux.
  4. The correct amount of solder per joint for each size pipe shall be used in accordance with the manufacturer's recommendations.
  5. Solder joints shall be made by using a direct flame from a torch.
  6. On pipe sizes larger than ¼-inch, the fittings and valves in the pipe shall be moved or tapped with a hammer when the solder starts to melt to insure an even distribution of the solder.
  7. The excess solder shall be removed while it is still in the plastic state leaving a fillet around the cup of the fitting.
  8. Solder joints shall be suitable for working pressure of 100 psig and for working temperature of not less than 250 degrees F. The type of solder and flux used will be submitted for approval. Type 95-5 shall be the minimum standard.
  9. Lead and antimony-based solders shall not be used for potable water systems. Brazing and silver solders are acceptable.
- E. Where copper piping joins steel piping, approved bronze adapters shall be used.
- F. Prohibited Connections: No direct weld, soldered, or brazed connections, without unions or flanges, shall be made to valves, strainers, apparatus, or related equipment. Right and left couplings, long threads, or caulking of pipe threads or gasket joints will not be permitted.
- G. When installing gas piping which is to be concealed (i.e., in walls), unions, tube fittings, running threads, right- and left-hand couplings, bushings, and swing joints made by combination of fittings shall not be used. All concealed piping within walls shall be welded.
1. Pipe Joints:
    - a). Pipe joints shall be designed and installed to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.
    - b). Threaded Metallic Joints: Threaded joints in metallic pipe shall have

tapered threads evenly cut and shall be made with UL approved graphite joint sealing compound for gas service. After cutting and before threading, pipe shall be reamed and burrs shall be removed. Caulking of threaded joints to stop or prevent leaks shall not be permitted.

- c). Welded Metallic Joints: Beveling, alignment, heat treatment, and inspection of welds shall conform to ASME B31.2. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected adversely. Electrodes that have been wetted or have lost any of their coating shall not be used.
  - d). Thermoplastic Joints: Jointing procedures shall conform to AGA 01. Solvent cement or heat of fusion joints shall not be made between different kinds of plastics.
  - e). Joining Thermoplastic to Metallic Piping: When compression-type mechanical joints are used, the gasket material in the fittings shall be compatible with the plastic piping and with the gas in the system. An internal tubular rigid stiffener shall be used in conjunction with the fitting, and the stiffener shall be flush with the end of the pipe or tubing and shall extend at least to the outside end of the compression fitting when installed. The stiffener shall be free of rough or sharp edges and shall not be a force fit in the plastic. A split tubular stiffener shall not be used.
  - f). Special Requirements; Drips, grading of the lines, freeze protection, and branch outlet locations shall be as shown and shall comply with NFPA 54.
  - g). Install containment conduits for gas piping below slabs, within building, in gastight conduits extending minimum of 4 inches (100mm) outside building, and vented to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end. Prepare and paint outside of conduits with coal-tar epoxy-polyamide paint according to SSPC-Paint 16.
- H. Plastic 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. Apply primer.
  - 2. PVC Piping: Join according to ASTM D2855.
  - 3. CPVC Piping: Join according to ASTM D284.6/D 2845M Appendix.

### 3.4. CLEANING PIPING

- A. All water and plumbing piping systems shall be cleaned by filling with a solution of one (1) pound of trisodium phosphate to each 50 gallons of water and circulating this solution for a period of six (6) hours during which time the system shall reach operating temperature. The systems shall then be flushed with fresh water and refilled with fresh water purged of all air.

- B. All water and plumbing piping system shall be flushed clean with fresh water. See Division 22 Sections, *Plumbing Fixture* and *Plumbing Equipment* for domestic potable water cleaning and sterilization.

3.5. TRAP PRIMING STATION PIPING

- A. Install all trap priming station piping from all floor drains to trap priming station locations.
- B. Insulate all underground trap priming station piping with ½ inch thick pipe insulation.
- C. Install all trap priming pipes from all floor drains to chase locations for future trap priming valve as indicated on Contract Drawings.

END OF SECTION

DIVISION 22 SECTION 224005  
PLUMBING EQUIPMENT

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## SECTION 224005 - PLUMBING EQUIPMENT

### PART 1. GENERAL

#### 1.1. GENERAL

- A. For General Mechanical Requirements, see Division 22 Section, *Common Work Results for Plumbing & Division 01, General Requirements*.
- B. Drawings and general provisions of the Contract, including *General and Supplementary Conditions* and Division 01 specifications apply to this Section.
- C. All plumbing materials and equipment shall be new and of best grade, free of defects and complete with all required appurtenances and accessories.
- D. Piping and insulation are specified under other sections.
- E. Provide all materials, equipment and perform all labor required to install plumbing system complete as specified, as drawings indicated and as required by the State of Delaware, National Standard Plumbing Code, International Plumbing Code, the local code, and all other authorities have jurisdiction.
- F. Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations:
  - 1. American Gas Association (AGA).
  - 2. National Sanitation Foundation (NSF).
  - 3. American Society of Mechanical Engineers (ASME).
  - 4. National Electrical Manufacturers' Association (NEMA).
  - 5. Underwriters Laboratories (UL).

#### 1.2. REFERENCES

- A. ANSI A112.21.1 - Floor Drains.
- B. ANSI/ASHRAE 90A - Energy Conservation in New Building Design.
- C. ANSI/NFPA 54 - National Fuel Gas Code.
- D. IBC - International Building Code

#### 1.3. DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of General Requirements.
- B. Accept equipment on site in factory packaging. Inspect for damage.
- C. Protect installed equipment from damage by securing areas and by leaving factory packaging in place to protect equipment and prevent use.

#### 1.4. FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings and per the manufacturer.

### PART 2. PRODUCTS

#### 2.1. FLOOR DRAINS

- A. Provide Nikaloy strainers on all floor drains unless specified otherwise.
- B. Provide flashing clamps on all drains penetrating waterproofing membrane.
- C. Provide suitable flashing material and clamping collar for drains which are not set in place when slab is poured.
- D. Provide traps for all floor drains connected to the sanitary system.
- E. Provide E & S primer valve (one valve per trap, per floor drain) on all remote floor drains. In Mechanical Rooms, mezzanines, penthouses, and all other locations indicated on the contract drawing, priming lines shall be connected to automatic trap primer.
- F. In lieu of joints specified in piping section, neoprene gaskets may be used if designed for use with the drains and cleanouts employed and if approved by the local plumbing authority.
- G. Schedule of Drains and Accessories:
  - 1. Trap priming lines to be installed at all floor drain locations and extended to trap priming station or trap primer valve locations.
  - 2. FDR.-1: General Service Floor Drain: Zurn ZN-415 floor and shower drain, dura coated cast iron body with bottom outlet, combination invertible membrane clamp and adjustable collar with Type "B" polished nickel bronze strainer. Provide with ½ -inch trap primer connection.
  - 3. FDR.-2: Floor Sink: Zurn A-1920 Sani-Flor receptor, 16-inch x 16-inch x 7-inch deep cast iron body and square slotted heavy duty grate, with white acid resisting coated interior and top, complete with aluminum anti-splash interior bottom dome strainer. Provide two (2) removable ½ grates with each unit. Provide with ½ inch trap primer connection. Provide stainless steel mesh bucket screen with each floor sink.
  - 4. FDR.-3: Mechanical Room Floor Drain: Zurn Z-566 12-inch square open top drain, dura coated cast iron body with bottom outlet, ½ top grate, large suspended cast iron sediment bucket. Provide flashing flange and ½" -inch trap primer connection.
  - 5. FDR.-4: Floor Sink: Zurn Z-1910 Sani-Flor receptor, 8-inch x 8-inch x 6-inch deep cast iron body and square slotted medium duty grate, with white acid resisting coated interior and top, complete with aluminum anti splash interior bottom dome

strainer. Provide two (2) removable ½ grates with each unit. Provide with ½ -inch trap primer connection. Provide stainless steel mesh bucket screen with each floor sink.

6. FDR-5: Trench Drains: Zurn-882 12"-inch wide pre-sloped trench drainage system. High density polyethylene (HDPE) drain channel with 1/8 -inch per foot bottom slope. All sections modular 8 foot length with interlocking ends. Complete with heavy duty, dura-coated steel frame at surface, combination anchor tabs/leveling devices at appropriate locations, and heavy duty galvanized steel grate suitable for automotive traffic. Install trench drain and all accessories per local codes and Zurn Industries, Inc. Instructions. A minimum of 4-inches of concrete must surround each trench segment. Provide ½" -inch trap primer connection.

H. Approved Manufacturers: Josam, J.R. Smith, Zurn, Wade, Ancon, Mifab, Watts.

## 2.2. CLEANOUTS

- A. Provide cleanouts in sanitary and storm drainage systems at ends of runs, at changes in direction, near the base of stacks, every 50 feet in horizontal runs, of 4-inch diameter or less, every 100 feet in horizontal runs over 4-inches, and where indicated.
- B. Cleanouts shall be full size of pipe up to 4-inches and shall be 4-inches for larger sizes. Where installed in finished floors inserts shall match adjacent floor construction.
- C. Materials and Approved Manufacturers: Josam, J.R. Smith, Zurn , Wade or Ancon, Mifab, Watts, equal to Josam numbers given below:

1.	<u>Concealed Piping</u>	<u>C.I. Pipe</u>
2.	<u>Unfinished Areas</u>	
3.	Floors	56070
4.	<u>Finished Areas - Floors</u>	
5.	Terrazzo	56040-13
6.	Composition Tile	56000-12
7.	Ceramic Tile	56000
8.	Carpet	56070-14
9.	Carpet insert to match adjacent carpet in type, color and grade.	

## 2.3. GREASE INTERCEPTOR

- A. Refer to detail on Contract Drawings.

## PART 3. EXECUTION

### 3.1. GENERAL INSTALLATION REQUIREMENTS

- A. Install all equipment in accordance with manufacturer's instructions.
- B. Install components plumb and level.
- C. Cleanouts in vertical pipes shall be installed in tees near floor. Cleanouts in horizontal pipes shall be installed with wyes on long sweep quarter beds. Cleanouts punching water proofing membranes shall have flashing clamps.
- D. Unless otherwise noted, drains are to be installed at the low point of floors. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- E. Install floor drains in low points so the top of grates are at or below the finished floor level.
- F. Drains not functioning properly shall be removed and re-installed properly at the expense of the contractor.
- G. Coordinate cutting and forming of floor construction to receive drains to required invert elevations.
- H. Extend cleanouts to finish floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- I. Encase exterior cleanouts in concrete flush with grade.
- J. Coordinate with plumbing piping and related fuel piping, gas venting and electrical work to achieve a complete operating system.
- K. Slopes and invert elevations of all interior piping shall be established before any piping is installed in order that proper slopes will be maintained. All piping shall be located and determined where to be run to avoid conflict with other trades.
- L. Coordinate with Architectural Drawings before roughing in plumbing.
- M. See site plan for extent of all piping leaving and entering building.
- N. Cleanouts shall be provided near base of each vertical waste or solid stack. Provide 18" minimum clearance for access.
- O. Unless otherwise noted, sanitary waste piping shown is below floor and all other piping is overhead, above ceiling.
- P. Unless otherwise noted, horizontal sanitary piping pitches shall be 1 percent.
- Q. All piping and installation shall comply with all local and national plumbing codes. Test piping as required by plumbing code and authority having jurisdiction.
- R. For sizes of all sanitary piping see plumbing fixture schedule and sanitary riser diagrams.

3.2. PREPARATION

- A. Review the Kitchen Equipment Consultant's equipment cut sheets. Confirm rough-in location and size of fixtures and openings prior to commencing work.
- B. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

END OF SECTION

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## SECTION 230500 COMMON WORK RESULTS FOR HVAC

### PART 1. GENERAL

#### 1.1. SUMMARY

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all mechanical work.
- C. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange piping, ductwork, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with *Submittals* specified below. The right is reserved to make reasonable changes in location of equipment, piping, and ductwork, up to the time of rough-in or fabrication.
- D. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.
- E. Coordinate the work under Division 23 with the work of all other construction trades.
- F. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.

#### 1.2. EXAMINATION OF SITE

- A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for contractors' failure to do so.
- B. Examine and verify specific conditions described in individual specifications sections.
- C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

#### 1.3. MATERIALS AND EQUIPMENT

- A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.
- B. Where material or equipment is identified by proprietary name, model number and/or

manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.

- C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.

#### 1.4. FIRE SAFE MATERIALS

- A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

#### 1.5. SHOP DRAWINGS/SUBMITTALS

- A. Prepare and submit shop drawings for all mechanical equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from that shown on contract drawings.
- B. Submit data and shop drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item and system and the applicable specification paragraph number and drawing number.
- C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.
- D. Items and Systems

Direct Buried Chilled Water Piping System

#### 1.6. PENETRATION OF WATERPROOF CONSTRUCTION

- A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

#### 1.7. EXCAVATION AND BACKFILLING

- A. General

1. Perform all necessary excavation, or installation of work under Division 23, in whatever materials or conditions encountered, using suitable methods and equipment.
  2. Accurately establish required lines and grades and properly locate the work.
  3. Determine the locations of all existing utilities before commencing the work.
- B. Excavation: (Refer also to other portions of the specifications)
1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.
  2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, OSHA Guidelines.
  3. Keep excavations dry. Protect excavations from freezing.
- C. Backfilling: (Refer also to other portions of the specifications)
1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.
  2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.
  3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.
  4. Do not backfill against frozen material. Do not use frozen material for backfill.

#### 1.8. DEFINITIONS

- A. *Approve* - to permit use of material, equipment or methods conditional upon compliance with contract documents requirements.
- B. *Furnish and install or provide* means to supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.
- C. *Contractor* means the mechanical contractor and any of his subcontractors, vendors, suppliers, or fabricators.
- D. *Piping* includes pipe, all fittings, valves, hangers, insulation, identification, and other accessories relative to such piping.
- E. *Ductwork* includes duct material, fittings, hangers, insulation, sealant, identification and other accessories

- F. *Concealed* means hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction or in crawl space.
- G. *Exposed* means not installed underground or *concealed* as defined above.
- H. *Invert Elevation* means the elevation of the inside bottom of pipe.
- I. *Finished Spaces*: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.
- J. *Review* - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.
- K. *Building Line*: Exterior wall of building.

## PART 2. ELECTRICAL REQUIREMENTS - NOT USED

## PART 3. EXECUTION

### 3.1. SUPPORTS, HANGERS AND FOUNDATIONS

- A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.
- B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. For un-insulated copper piping provide copper hanger to prevent contact of dissimilar metals. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.

### 3.2. CLEANING OF SYSTEMS

- A. Thoroughly clean systems after satisfactory completion of pressure tests and before permanently connecting fixtures, equipment, traps, strainers, and other accessory items. Blow out and flush piping until interior surfaces are free of foreign matter.
- B. Flush piping in re-circulating water systems to remove cutting oil, excess pipe joint compound, solder slag and other foreign materials. Do not use system pumps until after cleaning and flushing has been accomplished to the satisfaction of the Engineer. Employ chemical cleaners, including a non-foaming detergent, not harmful to system components. After cleaning operation, final flushing and refilling, the residual alkalinity shall not exceed 300 parts per million. Submit a certificate of completion to Engineer stating name of service company used.
- C. Pay for labor and materials required to locate and remove obstructions from systems that are clogged with construction refuse after acceptance. Replace and repair work disturbed

during removal of obstructions.

- D. Leave systems clean, and in complete running order.

### 3.3. PROTECTION OF WORK

- A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.
- B. Cover temporary openings in piping, ductwork, and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver pipes and tubes with factory applied end caps.
- C. Cover or otherwise protect all finishes.
- D. Replace damaged materials, devices, finishes and equipment.
- E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

### 3.4. WALL AND FLOOR PENETRATION

- A. All penetrations of walls and floors by piping under Division 23 shall be sleeved, sealed, and caulked airtight for sound and air transfer control.
- B. Where piping extends through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these specifications.
- C. Provide pipe escutcheons and duct flanges for sleeved pipes and ducts in finished areas.
- D. Piping sleeves:
  - 1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
  - 2. Twenty-two (22) gauge galvanized steel elsewhere.

### 3.5. INSTALLATION AND COORDINATION DRAWINGS

- A. Prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of work. Drawings shall include, but not be limited, to the following:
  - 1. Complete Plumbing, Sprinkler and HVAC Piping Drawings showing coordination with underground conduits, electrical equipment, HVAC equipment and structural amenities.
- B. Draw plans to a scale not less than 3/8-inch equals one foot. Include plans, sections, and elevations of proposed work, showing all equipment, piping and ductwork in areas

involved. Fully dimension all work including lighting fixtures, conduits, pullboxes, panelboards, and other electrical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.

- C. Identify all equipment and devices on wiring diagrams and schematics. Where field connections are shown to factory-wired terminals, include manufacturer's literature showing internal wiring.
- D. Refer to Division 01 Section "*Project Management and Coordination*" for additional requirements related to coordination drawings.

3.6. PIPING SYSTEMS TESTING

- A. The entire new HVAC piping systems shall be tested hydrostatically before insulation covering is applied and proven tight under the following gauge pressures for a duration of four (4) hours. Testing to be witnessed by Owner's representative and documented in writing.

<b>SYSTEM</b>	<b>TEST PRESSURE</b>
Chilled Water Supply & Return Piping	100 psi

- B. Testing and acceptance thereof shall be in accordance with local requirements and shall meet approval of authority having jurisdiction. Submit certificates and approved permits and insert one (1) copy in the *Operations and Maintenance Manuals*.

END OF SECTION

**OUTAGE REQUEST**

DATE APPLIED: \_\_\_\_\_ BY: \_\_\_\_\_

DATE FOR OUTAGE: \_\_\_\_\_ FIRM: \_\_\_\_\_

START OUTAGE-TIME: \_\_\_\_\_ DATE: \_\_\_\_\_

END OUTAGE -- TIME: \_\_\_\_\_ DATE: \_\_\_\_\_

AREAS AND ROOMS: \_\_\_\_\_

FLOOR(S): \_\_\_\_\_

AREA(S): \_\_\_\_\_

ROOM(S): \_\_\_\_\_

WORK TO BE PERFORMED: \_\_\_\_\_

SYSTEM(S): \_\_\_\_\_

REQUEST APPROVED BY: \_\_\_\_\_

(FOREMAN OR OTHER PERSON IN CHARGE)

**(FOR OWNER'S USE ONLY):**

APPROVED: \_\_\_\_\_

YES \_\_\_ NO \_\_\_ BY: \_\_\_\_\_ DATE: \_\_\_\_\_

DATE/TIME-AS REQUESTED: \_\_\_\_\_ OTHER : \_\_\_\_\_

OWNER'S PRESENCE REQUIRED: \_\_\_\_\_

YES: \_\_\_ NO: \_\_\_ NAME: \_\_\_\_\_

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

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## SECTION 230505 - HVAC PIPING, FITTINGS AND VALVES

### PART 1. GENERAL

#### 1.1. SUMMARY

- A. The conditions of the contract and other general requirements apply to the work specified in this section. All work under this section shall also be subject to the requirements of Division 23 Section, *Common Work Results for HVAC* and Division 01, *General Requirements*.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2. SYSTEM DESCRIPTION CONDITIONS

- A. Provide all labor and materials necessary to furnish and install all piping systems on this project as herein specified and/or shown on the drawings. Final connections to equipment furnished in other sections of the specifications shall be included under this section.
- B. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- C. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- D. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

#### 1.3. QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulation. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.
- C. Welders Certification: In accordance with ASME Section 9.
- D. Maintain one copy of each document on site.

#### 1.4. DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to site under as hereinbefore specified.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed systems.

#### 1.5. ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

### PART 2. PRODUCTS

#### 2.1. PIPE MATERIALS

- A. All materials, unless otherwise specified, shall be new and of the best quality of their respective kinds, and shall conform to the requirements and ordinances of local, state and insurance authorities having jurisdiction.
  - 1. Direct Buried Chilled Water Supply & Return Piping Outside of Building Below Grade:
    - a). General: All underground supply/return chilled water lines shall be the poly-therm type, as manufactured by Ecoflex, Perma-Pipe, Thermacor, Rovanco, Insultek, or approved equal. All straight sections, fittings, anchors and other accessories shall be factory fabricated to job dimensions and designed to minimize the number of field welds. Each system layout shall be computer analyzed by the piping system manufacturer to determine stress on the carrier, pipe, and anticipated thermal movement of the service pipe. The system design shall be in strict conformance with ANSI B31.1 latest edition. Factory trained field technical assistance shall be provided for critical periods of installation; unloading, field joint instruction, and testing. Test pits shall be constructed to insure proper installation prior to piping systems arriving on site.
    - b). Service Piping: Internal piping shall be standard weight carbon steel. All joints shall be butt-welded for 2 ½ inches and greater, and socket or butt-welded for 2-inches and below. Where possible, straight sections shall be supplied in 40 foot random lengths with piping exposed at each end for field joint fabrication.
    - c). Accessories: End seals, gland seals and anchors shall be designed and factory fabricated to prevent the ingress of moisture into the system.
    - d). Insulation: Service pipe insulation shall be spray applied nominal 2 pound per cubic foot density, polyurethane foam for straight sections and preformed polyurethane foam for all fittings. To ensure no voids are

present, all insulation shall be inspected by one of the following three methods: visually checked prior to application of the protective jacket; infrared inspection of the entire length; or x-ray inspection of the entire length. The insulation shall be applied to the minimum thickness specified below. The insulation thickness shall not be less than indicated in these specifications.

<u>Pipe Size (in.)</u>	<u>Insulation Thickness (in)</u>
1	1
1 ½ - 3	1.5
4 - 6	2
8 - 14	2.5
16 - 20	3
22 - 30	3.5

- e). Protective Jacket: All straight sections of the insulated piping system shall be filament wound, polyester rein/fiberglass reinforcement composite directly applied on the insulating foam. Thermoplastic casing material, e.g. PVC or PE, shall not be allowed. The minimum thickness for FRP jacket shall be as follows: For jacket diameter up to 15.5 inches-thickness = .055 inches, jacket diameter between 15.6 and 24.5 inches-thickness = .085 inches; jacket diameter between 24.6 and 31.0 inches- thickness = 110 inches; and jacket diameter between 31.1 and 40.0 inches-thickness = .140 inches. All fittings of the insulated piping system shall be prefabricated to minimize field joints and jacketed in a chopped spray-up, polyester rein/fiberglass reinforcement composite, directly applied onto the installation foam to a thickness related to the filament wound jacket thickness.
- f). Field Joints: The internal pipe shall be hydrostatically tested to 150 PSIG or 1 ½ inches times the operating pressure, whichever is greater. Insulation shall then be poured in place into the field weld area. All field applied insulation shall be placed only in straight sections. Field insulation of fittings shall not be acceptable. The mold for the polyurethane shall be made of clear adhesive backed polyester film. The installer shall seal the field joint area with a heat shrinkable adhesive backed wrap or with wrappings of glass reinforcement fully saturated with catalyzed resin identical in properties to the factory-applied resin. Backfilling shall not begin until the heat shrink wrap has cooled or until the FRP lay-up has cured. All insulation and coating materials for making the field joint shall be furnished by Perma-pipe, Ecoflex, Thermacor, Rovanco, or approved equal.
- g). Backfill: A 4-inch layer of sand or fine gravel shall be placed and tamped in the trench to provide a uniform bedding for the pipe. The entire trench width shall be evenly backfilled with a similar material as the bedding in 6 inch compacted layers to a minimum height of 6 inches above the top of the insulated piping system. The remaining trench shall be evenly and continuously backfilled in uniform layers with suitable excavated soiled.

- B. Steel pipe shall be similar and equal to National Tube Company, Grinnell, Republic, or Bethlehem black or zinc-coated (galvanized) as hereinafter specified. Pipe shall be free from all defects which may affect the durability for the intended use. Each length of pipe shall be stamped with the manufacturer's name.
- C. Copper pipe shall be Revere, Anaconda or Chase with approved solder fittings.
- D. Welding fittings for steel pipe shall meet the requirements of ASTM Standard A-23 and shall be standard catalog products. Fittings fabricated by metering and notching pipe will not be accepted.

2.2. DIELECTRIC CONNECTIONS:

- A. Furnish and install electrically insulated dielectric unions or flanges, as manufactured by EPCO Sales, Inc., at the following locations:
  - 1. Where steel piping systems join copper piping.
  - 2. Where copper tube connects to domestic water storage tanks, water heaters, heat exchangers, expansion tanks, and other steel vessels.
  - 3. Avoid the installation of steel nipples, cast iron or steel valves and specialties, or other ferrous components in predominately copper piping systems. Where such installation is necessary, isolate the component with dielectric connections. Do not mix steel pipe and copper tube in the same run of pipe or in the same section of a piping system.

2.3. SLEEVES

- A. Sleeves shall be provided around all pipes through walls, floors, ceilings, partitions, roof structure members or other building parts. Sleeves shall be standard weight galvanized iron pipe two sizes larger than the pipe or insulation so that pipe or insulation shall pass through masonry or concrete walls or floors. Provide 20 gauge galvanized steel sheet or galvanized pipe sleeves for all piping passing through frame walls.
- B. Sleeves through floors shall be flush with the floor except for sleeves passing through Equipment Rooms which shall extend 3/4-inch above the floor. Space between the pipe and sleeve shall be caulked. Escutcheon plates shall be constructed to conceal the ends of sleeves. Each trade shall be responsible for drilling existing floors and walls for necessary sleeve holes. Drilling methods and tools shall be as hereinbefore specified.
- C. Sleeves through walls shall be sealed with a waterproof caulking compound.

2.4. WATER PROOF PIPE PENETRATION SEALS

- A. Provide and install waterproof pipe penetration seals at all pipes that enter the building below grade or through exterior wall.
- B. Link seals are to be Metraflex Metraseals, Model MS, Linkseal, or approved equal, black

EPDM seal material, glass reinforced plastic pressure plates, zinc plated nuts and bolts, seals are to be resistant to sunlight and ozone, pressure rated to make a hydrostatic seal of up to 20 psig and up to 40 feet of head, temperature rated from -40 degrees F to 250 degrees Fahrenheit.

### PART 3. EXECUTION

#### 3.1. GENERAL PIPING INSTALLATION REQUIREMENTS

- A. All pipes shall be cut accurately to measurements established at the building, and shall be worked into place without springing or forcing, properly clearing all windows, doors and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted. All pipes shall be so installed as to permit free expansion and contraction without causing damage. All horizontal mains shall pitch down in the direction of flow with a grade of not less than 1 inch in 40 feet. All open ends of pipe lines, equipment, etc., shall be properly capped or plugged during installation to keep dirt or other foreign material out of the system. All pipes shall be run parallel with the lines of the building and as close to walls, columns and ceilings as may be practical, with proper pitch. All piping shall be arranged so as not to interfere with removal of other equipment on devices not to block access to doors, windows, manholes, or other access openings. Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment, coils, etc., and installed so that there will be no interference with the installation of the equipment, ducts, etc. All valves and specialties shall be placed to permit easy operation and access and all valves shall be regulated, packed and glands adjusted at the completion of the work before final acceptance. All piping shall be installed so as to avoid air or liquid pockets throughout the work. Ends of pipe shall be reamed so as to remove all burrs.
- B. All piping shall be run to provide a minimum clearance of 2-inches between finished covering on such piping and all adjacent work. Group piping wherever practical at common elevations.
- C. If the size of any piping is not clearly evident in the drawings, the Contractor shall request instructions for the Engineer as to the proper sizing. Any changes resulting from the Contractor's failure to request clarification shall be at his expense. Where pipe size discrepancies or conflicts exist in the drawings, the larger pipe size shall govern.
- D. Provide clearance for installation of insulation and access to valves and fittings.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

#### 3.2. DIRECT BURIED CHILLED WATER SUPPLY/RETURN PIPING INSTALLATION REQUIREMENTS

- A. Install piping and equipment as indicated, according to manufacturer's written instructions.
- B. Install piping below concrete floor slab.

- C. Provide conduit elbows where pipes penetrate flooring.
- D. Install piping with bending radius not less than recommended by piping manufacturer.
- E. Test and flush piping. Prepare written report of testing.
- F. Locator Tape: Install detectable metallic tape above all direct buried piping.

### 3.3. PIPE JOINTS INSTALLATION REQUIREMENTS

- G. Welded Joints: Joints in piping 2-1/2-inches and larger shall be fusion welded. Welding shall be in accordance with recommendations of the American Welding Society. Welding fittings shall conform in physical and chemical properties to the latest revisions of the American Society for Testing Materials.
- H. Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9 as applicable, for shop and project site welding of piping work. Certify welding of piping work using Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB). Submit welders qualifications for approval.
- I. Screwed Joints: All screwed joints shall be made with tapered threads properly cut. Screwed joints shall be made perfectly tight with a stiff mixture of graphite and oil, applied with a brush to the male threads on the fittings.
- J. Soldered Joints and Copper Piping: Joints in copper piping shall conform to the following minimum standards.
  - 1. The pipes shall be cut to a length making certain that the ends are square, using a fins hacksaw blade or tube cutter. The ends of all pipes shall be reamed and all burrs removed.
  - 2. The outside end of the pipe and the cut end of the fitting shall be cleaned with steel wool, sand cloth, or steel wire brush. All dark spots shall be removed.
  - 3. The flux shall be applied evenly and sparingly to the outside end of the pipe and the inside of the outer end of the fitting until all surfaces to be jointed are completely covered. The piping and fitting shall be slipped together and reworked several times to insure an even distribution of the flux.
  - 4. The correct amount of solder per joint for each size pipe shall be used in accordance with the manufacturer's recommendations.
  - 5. Solder joints shall be made by using a direct flame from a torch.
  - 6. On pipe sizes larger than 1/4-inch, the fittings and valves in the pipe shall be moved or tapped with a hammer when the solder starts to melt to insure an even distribution of the solder.

7. The excess solder shall be removed while it is still in the plastic state leaving a fillet around the cup of the fitting.
  8. Solder joints shall be suitable for working pressure of 100 psig and for working temperature of not less than 250 degrees F. The type of solder and flux used will be submitted for approval. Type 95-5 shall be the minimum standard.
  9. Lead and antimony-based solders shall not be used for potable water systems. Brazing and silver solders are acceptable.
- K. Where copper piping joins steel piping, approved bronze adapters shall be used.
- L. Prohibited Connections: No direct weld, soldered, or brazed connections, without unions or flanges, shall be made to valves, strainers, apparatus, or related equipment. Right and left couplings, long threads, or caulking of pipe threads or gasket joints will not be permitted.

#### 3.4. CLEANING PIPING AND EQUIPMENT

- M. All Chilled water piping systems shall be cleaned by filling with a solution of one (1) pound of trisodium phosphate to each 50 gallons of water and circulating this solution for a period of six (6) hours during which time the system shall reach operating temperature. The systems shall then be flushed with fresh water and refilled with fresh water and/or where indicated antifreeze solution and purged of all air.
- N. All chilled water piping system shall be flushed clean with fresh water. See Division 22 Sections, *Plumbing Fixtures* and *Plumbing Equipment* for domestic potable water cleaning and sterilization.

END OF SECTION

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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 ALTERNATES

- A. Refer to Division 01 Section, "Alternates" for description of work under this Section affected by Alternates.

1.3 SUMMARY

- A. Section Includes:
  - 1. Sleeves for raceways and cables.
  - 2. Sleeve seals.
  - 3. Foam Duct Sealant.
  - 4. Grout.
  - 5. Common electrical installation requirements.
- B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all electrical work.
- C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.
- D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with Article "Submittals" specified below. The right is reserved to make reasonable changes in location of equipment, boxes, conduit/wiring, and devices, up to the time of rough-in or fabrication.
- E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.
- F. Coordinate the work under Division 26 with the work of all other construction trades.
- G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the Contract Documents.
- H. Arrange conduit, work generally as shown, providing proper clearances and access. Carefully examine all Contract Drawings and fit the work in each location without substantial alteration.

Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with Article "Submittals" as hereinafter specified. The right is reserved to make reasonable changes in location of equipment, conduit and wiring up to the time of rough-in or fabrication.

#### 1.4 EXAMINATION OF SITE

- A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for Contractor's failure to do so.
- B. Examine and verify specific conditions described in individual Specifications sections.
- C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

#### 1.5 INTERPRETATION OF DOCUMENTS

- A. Any discrepancies between Drawings, Specifications, Drawings and Specifications, or within Drawings and Specifications shall be promptly brought to the attention of the Owner during the bidding period. No allowance shall subsequently be made by reason of failure to have brought said discrepancies to the attention of the Owner during the bidding period or of any error on the Bidder's part.
- B. The locations of products shown on Drawings are approximate. Place the devices to eliminate all interference with above-ceiling ducts, piping, etc. Where any doubt exists, the exact location shall be determined by the Owner.
- C. All general trades and existing conditions shall be checked before installing any outlets, power wiring, etc.
- D. Equipment sizes shown on the Drawings are estimated. Before installing any wire or conduit, obtain the exact equipment requirements and install wire, conduit, or other item of the correct size for the equipment actually installed. However, wire and conduit sizes shown on the Drawings shall be taken as a minimum and shall not be reduced without written approval from the Owner.
- E. Where variances occur between the Drawings and Specifications or within either document itself, the item or arrangement of better quality, greater quality, or higher cost shall be included in the Contract Price. The Engineer will decide on the item and manner in which the work shall be installed.
- F. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions, and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed Shop Drawings for approval in accordance with Article "Submittals" as herein after specified. The right is reserved to make reasonable changes in location of equipment, conduit/wiring, and devices, up to the time of rough-in or fabrication.

- G. Work not specifically outlined, but reasonably incidental to the completion of the work, shall be included without additional compensation from the Architect, Engineer, and Owner.
- H. Perform the work in a first-class, substantial and workmanlike manner. Any materials installed which do not present an orderly and neat workmanlike appearance shall be removed and replaced when so directed by the Engineer, at the Contractor's expense.
- I. Contact and coordinate service entrance equipment and layout with local power company prior to ordering or installing any service entrance equipment. Contractor shall furnish and install all incoming raceway and service entrance cables. If the power company plans to install cable and/or conduit, Contractor is responsible for proper coordination of cable, conduit, lug sizes, etc., for proper interface between utility owned/installed equipment and Contractor-installed equipment.
- J. The Owner shall make the application for electrical service and pay for all service charges, as coordinated with the Contractor.
- K. The complete set of Architectural, Civil, Structural, Mechanical, and Electrical Drawings and Specifications apply to this work. The successful Bidder shall familiarize himself with all other related documents.

#### 1.6 FIRE SAFE MATERIALS

- A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

#### 1.7 REFERENCED STANDARDS, CODES AND SPECIFICATIONS

- A. Specifications, Codes and Standards listed below are included as part of this Specification, latest edition:
  - 1. ADA - Americans with Disabilities Act
  - 2. ANSI - American National Standards Institute
  - 3. ASTM - American Society for Testing and Materials
  - 4. CSA - Canadian Standards Association
  - 5. EPA - Environmental Protection Agency
  - 6. FM - Factory Mutual
  - 7. IBC - International Building Code
  - 8. IEEE - Institute of Electrical and Electronics Engineers
  - 9. NEC - National Electrical Code
  - 10. NECA - National Electrical Contractors Association
  - 11. NEMA - National Electrical Manufacturers Association
  - 12. NFPA - National Fire Protection Association
  - 13. OSHA - Occupational Safety and Health Act
  - 14. UL - Underwriters' Laboratories
- B. The application standards of the local electric utility company.

- C. Electrical construction materials shall, where a listing is normal for the particular class of material, be listed in *Electrical Construction Materials List* of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Electrical equipment shall, where a listing is normal for the particular class of equipment, be listed in the *Electrical Appliance and Utilization Equipment List* of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Materials and equipment listed and labeled as "approved for the purpose" by other nationally recognized testing laboratory, inspection agency or approved organization (such as E.T.L. or Factory Mutual) shall be acceptable.

#### 1.8 SUBMITTALS

- A. Product Data: For items specified in Part 2 of this Section.

#### 1.9 SUBMITTALS, REVIEW AND ACCEPTANCE

- A. Submittals will be reviewed for general compliance with design concept in accordance with Contract Documents, but dimensions, quantities, or other details will not be verified.
- B. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted. Use only final or corrected submittals and data prior to fabrication and/or installation.
- C. For any submittal requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold Contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.

#### 1.10 SHOP DRAWINGS

- A. Prepare and submit Shop Drawings for designed systems where detailed design is not shown on the Contract Drawings, or where the proposed installation differs from that shown on Contract Drawings.
- B. Submit Product Data and Shop Drawings conforming to the paragraph above. Identify all shop drawings by the name of the item and system and the applicable Specification paragraph number and Drawing number.
- C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.

##### Items and Systems

1. Conduit and Raceway
2. Foam Duct Sealant
3. Grout
4. Handholes
5. Hangers and Supports
6. Identification Products
7. Junction and Pull Boxes, Custom Sizes
8. Junction and Pull Boxes, Standard Sizes

- 9. Record Drawings
- 10. Sleeve Seals
- 11. Sleeves

- D. Submit for approval other shop drawings as required by the Architect, Engineer, or Owner. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Engineer.
- E. For any shop drawing requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold Contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return for any reason.
- F. Prepare and submit a detailed schedule of values indicating the Contract costs for the major work items. Provide additional detail and information as requested by the Engineer.

#### 1.11 DEFINITIONS

- A. *Approve*: To permit use of material, equipment or methods conditional upon compliance with contract documents requirements.
- B. *Building Line*: Exterior wall of building.
- C. *Concealed*: Hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction.
- D. *Conduits* include conduit, all fittings, identification, and other accessories relative to such conduit.
- E. *Contractor*: The Electrical Contractor and any of his subcontractors, vendors, suppliers, or fabricators.
- F. *EPDM*: Ethylene-propylene-diene terpolymer rubber
- G. *Exposed*: Not installed underground or *concealed* as defined above.
- H. *Finished Spaces*: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.
- I. *Furnish and install* or *provide*: To supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.
- J. *Location, Damp*: Locations protected from water and not subject to saturation with water or other liquids, but subject to moderate degrees of moisture. Examples of such locations include interior locations such as basements, crawlspaces, attics, cold-storage rooms, etc...
- K. *Location, Dry*: A location not normally subject to dampness or wetness. A dry location may temporarily be subject to dampness or wetness during building construction.

- L. *Location, Wet:* Locations subject to saturation with water or other liquids, locations exposed to weather, and installations underground or in concrete slabs or masonry in direct contact with the Earth. Examples of such locations include all exterior locations (including those under canopies, roofed open porches, etc...) commercial kitchens, and vehicle washing areas.
- M. *NBR:* Acrylonitrile-butadiene rubber.
- N. *Review:* Limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

#### 1.12 WARRANTY

- A. Contractor's attention is directed to warranty obligations contained in the General Conditions.
- B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer's warranties shall be included in the operations and maintenance manuals.
- C. The Contractor guarantees for a two year period from the time of final acceptance by the Owner:
  - 1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.
  - 2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.
  - 3. That the Contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The Contractor shall also make good all damages caused to their work or materials in the process of complying with this section.
  - 4. That the entire work shall be water-tight and leak-proof.

#### 1.13 INSTALLATION AND COORDINATION DRAWINGS

- A. Prepare, submit and use composite installation and coordination drawings to assure proper coordination and installation of the work. Drawings shall include, but not be limited to the following:
  - 1. Mechanical Rooms boxes, conduits, and piping, etc...
  - 2. Electrical Rooms indicating enclosures, boxes, conduits, etc...
- B. Draw plans to a scale not less than ¼ inch equals one foot. Include plans, sections and elevations of the proposed work, showing all conduit areas involved. Fully dimension all work,

horizontally and vertically. Show coordination with other work including piping, mechanical work, columns, beams, joists and other architectural and structural work.

- C. Prepare, submit, and use scaled layout drawings indicating dimensions, clearances, and actual equipment dimensions. Layout Drawings shall include, but not be limited to the following:
  - 1. Underground conduits, ductbanks, and building penetrations.
- D. Prepare scaled coordination drawings in accordance with the Specifications. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
  - 1. Indicate the proposed locations of raceways, and materials. Include the following:
    - a. Exterior wall and foundation penetrations.
    - b. Fire-rated wall and floor penetrations.
    - c. Sizes and locations of required concrete bases.
  - 2. Prepare floor plans, elevations, and details to indicate penetrations in floors, and foundation walls, and their relationship to other penetrations and installations.
  - 3. The successful Bidder shall check all trades' Drawings, including Civil, Architectural, Structural, Plumbing, and Mechanical, to avoid possible demolition and installation conflicts.

## PART 2 PRODUCTS

### 2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
  - 1. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
    - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

### 2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

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. Advance Products & Systems, Inc.
  - b. Bridgeport Fittings, Inc.
  - c. Calpico, Inc.
  - d. GS Metals Corporation
  - e. Metraflex Co.
  - f. O-Z/Gedney
  - g. Pipeline Seal and Insulator, Inc.
  - h. Raco, Inc.
2. Sealing Elements: EPDM, or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Stainless Steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

### 2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

### 2.4 FOAM DUCT SEALANT

- A. Description: Two-part, high-expansion foam duct sealant to keep water, acids, dust, gases, insects and rodents out of ducts (conduits).
- B. 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. American Polywater Corporation
- C. Basis of Design: FST Foam Sealant by American Polywater Corporation.
- D. The foam duct sealant shall be a two-part "blown" urethane foam with 98% closed cell content.
- E. The foam duct sealant shall have a compressive strength of 300 pounds (ASTM D1691), a tensile strength of 250 pounds (ASTM D1623), and a flexural strength of 450 pounds (ASTM D790).
- F. The foam duct sealant shall be compatible with common cable jacket materials. The cured foam shall be an inert solid that does not affect jacket materials.

- G. The foam duct sealant shall withstand temperatures from -20 degrees Fahrenheit to 200 degrees Fahrenheit and shall not lose function in direct sunlight
- H. The foam duct sealant shall be chemically resistant to gasoline, oils, dilute acids and bases, and most unsaturated hydrocarbons.
- I. The foam duct sealant shall foam and react in five to ten minutes at 70 degrees Fahrenheit.
- J. When installed, the sealant shall be capable of holding 7.25 psi air pressure continuously (equivalent of 16.4 feet water-head pressure).

### PART 3 EXECUTION

#### 3.1 TEMPORARY FACILITIES:

- A. General: Refer to the Division 01 Sections for general requirements of temporary facilities.

#### 3.2 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Right of Way: Give to piping systems installed at a required slope.

#### 3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Cut sleeves to length for mounting flush with both surfaces of walls.
- E. Extend sleeves installed in floors **2 inches (50 mm)** above finished floor level.
- F. Size pipe sleeves to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- G. Seal space outside of sleeves with grout for penetrations of concrete and masonry
  - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- H. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for **1-inch (25-mm)** annular clear space between raceway or cable and sleeve for installing

mechanical sleeve seals. Seal interior of each raceway with Foam Duct Sealant as specified herein.

- I. Cut sleeves to length for mounting flush with both surfaces of walls.

### 3.4 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.5 SUPPORTS, HANGERS AND FOUNDATIONS

- A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.
- B. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.
- C. Installing Equipment Foundations (Housekeeping Pads):
  1. Provide four (4) inch high concrete foundations (housekeeping pads) for all floor-mounted equipment extending a minimum of 6 inches beyond equipment bases for interior equipment and a minimum of 12 inches beyond equipment bases for exterior equipment, unless otherwise noted. Furnish foundations, bolts, sleeves, and appurtenances and set under the section furnishing the equipment. Anchor the concrete foundations by dowels inserted into the floor slab. Provide welded wire fabric reinforcement, chamfer exposed edges and corners, and finish exposed surfaces smooth.
  2. Unless otherwise specified, provide all concrete work required in accordance with the requirements of Division 03.
  3. Equipment shall be properly aligned. Level and grout equipment where necessary. Support conduit independently of equipment and so as not to cause a strain or thrust.
  4. Determine exact location of all equipment, foundations, and supports after Shop Drawings of equipment have been approved.

### 3.6 PAINTING AND FINISHES

- A. Provide protective finishes on all materials. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.

- B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.
- C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.
- D. Protect all finishes and restore any finishes damaged as a result of work under Division 26 to their original condition.
- E. The preceding requirements apply to all work, whether exposed or concealed, as defined herein.
- F. Remove all construction marking and writing from exposed piping and building surfaces. Do not paint manufacturer's labels or tags.
- G. All exposed conduit, in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

### 3.7 FLOOR PENETRATIONS

- A. All penetrations of and floors by conduit under Division 26 shall be sleeved, sealed, and caulked airtight for sound and air transfer control. Room floors shall be as specified in Division 26.
- B. Where penetrating through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these Specifications.
- C. Conduit sleeves:
  - 1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
  - 2. Twenty-two (22) gauge galvanized steel elsewhere.

### 3.8 CONCRETE AND MASONRY WORK

- A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 26. Perform work in accordance with requirements of Division 03 and other applicable Divisions of these Specifications.
- B. Concrete shall test not less than 3,000 psi compressive strength after 28 days.
- C. Grout shall be non-shrink, high strength mortar, free of iron chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.
- D. Installing Outdoor Equipment Foundations:
  - 1. Provide equipment foundations as indicated in Article "Supports, Hangers, and Foundations" in this Section.

2. Place reinforcement accurately in position shown, securely fasten and support to prevent displacement before or during pouring. Clean, bend, place, and splice reinforcement in accordance with approved shop drawings. Lap ends and sides of mesh reinforcement in slabs not less than one inch. Coverage of main reinforcing shall be as follows:
  - a. Slabs - 3/4 inch
  - b. Concrete poured against earth - 3 inches
  - c. Other locations - 2 inches
3. Properly align, level, and grout all equipment where necessary.

### 3.9 COORDINATION

- A. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

### 3.10 EXCAVATION AND BACKFILLING

- A. General:
  1. Perform all necessary excavation, or installation of work under Division 26, in whatever materials or conditions encountered, using suitable methods and equipment.
  2. Accurately establish required lines and grades and properly locate the work.
  3. Determine the locations of all existing utilities before commencing the work.
- B. Excavation: (Refer also to other portions of the Specifications)
  1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.
  2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State and OSHA Guidelines.
  3. Keep excavations dry. Protect excavations from freezing.
- C. Backfilling: (Refer also to other portions of the Specifications)
  1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.
  2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.

3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.
4. Do not backfill against frozen material. Do not use frozen material for backfill.

END OF SECTION

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KITCHEN EQUIPMENT WIRING  
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SECTION 260512 - KITCHEN EQUIPMENT WIRING

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 WORK INCLUDED

- A. Kitchen underslab conduit.

PART 2 PRODUCTS

2.1 CONDUIT

- A. Refer to Division 26, Section "Raceways and Boxes".
- B. Provide only rigid steel conduit, zinc-coated, where concealed, and shall provide only rigid steel chrome-plated where exposed. All wiring and conduit shall be run concealed wherever possible.

2.2 OTHER PRODUCTS

- A. Refer to related sections for other product requirements.

PART 3 EXECUTION

3.1 COORDINATION

- A. Locations of conduit stubs shown on drawings are for bidding purposes only. Determine exact locations for conduit stubs from approved shop and setting drawings prepared by Kitchen Equipment Contractor.

3.2 INSTALLATION

- A. Rough-in location shall be within three (3) inches of the equipment.

END OF SECTION

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SECTION 260526  
GROUNDING AND BONDING  
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## SECTION 260526- GROUNDING AND BONDING

### 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 grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.
- B. Bond together system neutrals; service equipment enclosures; exposed non-current carrying metal parts of electrical equipment; metal raceway systems; grounding conductor in raceways; receptacle ground connectors; and plumbing systems.

#### 1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product Data for grounding rods, conductors, connectors and connection materials, and grounding fittings. Submit ground system manufacturer's recommended installation procedure for review.
- C. Qualification data for firms and persons specified in *Quality Assurance* Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

#### 1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: A *Nationally Recognized Testing Laboratory* (NRTL) as defined in OSHA Regulation 1910.7, or a full member company of the International Electrical Testing Association (NETA).
  - 1. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Comply with NFPA 70 - National Electrical Code.
- C. Comply with UL 467 - UL Standard for Safety Grounding and Bonding Equipment.
- D. Comply with ANSI/IEEE C2 - National Electrical Safety Code.

- E. Comply with ANSI/IEEE 32 - Requirements, terms and test procedures for neutral grounding devices.
- F. Comply with IEEE Standard 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- G. Comply with ANSI C33.8.
- H. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
  - 1. The Terms *Listed* and *Labeled*: As defined in the National Electrical Code, Article 100.
  - 2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* (NRTL) as defined in OSHA Regulation 1910.7.

#### 1.5 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of grounding electrodes and all primary grounding locations (i.e., water piping connection, building steel, etc.)

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- 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. Erico Inc.; Electrical Products Group.
  - 2. Heary Brothers Lightning Protection Co.
  - 3. Ideal Industries, Inc.
  - 4. ILSCO.
  - 5. O-Z/Gedney Co.
  - 6. Raco, Inc.
  - 7. Thomas & Betts, Electrical.

#### 2.2 GROUNDING AND BONDING PRODUCTS

- A. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

#### 2.3 WIRE AND CABLE GROUNDING CONDUCTORS

- A. Grounding Electrode Conductors: Size as indicated on the Drawings, in the Specifications, or as required by 2008 National Electrical Code (NEC) Table 250-66, whichever is larger. Insulated with green color insulation, unless installed in direct contact with earth, in which case conductors shall be bare.
- B. Underground Conductors: Bare, tinned, stranded, #4/0 AWG size minimum, except as otherwise indicated.
- C. Bare Copper Conductors: Conform to the following:
  - 1. Solid Conductors: ASTM B 3.
  - 2. Assembly of Stranded Conductors: ASTM B 8.
  - 3. Tinned Conductors: ASTM B 33.

#### 2.4 MISCELLANEOUS CONDUCTORS

- A. Braided Bonding Jumpers: Copper tape, braided No. 30 AWG bare copper wire, terminated with copper ferrules.
- B. Bonding Straps: Soft copper, 0.05 inch (1 mm) thick and 2 inches (50 mm) wide, unless otherwise indicated.

#### 2.5 CONNECTOR PRODUCTS

- A. Mechanical Connectors
  - 1. The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper ally material. Bolts, nuts, washers and lockwashers shall be made of silicon bronze and supplied as a part of the connector body and shall be of the two-bolt type.
  - 2. Split bolt connector types are NOT allowed unless indicated on the Drawings.
  - 3. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.
- B. Compression Connectors
  - 1. The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99 percent by IACS Standards.
  - 2. The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.
  - 3. The installation of the connectors shall be made with a compression, tool and die system, as recommended by the manufacturer of the connectors.

4. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.
  5. Each connector shall be factory filled with an oxide-inhibiting compound.
- C. Exothermic Connections: Provide exothermic-weld kit selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

## 2.6 GROUNDING ELECTRODES

- A. Grounding Rods: Copper-clad rod with rigid steel core.
1. Size: 3/4 inch by 120 inches (19 by 3000 mm). Provide the number of rods required to obtain proper ground resistance.
  2. Rods shall have a minimum of ten (10) mils of copper.
  3. Ground rods shall be UL listed #467.
- B. Plate Electrodes: Copper, square or rectangular shape. Minimum 0.10 inch (3 mm) thick, size as indicated.

## PART 3 EXECUTION

1. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

## 3.2 INSTALLATION

- A. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.
- B. Grounding Electrodes: Locate a minimum of 1-electrode length from each other and at least the same distance from any other grounding electrode.
1. Drive until tops are 24 inches (50 mm) below finished floor or final grade, except as otherwise indicated.
  2. Interconnect with grounding-electrode conductors using exothermic welds, unless otherwise indicated. Make these connections without damaging copper coating or exposing steel.
- C. Grounding Electrode Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- D. Underground Electrode Grounding Conductors: Use bare copper wire. Bury at least 24 inches (600 mm) below grade.

- E. Grounding shall satisfy requirements of the applicable publications. All exposed noncurrent-carrying metallic raceway systems, shall be grounded.

### 3.3 CONNECTIONS

- A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
  - 1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
  - 2. Make connections with clean, bare metal at points of contact.
  - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
  - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor (EGC) Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.
- E. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- F. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

### 3.4 FIELD QUALITY CONTROL

- A. Maximum grounding to resistance values are as follows:
  - 1. Equipment Rated 500 kVA and Less: 10 ohms.

2. Equipment Rated 500 to 1000 kVA: 5 ohms.
  3. Equipment Rated More than 1000 kVA: 3 ohms.
  4. Unfenced Substations and Pad-Mounted Equipment: 5 ohms.
  5. Manhole Grounds: 5 ohms.
- B. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify Owner promptly and include recommendations to reduce ground resistance and to accomplish recommended work.
- C. Report: Prepare test reports, certified by the testing organization, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results. Submit all tests to the Engineer for approval.

### 3.5 ADJUSTING AND CLEANING

- A. Restore surface features, including vegetation, at areas disturbed by work of this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION

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RACEWAYS AND BOXES  
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## SECTION 260533 - RACEWAYS AND BOXES

### 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 raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
  - 1. Raceways include the following:
    - a. EMT.
    - b. FMC.
    - c. IMC.
    - d. LFMC.
    - e. PVC.
    - f. PVC externally coated, rigid steel conduits.
    - g. RGS.
    - h. RMC.
    - i. RNC
    - j. Wireways.
  - 2. Boxes, enclosures, and cabinets include the following:
    - a. Floor boxes.
    - b. Pull and junction boxes.
  - 3. Miscellaneous Products include the following:
    - a. Expansion/Deflection fittings.
    - b. Bushings.

B. Related Sections include the following:

1. Division 26 Section "Hangers and Supports" for raceways and box supports.

1.3 DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. FMC: Flexible Metal Conduit.
- C. IMC: Intermediate Metal Conduit.
- D. LFMC: Liquidtight Flexible Metal Conduit.
- E. PVC: Rigid Polyvinyl Chloride Conduit.
- F. RGS: Rigid Galvanized Steel Conduit.
- G. RMC: Rigid Metal Conduit.
- H. RNC: Rigid Nonmetallic Conduit.

1.4 SUBMITTALS

- A. Product Data: For raceways, wireways and fittings, and floor boxes.

1.5 QUALITY ASSURANCE

- A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.
  1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100
  2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. Comply with NECA's "Standard of Installation" and NECA 101 "Recommended Practice for Installing Steel Conduits".
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.
- B. Verify routing and termination locations of conduits and boxes prior to rough-in.
- C. Conduit routing shown on Drawings is only approximate and diagrammatic. Route conduits as required for a complete conduit and wiring system.

1.7 PROJECT RECORD DOCUMENTS:

- A. Accurately record routing of all concealed conduits. Record actual routing of all exposed conduits/larger than 1 inch. Indicate actual locations and mounting heights of outlet boxes, pull and junction boxes, branch circuits, arrangements, etc.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- 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. Metal Conduit and Tubing:
  - a. Allied Tube & Conduit Corporation.
  - b. Anamet, Inc.; Anaconda Metal Hose.
  - c. AFC/Monogram Company.
  - d. Carol Cable Co., Inc.
  - e. Cole-Flex Corp.
  - f. Electri-Flex Co.
  - g. Flexcon, Inc.; Coleman Cable Systems, Inc.
  - h. Grinnell Co.; Allied Tube and Conduit Div.
  - i. Monogram Co.; AFC.
  - j. Spiraduct, Inc.
  - k. Triangle PWC, Inc.
  - l. Wheatland Tube Co.
2. Nonmetallic Conduit and Tubing:
  - a. Anamet, Inc.; Anaconda Metal Hose.
  - b. Arnco Corp.
  - c. Breeze-Illinois, Inc.
  - d. Cantex Industries; Harsco Corp.

- e. Certainteed Corp.; Pipe & Plastics Group.
  - f. Cole-Flex Corp.
  - g. Condux International; Electrical Products.
  - h. Electri-Flex Co.
  - i. George-Ingraham Corp.
  - j. Hubbell, Inc.; Raco, Inc.
  - k. Lamson & Sessions; Carlon Electrical Products.
  - l. R&G Sloan Manufacturing Co., Inc.
  - m. Spiraduct, Inc.
  - n. Thomas & Betts Corp.
3. Conduit Bodies and Fittings:
- a. American Electric; Construction Materials Group.
  - b. Crouse-Hinds; Div. of Cooper Industries.
  - c. Emerson Electric Co.; Appleton Electric Co.
  - d. Hubbell, Inc.; Killark Electric Manufacturing Co.
  - e. Lamson & Sessions; Carlon Electrical Products.
  - f. O-Z/Gedney; Unit of General Signal.
  - g. Scott Fetzer Co.; Adalet-PLM.
  - h. Spring City Electrical Manufacturing Co.
  - i. Thomas & Betts Corporation.
4. Floor Boxes:
- a. Crouse Hinds.
  - b. Hubbell.
  - c. Square D.
  - d. Wiremold.

## 2.2 METAL CONDUIT AND TUBING

- A. Rigid Galvanized Steel Conduit: ANSI C80.1 and UL 6.
- B. IMC: ANSI C80.6.
- C. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.
- D. Plastic-Coated IMC and Fittings: NEMA RN 1.
- E. EMT and Fittings: ANSI C80.3, galvanized tubing.
  - 1. Fittings: Compression type, NEMA FB1.
- F. FMC: Zinc-coated steel.
- G. LFMC: Flexible steel conduit with PVC jacket.
- H. Fittings: NEMA FB 1; compatible with conduit/tubing materials.

## 2.3 NONMETALLIC CONDUIT AND TUBING

- A. PVC: NEMA TC 2, Schedule 40 or 80.
- B. PVC Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

## 2.4 MULTI-SERVICE FLOOR BOXES (RECTANGULAR):

- A. In-floor multi-service box consisting of floor box housing, protective cover, all fittings, materials and labor.
- B. Make adjustments in leveling and placement during rough-in to accommodate structural and architectural elements, and other equipment. Coordinate exact locations with Owner prior to concrete pour.
- C. Construction:
  - 1. Cast iron for on-grade applications and formed steel at all above grade levels unless otherwise noted on the Drawings.
  - 2. Galvanized steel per ASTM 525 G-60.
  - 3. Concrete-tight for in-floor use.
  - 4. Adjustable legs for leveling and adjustment prior to pour.
  - 5. Knockouts for conduit entry and feed-through use.
  - 6. Four (4) wiring compartments, individually sectionalized.

- a. Allocated space for two (2) duplex 5-20R power receptacles.
  - b. Allocated space for two (2) duplex data RJ45 jacks, Category 5.
7. UL listed, with separation of power and low voltage.
- D. Walkerbox Resource RFB Multi-Service steel recessed floor boxes, or approved equal, by American Electric or Hubell.

## 2.5 FLOOR MOUNTED DEVICES

- A. Individual, floor-mounted power, microphone, telephone, data, CATV, etc..., outlets per plans. For multiple floor devices, combine outlets or jacks in common divided box with single, multi-gang coverplate.
- B. General:
- 1. Flush-mounted, rectangular boxes: 1, 2, or 3 gang.
  - 2. For tiles, wood, or other hard floors, provide flush trim and coverplates, with no projections above the floor surface.
  - 3. Single or multi-gang protective coverplates as required.
- C. Construction:
- 1. Cast iron boxes, 3-5/16 inches deep.
  - 2. 1, 2, or 3 divided compartments.
  - 3. Fully adjustable prior to concrete pour.
  - 4. Walker Omnibox 880CS Series, or equal.

## 2.6 PULL AND JUNCTION BOXES

- A. Small Sheet Metal Boxes: NEMA OS 1.
- B. Sheet metal boxes over 12" in any dimension shall comply with the requirements of Article "Enclosures and Cabinets" of this Section.
- C. Boxes for Outdoor and Wet Locations: Flat flanged, surface-mounted, UL listed as raintight, galvanized cast iron box and cover with neoprene gasket and stainless steel cover screws.
- D. Boxes for Buried Flush Grade Locations: NEMA 250, Type 6, flat flanged, UL listed as watertight, galvanized cast iron, aluminum or PVC box.
- 1. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
  - 2. Cover Legend: "Electric" or "Communications" as appropriate.

## 2.7 EXPANSION / DEFLECTION FITTINGS

- A. Provide an expansion/deflection fitting in each concealed or exposed electrical run crossing a building expansion joint. Fittings shall be complete with bronze end couplings, neoprene sleeves, tinned copper braid integral bonding jumper and stainless steel bands. Expansion/deflection fittings shall be suitable for the size and type of conduit run they connect. Bonding jumper shall comply with NEC and UL requirements.
- B. Expansion/deflection fitting shall accommodate the following movements without collapsing or fracturing the conduit and damaging the wires it contains:
  - 1. Axial expansion or contraction up to 3/4-inch.
  - 2. Angular misalignment of the axes of the conduits up to 30 degrees in all directions.
  - 3. Parallel misalignment of the axes of the conduits up to 3/4-inch in all directions.
- C. Expansion/Deflection fitting shall be OZ/Gedney Type "DX" or approved equal by Crouse Hinds (Type XD).

## 2.8 BUSHINGS

- A. Bushings for 1-inch conduit and smaller shall be self-extinguishing thermoplastic type - 150°C temperature rating.
- B. Bushings for 1-1/4" conduit and larger shall be malleable iron body with 150 degrees C insulating ring. Insulating material shall be locked in place and non-removable.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine surfaces to receive raceways, compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 RACEWAY REQUIREMENTS

- A. Conduit Application Schedule:

Application	Conduit Type	Remarks
In or under concrete slab	RNC	
Exposed exterior locations.	RGS	Use threaded or rain-tight fittings.
Concealed in masonry walls.	EMT	

- 1. Provide hot-dip Rigid Galvanized Steel Conduit (RGS), galvanized Intermediate Metal Conduit (IMC) or galvanized Electrical Metallic Tubing (EMT) for concealed work above suspended ceilings and within interior partitions and for exposed interior work above 7'-0".

2. Provide hot-dip Rigid Galvanized Steel Conduit (RGS) with bonded PVC jacket (Plastic-Bond or Kor-Kap) for work not completely encased in concrete but laid directly in or in contact with ground or on a vapor barrier and additionally, as directed.
3. Aluminum conduit is prohibited.
4. Where indicated on the drawings, Rigid Non-metallic Conduit may be used as permitted in Article 352 of the NEC, with or without concrete encasement. Where rigid non-metallic conduit is exposed, it shall be Schedule 40 PVC, with all provisions for thermal expansion/contraction as recommended by the Manufacturer.
5. Conduits for exterior underground electric work shall be rigid steel, galvanized and sherardized, leaving the building and to points 5 feet beyond footings. Beyond 5 feet of building, underground conduits shall be non-metallic Schedule 40 PVC plastic, Type II.
6. All steel conduits from outside terminations to service entrance equipment shall be painted with two heavy coats of asphaltum.
7. Conduits shall slope from entrance equipment toward outside of building.

B. Fittings:

1. All fittings to match conduit material and to be suitable for the purpose intended. Join conduit with fittings designed and approved for the purpose and make joints tight.
2. Provide UL listed compound filled sealing fittings for NEC-required locations, for conduits passing from interior to exterior, and at the interface of widely different space temperatures such as refrigeration or cold storage rooms where conduits pass from warm locations to cool locations, such as the boundaries of air conditioned spaces and non-conditioned air spaces. For concealed conduits, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.
3. Provide expansion fittings with bonding jumpers where conduits cross expansion joints or where otherwise required to compensate for thermal expansion and contraction. Provide expansion fittings in each straight uninterrupted run of surface-mounted conduit, both horizontal and vertical, in excess of 200 feet. Distance between fittings shall not exceed 200 linear feet. The Contractor shall refer to the Architectural Drawings for expansion joint locations.
4. Fasten rigid steel conduit with threaded galvanized steel fittings, double locknuts, and insulated bushings. Insulated bushings shall be OZ/Gedney type "B", or equal.
5. Fasten EMT conduit with "Concretight" or "Raintight" compression fittings made from galvanized steel or malleable iron. Fittings using set screw or indentations as a means of attachment or made from cast "white metal" are prohibited. All connectors shall have insulated throats.

6. Fasten liquid-tight conduit with fittings incorporating a threaded ferrule, nylon sealing ring, and steel or malleable iron compression nut and body. Furnish Crouse Hinds metallic liquid-tight fittings, or equal.
7. Fasten Flexible Metallic Conduit (FMC) with Thomas & Betts (T&B) "Tite-Bite" insulated connectors, or equal.
8. Watertight fittings shall use a copper base anti-corrosive conductive compound. Provide watertight fittings in conduits exposed to weather, in wet locations, in underground locations, and in slabs.

### 3.3 INSTALLATION

- A. Install raceways, as indicated, according to manufacturer's written instructions.
- B. Furnish and install a separate and independent raceway system as shown on the Drawings for each of the various wiring systems including, but not limited to, the following:

Communications System  
Control Wiring  
Fire Alarm System  
Incoming Telephone Service  
Incoming Electric Service  
Incoming CATV System  
Security System  
Telephone Wiring

1. Raceways, generally, shall be concealed conduit as specified herein. Where wiring troughs are required or used to facilitate the wiring installation, they shall be equal to Square D Company's Square-Duct and fittings, with hinged cover arranged for total removal, all finished in baked enamel and all components U/L listed. The gutters shall be of ample size to accommodate conductors therein and as required by the NEC.
  2. Underground conduits for services outside of building and entrance into building shall be as specified herein.
  3. Support all conduit not embedded in concrete or masonry such that strain is not transmitted to and pull/junction boxes, etc. Rigid to prevent distortion of conduits during wire pulling.
- C. Minimum Raceway Size: 3/4-inch trade size (DN21).
  - D. Conceal conduit and EMT, unless otherwise indicated floors.
  - E. Keep raceways at least 12 inches (300 mm) away from parallel runs of flues, steam or hot-water pipes and other hot surfaces above 77 degrees F. Install horizontal raceway runs above water and steam piping.

- F. Support raceways as specified in Division 26 Section "Hangers and Supports". Arrange supports to prevent misalignment during wiring installation.
- G. Use capped bushings or "push-penny" plugs to prevent foreign matter from entering the conduit system during construction. Clean and plug or cap all conduits left empty for future use.
- H. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab. Conduit stub-ups and stub-downs shall be arranged in a neat and orderly manner and shall emerge at right angles to floors or ceilings.
- I. Make bends and offsets so the inside diameter is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
- J. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.
- K. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.
- L. Conduits shall not be installed in elevated concrete floor slabs so that composite action between the slab and beams is not affected. Conduits may be installed in grade level concrete floor slab with the following limitations:
  - 1. Maximum size - 1-1/4".
  - 2. Minimum concrete cover – 1.0", above and below.
  - 3. Minimum spacing between conduits - 6" on center.
  - 4. Conduit outside diameter - 1/3 of slab thickness.
  - 5. Installed between bottom and top reinforcing, and centerline of conduit at the mid-depth of the slab.
  - 6. Secured to prevent possible change in position, sagging, or shifting as concrete is poured.
  - 7. Water or damp-proofing integrity of slab is not disturbed.
- M. Conduits larger than 1-1/4" may be installed in concrete floor slabs only with the specific permission of the Engineer, or as specifically indicated on the drawings, all in accordance with the above limitation.
- N. Conduits in close proximity to each other at panelboards, etc., shall be located and wrapped with wire mesh to prevent cracking of slab.
- O. Transition non-metallic tubing to rigid steel conduit before rising above the floor.

- P. Space raceways laterally to prevent voids in the concrete.
- Q. Run conduit parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place conduit close to slab support.
- R. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
- S. Run parallel or banked raceways together, on common supports where practical.
- T. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- U. Join raceways with fittings designed and approved for the purpose and make joints tight.
  - 1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
  - 2. Use insulating bushings to protect conductors.
- V. Tighten set screws of threadless fittings with suitable tools.
- W. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.
- X. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.
- Y. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
- Z. Install no more than equivalent of three 90° bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2 inches (50 mm) in size.
- AA. Avoid moisture traps; provide junction box with drain fittings at low points in conduit system.
- BB. Die-cast fittings of pot metal will not be accepted.
- CC. Conduits shall be free of any burrs, foreign objects, and water prior to conduit installation.
- DD. Conduit placed against concrete or masonry above ground shall be fastened to the concrete or masonry with pipe straps or one screw clamp attached to the concrete by means of expansion screw anchors and screws. "Caddy Clip" type hangers or straps will be permitted only in non-exposed areas and restricted to 3/4" conduit.

- EE. Where conduits turn up out of concrete slabs and are not concealed by wall construction, bends shall be carefully made so that no portion of the radius is above the floor.
- FF. Conduit shall be installed in such manner as to insure against the collection of trapped condensation, and runs of conduit shall be without traps wherever possible. Drill 1/8" diameter weep holes where necessary.
- GG. Conduits run to and from cabinets shall be run neatly, in accurate manner and shall emerge from the floors and ceilings at right angles thereto.
- HH. Conduit risers shall be rigidly supported on the building structure, using appropriate supports only.
- II. Screws for all exposed work shall be stainless steel, unless otherwise noted.
- JJ. Zinc coated galvanized steel screws may be used for interior dry locations only.
- KK. No running threads shall be cut or used.
- LL. Conduits which are installed at this time and left empty for future use and which are five feet or more in length, including all telephone and communication conduits shall have a non-ferrous, 600 lb. tensile strength drag line left in place for future use. All empty conduits including conduit stubs shall be tagged at all exposed ends with tags identifying the location of the end of the conduit.

### 3.4 INSTALLATION OF TERMINATIONS

- A. Open ends shall be capped with approved manufactured conduit seals as soon as installed and kept capped until ready to pull in conductors.

### 3.5 CLEANING

- A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.
- B. After conduits and accessories have been installed, and concreting operations completed, conduit runs shall be satisfactorily cleared of obstructions and foreign matter. Defects which might damage cable upon installation shall be corrected, the entire run to the nearest box or other termination point shall be cleaned.

END OF SECTION

DIVISION 26  
SECTION 260543  
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## SECTION 260543 - UNDERGROUND DUCTBANKS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications apply to this Section.
- B. Sections of other Divisions in this Specification which relate to excavation and concrete construction.

#### 1.2 SUMMARY

- A. This Section includes complete ductbank construction, direct burial materials and methods for outside power and communications systems transmission and distribution.
- B. Provide adjustment of existing manholes and handholes to set flush with new finished grade level.
- C. This Section specifies underground duct placement, materials, and installation procedures.

#### 1.3 CONTRACTOR RESPONSIBILITIES

- A. Existing Subsurface Utilities: Existing subsurface facilities are shown on the plans to help the Contractor avoid damage to essential utilities which must remain in service. Take reasonable steps to ascertain the exact location of all underground facilities prior to doing work that may damage such facilities. If the discovery of underground facilities not indicated on the plans or in a location different from what is indicated on the plans, protect such facilities, notify the Owner's representative immediately, and record actual conditions found onto the record drawings.
- B. Construction Staking:
  - 1. Provide the stakes and reference marks necessary for the construction of the improvements covered by this Contract.
  - 2. Control stakes which constitute reference points for all Construction work shall be conspicuously marked with red flagging tape. Provide responsibility to inform employees and Subcontractors of the stakes' importance, and the necessity for their preservation. The cost of replacing such controls, should it become necessary for any reason whatsoever, shall be furnished at no additional cost to the Owner.

#### 1.4 QUALITY ASSURANCE

- A. Manufacturer's Recommendations: Whether specifically mentioned or not in these Specifications, all materials, equipment, devices, etc., shall be installed in a manner meeting the approval of the manufacturer of the particular item.

- B. Codes and Standards: Provide underground ducts and manholes conforming to the following:
1. National Electrical Manufacturers Association (NEMA) - Conform to the manufacturing standards of the following:
    - a. RNI: PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
    - b. TC 2: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
    - c. TC 3: PVC Fittings for Use with Rigid PVC Conduit and Tubing.
    - d. TC 6: PVC and BAS Plastic Utilities Duct for Underground Installation.
    - e. TC 7: Smooth-Wall Coilable Polyethylene Electrical Plastic Duct.
    - f. TC 8: Extra-Strength PVC Plastic Utilities duct for Underground Installation.
    - g. TC 9: Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.
  2. Underwriters Laboratories, Inc. (UL): Conform to the following:
    - a. 6: Rigid Metal Conduit.
    - b. 651: Schedule 40 and 80 Rigid PVC Conduit.
    - c. 651A: Type EB and A Rigid PVC Conduit and HDPE Conduit.
  3. American Concrete Institute (ACI):
    - a. 318: Building Code Requirements for Reinforced Concrete.
  4. American Society for Testing & Materials (ASTM)
    - a. F512: Smooth-Wall PVC Conduit & Fittings for Underground Installation.
- C. Certification: Manufacturer shall be a company specializing in ductbank structures with a minimum five years documented experience.

## 1.5 SUBMITTALS

- A. Submit shop drawings and product data for all conduit, accessories, and miscellaneous components. Submit product data for each type of manufactured material and product indicated.

- B. Submit coordination shop drawings of ductbank and underground cable installations including profiles and elevations of all utility crossings. Proposed deviations from details on the Drawings shall be clearly marked on all Submittals.
- C. Record Documents: Show dimensional locations of underground ducts, and handholes, and manholes.

## 1.6 SITE CONDITIONS

- A. General: Clearing work shall not begin until temporary fences, barricades, warning signs and other pedestrian control devices are installed.
- B. Traffic Access:
  - 1. Conduct operations and schedule cleanup in a manner which causes the least possible obstruction and inconvenience to adjacent property owners, pedestrians and vehicular traffic. Furnish, erect, construct and maintain such temporary fences, barriers, lights, reflectors, cones, signs, ramps, etc., that may be necessary to adequately provide separation and warn the public of work in progress and of any existing dangerous conditions. This requirement shall apply continuously and shall not be limited to normal working hours.
  - 2. Provide responsibility for coordinating and obtaining approvals of the location for temporary barricades and/or detours of traffic from the Police and Fire Departments.
  - 3. If peripheral fencing is used, it shall be provided with reflectors, flashers, signs, dangles, or barricades as the fence is being built.
  - 4. Maintain continued access to parking areas, roads, abutting properties, and other facilities which the construction will cross.
  - 5. If traffic is reduced to one way, provide a flag person. A minimum of one lane shall be maintained open to traffic at all times.
  - 6. When entering or leaving road ways carrying public traffic, the equipment whether empty or loaded, shall in all cases yield to public traffic.
  - 7. Supply and maintain cone placements at his sole additional expense.
  - 8. All traffic signs which fall within the line of Construction or are obstructed by the equipment or operations shall be temporarily relocated to an unobstructed area. Temporarily relocated traffic signs shall be returned to their original location at the end of construction.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering the specified products that may be incorporated in the work, include, but are not limited to, the following:
1. Conduit and Fittings:
    - a. Carlon Electrical Products.
    - b. George-Ingraham Corporation.
    - c. Condux International.
  2. Ductbank Accessories:
    - a. Carlon.
    - b. Osburn Associates.
    - c. Underground Devices, Inc.
    - d. OZ/Gedney

## 2.2 UNDERGROUND DUCTBANKS

- A. General: Underground ductbanks to be arrangements of single bore, PVC plastic conduits. The number and size of conduits to be as indicated. Turn up connections through slabs or floors shall be rigid metal.
- B. Material:
1. Conduit and Fittings:
    - a. Type II, heavy wall Schedule 40 PVC plastic, sunlight UV-resistant, in accordance with the requirements of NEMA publications TC-2 and TC-3 (fittings).
    - b. Rigid galvanized heavy wall steel conduit (UL 6) with threaded couplings.
    - c. Rigid Metal Conduit, PVC Coated, UL 6, galvanized steel, threaded type, coated with a polyvinyl chloride (PVC) sheath bonded to the galvanized exterior surface, nominal 40 mils thick, conforming to NEMA RN 1, Type A40.
    - d. Conduit and fittings shall have a temperature rating at least equal to the operating temperature of the cable which it contains, minimum 90 degrees C. Conduit and fittings shall be free from all substances that injuriously affect any wire or cable insulation.

- e. The Manufacturer shall certify that the plastic is 100 percent virgin material and the finished product meets the specifications. All PVC conduit and fittings shall have solvent-weld connections and shall provide a water-tight joint.
  2. Use pea gravel aggregate for void-free duct penetration.
  3. Spacers: Manufactured precast plastic assembly, base spacer, top spacers and intermediate spacers, to maintain 4-inches between conduits and completely enclosed and locked conduit assembly. Set on masonry leveling blocks prior to pour.
  4. Joint Sealant: Watertight as recommended by conduit manufacturer.
  5. Cable Sealing Bushings: OZ type CSB, with PVC coated discs, or equal.
  6. Thruwall and Floor Seals: OZ type *FSK* or *WSK*, or equal.
  7. Expansion Joints: Expansion joints shall be *Dylite*, as manufactured by Copper, Scorogord, or Dow Chemical and shall conform to ASTM D-1752, Type II.
- C. Conduit:
1. Size as indicated on the Drawings. If conduit sizes are not indicated on the Drawings, then the conduits shall be sized as follows:
    - a. Four inches nominal for 600 volts or lower and for Communication
    - b. Five inches nominal for voltages above 600 volts.
- D. Elbows: rigid heavy wall galvanized steel with a minimum bend radius of 36 inches (915 mm).
- E. Conduit Termination in Utility Holes and Buildings
1. End Bells: Manufactured end bells of appropriate sizes at each end of conduit. When entering a new building or a new manhole, the end bells for PVC shall be a pre-manufactured system (as manufactured by Formex, or equal) with conduit seals, provision for roughing into the concrete, and water stops.
  2. Bushings: Pre-manufactured groundable steel bushings of appropriate sizes where bell ends are not used. Steel bushings shall be used on all metal conduit. When entering a new building, or a new manhole, the bell ends for PVC shall be a pre-manufactured system (System as manufactured by Formex or equal) with conduit seals, provisions for roughing into the concrete pour and water stops.
  3. Seals: When entering, below grade, an existing building or manhole, the concrete shall be core-drilled for the appropriate size conduit and seal. The seal shall be a mechanical interlocking assembly seal of modular synthetic rubber links properly

sized to fit the pipe and tightened in place, in accordance with the manufacturer's instruction.

4. Fire Stopping/Sealant: All cable filled conduits shall be sealed with 3M Fire Barrier 2001 Silicone RTV Foam Conduit Sealant manufactured by 3M Fire Protection Products, or approved equal.
- F. Plugs: Closure plugs or caps of the same material as the conduit at the ends of the unused sections at manholes, and at building entrance openings.
- G. Pull wire: Provide a polypropylene, twisted yellow, rot and mildew-resistant 3/8" minimum pull rope (2400 lbs. tensile strength) in each empty duct.
- H. Grounding: Steel grounding bushings shall be grounded to the manhole or junction box ground. On steel conduit with end bells, provide an Appleton Catalog No. XJB Series or equal bonding fitting with bonding strap. Connect bonding strap to ground wire in manhole or junction box.

### 2.3 ACCESSORIES

- A. Duct Supports: Rigid PVC spacers selected to provide minimum duct spacings and concrete cover depths indicated, while supporting ducts during concreting. Spacers shall be interlocked horizontally only. Provide nylon tie-downs to hold ducts to spacers. Concrete blocks are prohibited for duct spacers.
- B. End Bells: Flared, smooth-surfaced fittings of same material as conduit; if of different material, including adapter for connection to conduit.
- C. Warning Tapes:
  1. Refer to Division 26 Section, "Electrical Identification" for product requirements.
  2. Bury marker tape 12-inches below grade above every ductbank and buried conduit.

### 2.4 TEST PITS

- A. Provide test pits to locate all utilities and structures. Provide test pits as necessary to determine actual locations and profiles of obstructions to proposed new work.
- B. Verify existing utilities, locations, and inverts and points of connection.

### 2.5 PAINTING

- A. General: All exposed conduit shall be primed and painted to match existing building exteriors.
  1. First coat: Zinc Duct - Zinc oxide primer house and trim paint.

2. Second Coat: Type and color to match existing building walls and/or trim where applicable.

### PART 3 EXECUTION

#### 3.1 LOCATION AND LAYOUT:

- A. Indicated plans and profiles - approximate, based on field information and available as-built plans.
- B. Actual locations and profiles - based on test pits to locate all shown utilities and structures. Test pits at beginning, center, end, and at all ductbank bends and utility crossings.
- C. Plan and profile adjustments - All provided at no additional cost to Owner, subject to approval.
- D. Examine site to receive ducts and handholes for compliance with installation tolerances and other conditions affecting performance of the underground ducts and manholes. Do not proceed with installation until unsatisfactory conditions have been corrected.
- E. Connection to existing duct banks - Contractor to verify location and inverts of existing duct banks, at points of connection.

#### 3.2 INSTALLATION:

- A. In accordance with NEMA publication TC-2 and manufacturer's recommendations.
- B. Top of envelope below grade - Minimum as follows: [as indicated on the Drawings] minimum (600 volts and below).
- C. Concrete envelope - 3 inches minimum beyond surface of any conduit, minimum 2 inches between conduits. Top of ductbank shall be crowned to prevent puddling of water.
- D. Seal and Thru Wall Fittings - At entrances to buildings for watertight construction.
- E. Sweeps and bends - Minimum 25 foot radius (except at conduit risers) unless otherwise approved to accomplish changes in direction of runs either horizontally or vertically. Double offsets: Minimum 100 foot radius. Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 36 inches.
- F. Mandrel conduits - Mandrel 12 inch long, 1/4 inch less than conduit I.D. Draw a testing mandrel through each duct.
- G. Clean conduits - After mandrel, with stiff brush, leave no particles or debris. Immediately install end plugs after cleaning.
- H. Pull Line - Provide 100-pound-tested nylon pull line in all conduits, including spares. Provide 3 feet of slack at each end of conduit and tag.

- I. Stagger vertical conduit joints - minimum 6 inches. All joints shall have couplings installed.
- J. Reinforcing steel - Provide reinforcing steel the entire length of the duct system. Provide four #4 bars, one in each corner minimum, overlap the joints 12-inches, and tie them into the respective utility, vaults, and buildings, etc. Rebar shall not be installed less than 2-inches from sides of any duct.

3.3 EXCAVATION, BACKFILLING, COMPACTING AND SITE PREPARATION:

- A. Provide all excavating and backfilling and site preparation necessary to install underground ductbanks, cables, etc., included in this section of the work. Excavation and backfill shall be performed in accordance with the requirements of Division 26 Section, "Common Work Results for Electrical".
- B. Install forms on sides of the ductbank if the trench is not of the proper firmness to prevent cave-in. Provide all required excavating, shoring, sheeting, bracing, and backfilling.
- C. The bottom of the trench shall be undisturbed earth. If the trench bottom is too low for proper grade, fill to the proper level with sand and mechanically compact it. Cut trenches neatly and uniformly.
- D. Each excavated section from manhole to manhole and from manhole to building shall be completely excavated and graded before any duct is laid in that section.
- E. Provide underground detectable warning tape 12-inches below finish grade over all ductbanks.
- F. Excavation and Backfill: Conform to Division 02, Section *Earthwork*, but do not use heavy-duty, hydraulic-operated compaction equipment.
- G. After excavation of the trench, stakes shall be driven in the bottom of the trench at four-foot intervals to establish the grade and route of the duct bank.
- H. Pitch the trenches uniformly towards manholes or both ways from high points between manholes for the required duct line drainage. Avoid pitching ducts towards buildings wherever possible.
- I. The walls of the trench may be used to form the side walls of the duct bank provided that the soil is self-supporting and that concrete envelope can be poured without soil inclusions. Forms are required where the soil is not self-supporting.
- J. After the concrete-encased duct has sufficiently cured, the trench shall be backfilled to grade with earth.
- K. Restore surface features at areas disturbed by excavation, and reestablish original grades except as otherwise indicated. Replace removed sod as soon as possible after backfilling is completed. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other

work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.

- L. Restore disturbed paving. Refer to "Cutting and Patching" in Division 02.
- M. Remove pavements, sidewalks, curbs, and gutters where necessitated by construction of ducts.
- N. Place temporary bituminous pavement in accordance with Section 02807, when required by the sequence of operations.
- O. Surplus earth from the trenches, after compacting, shall be removed and disposed of.

### 3.4 PLACEMENT OF CONDUIT

- A. Within five (5) feet of each existing building wall or utility hole penetration, install heavy wall galvanized steel conduit within the concrete envelope to provide protection against vertical shearing.
- B. Install spacers as recommended by the conduit manufacturer and requirements stated above, but not to exceed a maximum of four feet on center for PVC conduit and eight feet on center for steel conduit. Bottom spacers shall rest on 8-inch x 16-inch x 2-inch minimum concrete pads to prevent them from sinking into the ground and reducing the bottom concrete cover. Stagger conduit joints in concrete encasement 6 inches minimum horizontally.
  - 1. Spacer assembly shall consist of base spacers, intermediate spacers, and top spacers to provide a completely enclosed and locked conduit assembly.
  - 2. Before placing concrete, anchor duct bank assemblies to prevent the assemblies from floating during concrete placement. Anchoring shall be done by driving reinforcing rods adjacent to every other duct spacer assembly and attaching the rod to the spacer assembly.
  - 3. Set on masonry leveling blocks prior to pour.
- C. Pitch conduit properly for drainage to manhole or pull box and to prevent low pockets or irregular dips between conduit ends. Minimum pitch to be 4 inches per 100 feet.
- D. Provide accurate locations of conduit in utility hole.
- E. Depending on encasement necessary for duct formation, place conduits on spacers. The minimum encasement thickness 1-1/2-inches on all sides.
- F. Lay conduits using spacers to provide tier spacing.
- G. Make tight conduit joints by complying with recommendations of conduit manufacturer, using coupling jointing compound or PVC primer and solvent cement. All joints in conduits and fittings shall be made up tight and shall be watertight. All threaded portions of steel conduits that are not to be encased in concrete and adjoining ends of conduits, couplings and

fittings, shall be heavily coated with asphaltum after installation. All connections between conduits of different types shall be made in an approved manner, using adapters of other materials and methods recommended for the purpose by the conduit manufacturers.

- H. Provide not more than one 90-degree bend or equivalent between pull points for primary conduit and two 90-degree bends or equivalent for signal conduit.
- I. In ductbanks with both primary and signal conduit, primary conduit shall be straight and the signal conduit shall contain bends as necessary to accommodate the primary duct. Any offsets or bends shall be made in steel conduit. PVC conduit may only be used in straight lengths.
- J. Provide flush bell ends on duct at utility holes. When entering a new building or a new manhole, the bell ends for PVC shall be a pre-manufactured system (system as manufactured by Formex or equal) with conduit seals and provisions for roughing into the concrete.
- K. Provide insulated, grounding bushings on duct ends in equipment enclosure.
- L. Plug or cap empty conduits. Provide standard manufactured plugs.
- M. Seal all spare ducts and conduits, at all new and existing building entrances and at outdoor terminations at equipment pedestals with a suitable compound to prevent the entrance of moisture and gases.
- N. After ducts are in place and before the concrete is poured, the installation shall be inspected by the Engineer. Notify the Engineer at least two days before the time of inspection.
- O. Clear conduit by rod and pull an approved test mandrel from structure to structure or from structure to the conduit termination.
- P. Leave nylon or polyester pull line in each conduit, tagged to identify the conduit's point of origin, contents and final destination.
- Q. Conduit Couplings: Conduit couplings shall be staggered so that couplings on adjacent conduits will not lie in the same transverse plane. End bells shall be spaced approximately 9 inches center to center at face of manhole wall for 4-inch conduits and proportionately spaced for other sizes. The change from regular conduit spacing to end bell spacing shall start 10 feet from the face of the manhole wall and shall be made in such a way that the slope of any conduit will not be less than that of the main bank and no trap will be formed. New conduit entrances into existing manholes and building walls shall enter at the most desirable locations consistent with grading requirements and existing entrance and shall be waterproofed in a satisfactory manner.
- R. Bends: Conduit generally shall be straight between manholes or upturned elbows. Where bends are unavoidable in non-metallic conduits, they may be made by assembling couplings at a slight angle, provided the watertight seals are not broken and the resulting radius is not less than 100 feet. For radii less than 100 feet, 5-degree angle couplings or 5-degree factory-made bend sections shall be used.

1. Install top of duct bank minimum 30 inches below finished grade.
  2. Terminate conduit in end bell at manhole entries.
  3. Provide minimum 3-inch concrete cover at bottom, top, and sides of duct bank.
- S. Multiple conduit: Install multiple conduit as follows:
1. Multiple conduit runs, direct burial or in duct bank, shall be supported on preformed, non-metallic separators. Spacing between exterior surfaces of conduits generally shall be not less than the following:
    - a. Two (2) inches between telephone conduit.
    - b. Two (2) inches between conduits containing cables operating at not over 600 volts.
    - c. Six (6) inches between a telephone conduit and any power conduit in the same envelope.
    - d. One and a half (1-1/2) inches between conduits containing cables operating at over 600 volts.
    - e. Spacing between separators shall be close enough to prevent sagging of conduits and breaking of couplings and watertight seals. Separators shall also be spaced to keep deformation of conduit at the separators to 0.10-inch or less. Separators shall be secured with cords where necessary and no tie wires, reinforcing rods or other metallic materials shall be placed around the conduits, either individually or in groups, in such a manner as to form a magnetic loop.
  2. Multiple conduit runs shall be arranged substantially as shown on the drawings, but minor changes in location or cross sectional arrangement shall be made as necessary to avoid obstructions. Where conduit runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, the condition shall be referred for instructions before further work is done. All underground conduit work shall be coordinated with other outside service work. Existing outside services shall be maintained in operation unless directed otherwise.

### 3.5 CONDUIT AND DUCT INSTALLATION

- A. Install nonmetallic conduit and duct as indicated according to Manufacturer's written instructions.
- B. Slope: Pitch ducts a minimum of 4 inches per 100 feet (1:300) to drain toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two (2) manholes to drain in both directions. Trenches shall be evenly graded so that conduits will have a uniform rate of fall of not less than 3 inches per 100 feet and will

be free from either horizontal or vertical waves. Unless otherwise specified, each conduit shall slope uniformly from one manhole to the next or from a high point between manholes. Low points between manholes or between upturned elbows, shall be avoided wherever possible. Where it is not possible to avoid a trap or low point in a conduit which has no concrete envelope, provide a 1/2-inch hole drilled in the bottom of the conduit at the low point and a crushed stone sump of suitable volume below the conduit. If possible, install the sump above the high water table elevation for the particular location. Otherwise, provide special means to prevent the accumulation of water within the conduit.

- C. Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 50 feet (15 m) both horizontally and vertically at other locations.
- D. Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- E. Installation of warning tapes: After lacing a minimum of 12 –inches or a maximum of 18 inches of backfill over the ducts, place the appropriate warning tapes above and parallel to the centerline of the duct for the entire length of the duct trench.
- F. Provided pull rope and measuring tape shall be installed at the time the mandrel is pulled through each conduit. Record the wall-to-wall measurements and the size of mandrel used at this time. Provide this documentation to the Project Engineer on the following working day. After acceptance of these documents, the Contractor shall remove the measuring tape, leaving only the pull rope in the conduits.
- G. All work and materials covered by these Specifications shall be subject to inspection at times by the Owner's designated representative. Any work concealed before it has been inspected by the Owner's designated representative shall be re-opened or uncovered and any required modification made to that portion of the work. All trenches shall be opened from manhole to manhole or manhole to building prior to laying conduit in that trench. Exceptions (such as street crossings) will be approved prior to excavation on a case-by-case basis by the Owner at a regular project meeting. These sites shall be inspected by the Owner's representative during excavation, installation, backfill, restoration, and cleanup.
- H. Separation distance from other buried utilities as follows:
  - 1. Insulated Steam: 24-inches.
  - 2. Un-insulated Steam: 48-inches.
  - 3. All others: 18-inches.

### 3.6 REUSE OF EXISTING DUCTBANKS:

- A. Where new cables are to be installed in existing ductbanks and conduit , mandrel and brush clean each duct prior to installation of new cable. Mandrel and brush procedures shall be as specified for new conduit and ductbanks. If any duct is found to be collapsed, or deformed, it shall be brought to the attention of the Engineer immediately.

### 3.7 DIRECT BURIED DUCT CONDUIT:

- A. Provide where indicated direct-buried electrical circuits utilizing either PVC Schedule 40 or PVC-coated rigid galvanized steel conduit, as indicated. Conduit shall be as specified in Division 26 Section, "Raceways and Boxes". Burial depth shall be as follows:
  - 1. Below paved roads (PVC and RGS): 30-inches below bottom of paving.
  - 2. Under non-vehicle concrete (PVC and RGS): 24-inches below bottom of paving.
  - 3. Other areas (PVC): 24-inches.
  - 4. Other areas (RGS): 24-inches.
- B. Minimum separation from other utilities shall be the same as for ductbanks, specified previously in this Section.
- C. Where feasible, and where indicated, install direct-buried lines parallel, but separated from other utility lines. Group several direct-buried conduits in a common trench where running in the same direction, or to/from the same source. All direct-buried conduits shall have yellow plastic warning tape buried midway between the conduit and finished grade. Tape shall be the same as used for ductbanks.
- D. Where direct-buried conduits penetrate walls or floor slabs, seal all spaces around conduit and fittings. Provide through-wall fittings on all wall penetrations.
- E. Where an underground conduit, without a concrete envelope, enters the building through a non-waterproofed wall or floor, provide a sleeve made of Schedule 40 galvanized pipe. The space between the conduit and the sleeve shall be filled with a suitable plastic expansible compound or an oakum and lead joint on each side of the wall or floor in such a manner as to prevent entrance of moisture. A watertight entrance sealing device hereinbefore specified will be acceptable in lieu of the sleeve.

### 3.8 RECORD DOCUMENTS

- A. Provide record set data of the actual elevation of the top of each end of each raceway or ductbank at the midpoint, at no more than 100 foot intervals, where changes in elevation are less than 2 feet between data points, or 10 foot intervals when the elevation between intervals is different by 2 feet or more between data points.
- B. Provide record drawings indicating actual locations of all installed ductbanks and manholes including elevations. The record drawing shall indicate location, elevation, and type of service for all utilities crossed by new ductbank.
- C. Cable Records: The Contractor shall provide a complete listing of all cables installed in each conduit and ductbank, along with all cable splice locations.

### 3.9 FIELD QUALITY CONTROL

- A. Exposed surfaces of concrete shall be kept wet (damp) throughout the curing period.
- B. Seal the ducts and conduits at building entrances, and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of moisture and gases.

END OF SECTION

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## SECTION 260553 - ELECTRICAL IDENTIFICATION

### 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 electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.
- B. This section includes labeling of all terminations and related subsystems; including, but not limited to, nameplates, stenciling, wire and cable markers, labeling and identification of cables, equipment and other products.

#### 1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels. Provide a schedule of nameplates and stenciling.
- C. Samples: Prior to installation, submit samples for each type of label and sign to illustrate color, lettering style, and graphic features of identification products. These samples shall include examples of the lettering to be used. Samples shall be mounted on 8-1/2-inch x 11-inch sheets annotated, explaining their proposed use.

#### 1.4 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with ANSI A13.1 and NFPA 70 for color-coding.
- D. Comply with applicable EIA/TIA Standards.
- E. Comply with OSHA Standards.

#### 1.5 DEFINITIONS

- A. Emergency systems include, but are not limited to, generator circuits and systems, fire alarm systems, exit sign circuits, emergency lighting circuits, etc.

### PART 2 PRODUCTS

## 2.1 UNDERGROUND LINE WARNING TAPE

- A. Non-biodegradable, polyethylene tape, 8 mil thick and a minimum of 6 inches wide with detectable metallic foil. Provide warning labels on 3 foot centers and be colored as follows:
  - 1. Electrical ducts, piping or cable (600V and below) - Yellow tape with black printed labeling: CAUTION-BURIED ELECTRICAL LINE BELOW.
  - 2. Electrical ducts, piping or cable (above 600V) - Red tape with black printed labeling: CAUTION -HIGH VOLTAGE CABLE BURIED BELOW.
  - 3. Telephone conduits or cable - Orange tape with black printed labeling: CAUTION -BURIED TELEPHONE LINE BELOW.
  - 4. Fiber Optic conduits or cable - Orange tape with black printed labeling: CAUTION -BURIED FIBER OPTIC LINE BELOW.
  - 5. Cable TV(CATV) conduits or cable - Orange tape with black printed labeling: CAUTION-BURIED CABLE TV LINE BELOW.
- B. Where two (2) or more services share a common ductbank, i.e. telephone and fiber optic, warning tape for each service shall be installed above each service's respective conduit(s).
- C. Bury marker tape 12-inches below grade above every ductbank and buried conduit.

## 2.2 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
  - 1. Minimum Width: 3/16 inch (5 mm).
  - 2. Tensile Strength: 50 lb (22.3 kg) minimum.
  - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
  - 4. Color: According to color-coding.
- B. Paint: Formulated for the type of surface and intended use.
  - 1. Primer for Galvanized Metal: Single-component acrylic formulated for galvanized surfaces.
  - 2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
  - 3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
  - 4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

- C. Stenciling: Normal power system stenciling shall use black paint. Emergency system stenciling shall use red paint.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- A. General:
  - 1. Bands: Pre-tensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches (51 mm) wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
  - 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- B. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground line warning tape located directly above line at 12 inches (150 to 200 mm) below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm) overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

END OF SECTION

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## SECTION 261120 - UTILITY INCOMING SERVICE PROVISIONS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the General Requirements, apply to the work specified in this Section.
- B. Division 26 Section "Common Work Results for Electrical" sections apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The Contractor shall provide all materials and labor required by the utility for service provisions.
- B. The Contractor shall provide all materials and labor for complete empty conduit power, telephone and CATV distribution systems as shown on the drawings and as specified herein.

#### 1.3 RELATED WORK SPECIFIED ELSEWHERE IN DIVISION 26

- A. Section "Common Work Results for Electrical".
- B. Section "Raceways and Boxes".
- C. Section "Underground Ductbanks".
- D. Section "Grounding and Bonding".

#### 1.4 UTILITY COMPANY COORDINATION

- A. Contact *Miss Utility* (1-800-257-7777) prior to any excavation or underground work. The Contractor shall verify the location and depth of all utilities. Provide test pits to verify location and depth of all existing utilities crossing new incoming services.
- B. Contact serving utility companies immediately upon award of Contract. Do not install related equipment until fully coordinated with appropriate utilities.
- C. Provide all Construction Schedules, dates of requested services, outage windows, equipment locations, etc., necessary for utility work.
- D. The Contractor shall coordinate the electric and telephone services points of entry to be within twenty (20) feet (7.0 m), or as required to comply with NEC Article 800-11.
- E. The Contractor shall ascertain, from the utility companies, the exact amount of work required in connection of the utilities. Work required which is not provided by the utility companies shall be provided by the Contractor.

- F. Provide and coordinate all temporary services with utility companies.
- G. The Contractor shall coordinate the required separation distances for all utilities.
- H. The Contractor shall obtain all permits and permissions required.

#### 1.5 SUBMITTALS

- A. Certificate of Compliance: Contractor shall submit a documentation certifying that work complies with all utility company requirements including the following:
  - 1. Construction Standards of each Utility Company.
  - 2. Trench and cover Depth.
  - 3. Spacing and Support of Utilities.
  - 4. Installation of underground marking tape.
  - 5. Pull cords and Mandrels.
- B. Photographs: Contractor shall submit photographs of each utility installation at each of the above described levels of completion and attach photographs to Certificate of Compliance for verification. Submit a minimum of six (6) color 4-inch x 6-inch photographs for each utility service.
- C. Submit Certificate of Compliance and photographs to each utility company for verification and approval.
- D. Include Certificate of Compliance, photographs, and utility company approvals in O&M Manual.
- E. The Contractor shall provide and submit all required documentation to each utility company, including service application, site plan and coordination drawings.

#### 1.6 QUALITY ASSURANCE

- A. Comply with the requirements of Delaware Electric Cooperative.
- B. Comply with the requirements of NFPA 70, National Electrical Code.
- C. Comply with the NECA Standard of Installation.
- D. Comply with NFPA 70E, National Electrical Safety Code.
- E. Contractor shall have experience with not less than 5 comparable projects for which the Contractor completed service provisions with each utility. Contractor shall be familiar with all current utility requirements and guidelines.

- F. Obtain utility company inspector's approval for all work.

## PART 2 - PRODUCTS

### 2.1 ELECTRIC UTILITY COMPANY PROVISIONS

- A. The electric utility company is Delaware Electric Cooperative.
- B. Coordinate service entrance equipment and layout with power company prior to ordering or installing any service entrance equipment.
- C. Furnish and install all incoming raceway.
- D. Provide concrete pad for utility company's transformer as required by the Utility. Provide grounding and clearances as required by the Utility.
- E. Contact and coordinate service entrance equipment and layout with local power company prior to ordering or installing any service entrance equipment. Contractor shall furnish and install all incoming raceway and service entrance cables. If the power company plans to install cable and/or conduit, the Contractor is responsible for proper coordination of cable, conduit, lug sizes, etc., for proper interface between utility-owned/installed equipment and Contractor-installed equipment.
- F. The Contractor shall ascertain from the utility companies, the available short circuit fault current.

### 2.2 TELEPHONE COMPANY PROVISIONS

- A. The telephone utility is Verizon.
- B. Incoming Telephone service:
  - 1. Coordinate incoming telephone service requirements with area public telephone system utility. Provide two (2) 4-inch Schedule 40 PVC underground telephone service conduits from the telephone service equipment backboard to the vicinity of the power company's pad-mounted transformers or as indicated on the Drawings Verizon Service Drop and terminate ducts in the exact location and manner as directed by the telephone company.
  - 2. Provide pre-cast pulling handholes in duct run in location(s) as directed if deemed necessary by the telephone utility. Size of handholes (L x W x H) shall be as required by the utility. Handholes installed in roadways shall be H20 roadway type.
  - 3. Extend two (2) 4-inch PVC Schedule 40 underground service conduits along with primary electrical feeder from power company transformer location to 5'-0-inches beyond property line, or as indicated on the Drawings, then capped and stubbed.
  - 4. In addition to the above requirements, install raceways in maximum lengths of as required by telephone company and a maximum of two 90-degree bends or

equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

- C. Coordinate incoming raceway with telephone utility company. Provide required conduit size as determined by the telephone company.
- D. Contractor shall be responsible for contacting and coordinating with the telephone company prior to ordering or installing any telephone entrance equipment and provisions.

### 2.3 CABLE TELEVISION COMPANY PROVISIONS

- A. The Cable Television Company is COMCAST.
- B. Incoming CATV Service:
  - 1. Coordinate incoming CATV service requirements with the cable company. Provide two (2) 4-inch Schedule 40 PVC underground from the telephone service equipment backboard to the cablevision pedestal as directed by the Cable Company. Extend one (1) 4-inch Schedule 40 underground service conduit along with primary electrical feeder to 5'-0" beyond the property line, then cap and stub.
  - 2. Extend two (2) 4 -inch empty EMT conduit run concealed, from main telephone equipment wall space to TV/Communication Room and terminate at MATV/CATV head-end equipment in exact location and manner as required.

### 2.4 TYPICAL INCOMING SERVICE PROVISIONS

- A. Pull Wire: ¼-inch nylon pull cord with 500 lb. minimum tensile strength in each conduit.
- B. Conduit, Elbows, and Couplings: UL Schedule 40, EB-35, DB-60, DB-120, or ANSI/ASTM F-512 as required by utility for the specific application.
- C. Spacers: Every 4 feet of conduit.
- D. Splice Boxes: Purchase from utility company. Provide as required.
- E. Manholes: Purchase from utility company. Provide as required.
- F. Underground Marking: Provide detectable warning tape over all conduits.
- G. Bends: Minimum 5 foot radius (horizontal) and 36-inch radius (vertical).
- H. Backfill: Virgin soil/select backfill only. Backfill shall be stone dust, rock-free earth, or top soil with no stones larger than 1-1/2-inches in diameter permitted.
- I. Miscellaneous Materials: Provide bushings, bell ends, conduit plugs and other miscellaneous materials as required by utility companies.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Mandrel: Contractor shall pull a mandrel (1/2-inch smaller in diameter than the conduit, and six inches long) through each conduit.
- B. Pull Wires: Pull wires shall be left in all conduits, after mandrel pull.
- C. Coordination: Coordinate location of telephone and CATV wall spaces, raceways, and boxes, as necessary, to interface installation of telephone and CATV systems with other work.
- D. Bushings: Provide conduit bushing at each end of all conduits.
- E. Bell Ends & Plugs: Provide Bell ends and plugs for each conduit.
- F. Sealing Conduits: Provide duct sealant in each conduit after utility cable is installed.

### 3.2 UTILITY COMPANY ELECTRIC-METERING EQUIPMENT

- A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company. Provide lugs as required by utility.

### 3.3 PREPARATION

- A. Contractor shall provide conduits at all street or road crossings for all utility facilities.
- B. Provide a level area at final grade for all transformer, pedestal, and utility equipment locations.
- C. Coordinate utility line separation requirements between electric, water, sewer, gas, telephone and CATV.
- D. Contractor shall clear area for all utility cables of rubble, debris, stumps, and other obstructions.

END OF SECTION

## SECTION 311000 - SITE CLEARING

### 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 the following:
  - 1. Removing existing trees, shrubs, groundcover, plants, and grass.
  - 2. Clearing and grubbing.
  - 3. Stripping and stockpiling topsoil.
  - 4. Removing above- and below-grade site improvements.
  - 5. Disconnecting, capping or sealing, and abandoning site utilities in place removing site utilities.
  - 6. Replacing any damaged site features not indicated to be removed (i.e. fencing, walks, landscaping, etc.)
  - 7. Temporary erosion and sedimentation control measures.
- B. Related Sections include the following:
  - 1. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
  - 2. Division 32 Section "Turf and Grasses" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

#### 1.3 DEFINITIONS

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
- B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 MATERIAL OWNERSHIP

- A. For ownership of cleared materials, Contractor shall coordinate with Construction Manager scope of work. Except for stripped topsoil that can be reused on site or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS (NOT USED)

1.6 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without written permission from the Owner.
  - 2. Provide alternate routes around closed or obstructed traffic ways.
- B. Utility Locator Service: Notify Miss Utility a minimum of 3 days prior to performing any land disturbing activities. Contact Miss Utility of Delmarva 1-800-282-8555
- C. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS (Not Applicable)

2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 2 Section "Earthwork."
  - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. 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 temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
  1. Do not store construction materials, debris, or excavated material within fenced area.
  2. Do not permit vehicles, equipment, or foot traffic within fenced area.
  3. Maintain fenced area free of weeds and trash.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Where excavation for new construction is required within tree protection zones, 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 redirected 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. 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 Architect.
  1. Replace trees that cannot be repaired and restored to full-growth status, as determined by Architect.

### 3.3 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
  1. Arrange with utility companies to shut off indicated utilities.
  2. Owner will arrange to shut off indicated utilities when requested by Contractor.
- 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 the Owner not less than two days in advance of proposed utility interruptions.
  2. Do not proceed with utility interruptions without the University's written permission.
- C. Excavate for and remove underground utilities indicated to be removed.

- D. Removal of underground utilities is included in Division 2 Sections covering site utilities.

### 3.4 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
  - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
  - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
  - 3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 24 inches below exposed subgrade.
  - 4. Use only hand methods for grubbing within tree protection zone.
  - 5. Chip removed tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
  - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

### 3.5 TOPSOIL STRIPPING

- A. Remove grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials. Contactor may refer to Geotechnical Report for more detailed site conditions.
  - 1. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Do not stockpile topsoil within tree protection zones.
  - 2. Dispose of excess topsoil as specified for waste material disposal.
  - 3. Stockpile surplus topsoil to allow for re-spreading deeper topsoil.

### 3.6 SITE IMPROVEMENTS

- A. Replace any existing site improvements damaged during construction operations, not indicated to be removed (i.e. fencing, walks, landscaping, utilities, sanitary and storm structures, etc.)
- B. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

- C. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
  - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
  - 2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

### 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.
  - 1. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION 311000

## SECTION 312000 – EARTH MOVING

### PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.02 SUMMARY

- A. This Section includes the following:

1. Preparing subgrades for pavements, walkways, pads, and slabs on grade.
2. Excavating and backfilling for retaining walls and structures.
3. Subbase course for concrete walks.
4. Subbase course for asphalt paving.
5. Subsurface drainage backfill for walls and trenches.
6. Excavating and backfilling for utility trenches.
7. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.

- B. Related Sections include the following:

1. Division 31 Section *Site Clearing* for, site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2. Division 32 Section *Erosion and Sediment Control*, for temporary erosion and sediment control.
3. Division 32 Section *Turf and Grasses* for finish grading, including preparing and placing topsoil and planting soil for lawns.

#### 1.03 DEFINITIONS

- A. Backfill: Soil materials used to fill an excavation, including the backfill of retaining walls, footings and foundations.
  1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
  2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill. See section 2.1 for the requirements of borrow soil.

- E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
  - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect.
  - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by an independent geotechnical testing agency, according to ASTM D 1586.
- I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- J. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- K. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

#### 1.04 SUBMITTALS

- A. Comply with Division 1 Section *Submittal Procedures*.
- B. For Approval
  - 1. Product Data: For the following:
    - a. Geotextile support fabric.
    - b. Geotextile filter fabric.
- C. For Information:
  - 1. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
    - a. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
    - b. Laboratory compaction curve according to ASTM D 698 for each on-site and borrow soil material proposed for fill and backfill.

1.05 PROJECT/ SITE CONDITIONS

- A. Test borings and other exploratory operations may be made by the Contractor at no cost to the Owner.
- B. Existing Utilities: Locate existing underground utilities by hand excavation in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.
  - 1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner. Do not break utility connections without providing temporary services, as acceptable to Engineer.
  - 2. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.
    - a. Provide, to Architect, a minimum of 48 hour notice to proceed before interrupting any utility.
  - 3. Demolish and completely remove from site any existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.
- C. Use of Explosives: The use of explosives is not permitted.
- D. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.
  - 1. Operate warning lights as recommended by authorities having jurisdiction.
  - 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

1.06 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with applicable regulatory requirements of municipality and utility companies.
- B. Under pavements, prepared subgrade must be proof rolled to a visually firm and stable condition and to a minimum of 95 percent maximum dry density as determined by a standard proctor test (ASTM: D698) with a minimum 10-ton smooth-wheeled roller in presence of a qualified Geotechnical Engineer or Technician prior to the placing of any base material.
- C. A qualified Geotechnical Engineer or Technician, paid for by the Owner, shall monitor all site preparing, grading, and fill construction. The Engineer/Technician should observe and document the site preparation, existing fill material removal, and fill/backfill construction work, and make appropriate field tests, as necessary, to verify that acceptable fill materials are being used and that construction is being performed in accordance with applicable plans, specifications and acceptable construction practices.

## PART 2 - PRODUCTS

### 2.01 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations. **Note: No warranty is made regarding the amount of on site soils material suitable for use as fill or backfill of any kind.** Contractor is required for removal of unsuitable excavated materials and importing of suitable soils for backfill.
- B. Satisfactory Soils: Satisfactory soils for use as fill are defined below:
1. Structural fill, Fill under building slabs on grade and foundations, drives and parking, and behind retaining walls (where applicable): Where available, on site soil materials may be used where these on site soils conform to the requirements of the Delaware Department of Transportation Type G – Select borrow. Where sufficient on site soils materials are not available, off site borrow conforming to the requirements of the Delaware Department of Transportation Type G – select borrow shall be provided.
  2. Fill under walkways: Where available, on site soil materials may be used where these on site soils conform to the requirements of the Delaware Department of Transportation Type C – select borrow. When sufficient on-site soils materials are not available, off site borrow conforming to the requirements of the Delaware Department of Transportation Type C – select borrow shall be provided.
  3. Fill under unimproved, grass or landscape areas: Any on site soil material free of organic material and rocks or clumps larger than 2 inches.
- C. Backfill:
1. Backfill for all utility trenches under asphalt, walkway areas: may be on site material where these on site soils conform to the requirements of the Delaware Department of Transportation Type C – Select borrow. When sufficient on-site soils materials are not available, off site borrow conforming to the requirements of the Delaware Department of Transportation Type C – select borrow shall be provided.
  2. Backfill for all utility trenches under unimproved, grass areas: Any on site soil material free of organic material and rocks or clumps larger than 2 inches.
- D. Fill: All fill shall be comprised of satisfactory soil material as defined above, section 2.01.B.
- E. Subbase: Shall be Delaware Department of Transportation Type A CR-1 graded aggregate, DelDOT specification section 821.03.
- F. Bedding: Shall be Delaware Dept. of Transportation #57 stone.
- G. Drainage Fill Course: Shall be Delaware Dept. of Transportation #57 stone.

### 2.02 GEOTEXTILES

- A. Geotextile Filter Fabric: Nonwoven geotextile, specifically manufactured as a drainage and separation geotextile; made from polypropylene staple fibers; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
  - 1. Grab Tensile Strength: 120 lb; ASTM D 4632
  - 2. Tear Strength: 60 lb; ASTM D4533
  - 3. Puncture Resistance: 70 lb; ASTM D 4833.
  - 4. Water Flow Rate: 135 gpm per sq. ft.: ASTM D 4491
  - 5. Apparent Opening Size: No. 70; ASTM D 4751
  
- B. Geotextile Support Fabric: Woven geotextiles, specifically manufactured for use as a support and separation geotextiles, comprised of UV stabilized polypropylene slit film; and with the following minimum properties according to ASTM D 4759 and referenced standard test methods:
  - 1. Grab Tensile Strength: 315 lb; ASTM D 4632.
  - 2. Tear Strength: 120 lb; ASTM D 4533.
  - 3. Puncture Resistance: 120 lb; ASTM D 4833.
  - 4. Apparent Opening Size: No. 40; ASTM D 4751.

## 2.03 GEOGRID REINFORCEMENT

- A. For use in unsuitable soil areas, as directed by the Architect, shall be an integrally formed grid structure manufactured of a stress resistant polypropylene material. The geogrid shall accept applied force in use by positive mechanical interlock with compacted soil or construction fill materials. The geogrid shall possess sufficient flexural stiffness to enable efficient installation over weak or wet in situ soils and shall possess complete continuity of its properties throughout its structure. Geogrid soil reinforcement shall be Tensar BX1100 geogrid, or approved equal.

## PART 3 - EXECUTION

### 3.01 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 2 Section "Site Clearing."
- C. Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing," during earthwork operations.
- D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

### 3.02 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area. The bidder is responsible for complete dewatering for all site work including stormwater management and erosion control facilities. All dewatering methods must be approved by DNREC and must be per the DNREC ESC Handbook, latest revision effective July 1, 2005. The bidder should thoroughly familiarize themselves with existing on-site soils and groundwater conditions and review the Geotechnical Report. **With the exception of DNREC Well-Pointing (if applicable), contractor is responsible as part of the base bid contract scope of work to provide all required dewatering for all excavation & construction activities (utilities, storm, tie-in to pond, structures, etc.). Dewatering must be performed per DNREC specifications (i.e. pump through dirt bag with stone pit).**
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
  - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
  - 2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

### 3.03 EXPLOSIVES

- A. Explosives: Do not use explosives.

### 3.04 SITE STRIPPING AND PREPARATION IN STRUCTURAL AREAS

- A. At the start of construction all existing topsoil, roots, asphalt and existing fill material should be stripped and removed in their entirety from the proposed building, parking, and drive areas extending to a minimum lateral distance of 10' beyond outer edge of paved areas and 15' beyond outside edge of building footings. Any existing fill material that may be encountered in previously disturbed areas (e.g., utility trenches), as well as any existing utility lines, should also be removed in their entirety from the building area. Contractor may refer to Geotechnical Report for more detailed site conditions.
- B. After completing removal of the above, and upon reaching grade (in cut areas) and/or subgrade (in fill areas), the entire area should be proof-rolled with a minimum 10-ton smooth-wheeled roller or other approved equipment. The purpose of the proof-rolling is to densify the exposed grade/subgrade areas, which have been loosened or disturbed during the stripping/grading operation. In addition, the proof-rolling will expose any localized soft areas not encountered during the test boring program. In subgrade areas to receive structural fill, the exposed subgrade areas should be compacted to a visually firm and stable condition; compacted subgrade must be inspected and approved by the Geotechnical Engineer. This subgrade compaction effort will enable any structural fill to be placed and compacted at the required densities. Any localized soft and/or excessively wet subgrade areas encountered during this program, which cannot be adequately stabilized by drying and compacting, should be undercut and replaced with properly compacted structural fill (DelDOT Type G) or other suitable materials as directed by Geotechnical Engineer.

### 3.05 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

- 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

### 3.06 EXCAVATION FOR RETAINING WALLS AND OTHER STRUCTURES (if applicable)

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

- 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
  - 2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

### 3.07 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

### 3.08 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit.
  - 1. Clearance: 12 inches each side of pipe or conduit.
- C. Trench Bottoms: Excavate trenches deeper than bottom of pipe elevation to allow for bedding course (bedding course thickness and material shall be as specified on the drawings and/or specs and as recommended by manufacturer). Hand excavate for bell of pipe.

### 3.09 SUBGRADE INSPECTION

- A. Notify Architect/Geotechnical Engineer when excavations have reached required subgrade.
- B. If Geotechnical Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below pavements, walkways and structures with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated, or frozen subgrades.

1. Completely proof-roll subgrade in one direction.
  2. Proof-roll with a minimum 10 ton vibratory roller or a fully loaded tandem dump truck in the presence of a qualified soils technician.
  3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Geotechnical Engineer, and replace with compacted backfill or fill as directed.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, dust/drought conditions, or construction activities, as directed by Geotechnical Engineer.

### 3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

### 3.11 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
1. Construction below finish grade including, foundations and retaining walls.
  2. Surveying locations of underground utilities for Record Documents.
  3. Testing and inspecting underground utilities.
  4. Removing concrete formwork.
  5. Removing trash and debris.
  6. Removing temporary shoring and bracing, and sheeting.
  7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

### 3.12 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Place and compact initial backfill, material as defined in section 2.01.C to a height of 12 inches over the utility pipe or conduit.
1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- D. Place and compact final backfill of material specified in section 2.01.C to final subgrade elevation.

### 3.13 STRUCTURAL LOAD BEARING FILL/BACKFILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. The load bearing fill material should be placed in horizontal thin lifts with a loose thickness no greater than 8 inches. For top 1-foot of pavement and slab subgrades, each thin lift of fill material should be compacted to 100% maximum dry density, as determined by the Standard Proctor Test (ASTM D-698). For fills below 1 foot of pavement subgrade and for structural fill below building slab and footings/foundations, each thin lift of fill material should be compacted to 95% maximum dry density, as determined by the Standard Proctor Test (ASTM D-698). Structural fill placement, as defined above, shall extend to a minimum lateral distance of 10' beyond outer edge of paved areas and 15' beyond outside edge of building footings.
- C. Place soil material on subgrades free of mud, frost, snow, ice, or other deleterious materials.

### 3.14 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
  - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
  - 2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

### 3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
  - 1. Under structures, building slabs, steps, and fills below 1-foot of pavement subgrade, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
  - 2. For top 1-foot of pavement and slab subgrades, each thin lift of fill material should be compacted to 100% maximum dry density.
  - 3. Under walkways, scarify and recompact top 6 inches (below subgrade and compact each layer of backfill or fill soil material at 95 percent.
  - 4. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
  - 5. For utility trenches, compact each layer of backfill soil material at 95 percent.

### 3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
  - 1. Provide a smooth transition between adjacent existing grades and new grades.
  - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
  - 1. Lawn or Unpaved Areas: Plus or minus 1 inch.
  - 2. Walks: Plus or minus 1 inch.
  - 3. Pavements: Plus or minus 1/2 inch.

### 3.17 SUBBASE AND BASE COURSES

- A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase and base course under pavements, courts, and walks as follows:
  - 1. Where shown on the plans, install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
  - 2. Shape subbase course to required crown elevations and cross-slope grades.
  - 3. Place subbase course 6 inches or less in compacted thickness in a single layer.
  - 4. Place subbase course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
  - 5. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

### 3.18 FIELD QUALITY CONTROL

- A. Testing Agency: Owner shall engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B. Testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work complies with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved Areas, Building Slabs, and Areas beneath athletic courts: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than 3 tests.
  2. Structural Fill and Backfill: At each compacted backfill layer, at least 1 test for each 2000 square feet, but no fewer than 3 tests.
  3. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet or less of trench length, but no fewer than 2 tests.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

### 3.19 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

### 3.20 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property to DNREC approved location.

END OF SECTION 312000

## SECTION 321216 - ASPHALT PAVING

### PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the Work specified in this Section.

#### 1.02 SECTION INCLUDES

- A. Refer to Scope Information Sheets for this contract bound in the Project Manual. The Scope Information Sheets describe generally the work included in each contract, but the work is not necessarily limited to that described.
- B. Provisions for hot-mixed asphalt paving over prepared subbase.
- C. Proof rolling of prepared sub base.
- D. Traffic Paint
- E. Contractor shall coordinate all construction documents related to work specified herein; where conflicts arise between these specifications and the design drawings, the more stringent shall apply. The Contractor is advised to contact the Architect with any questions prior to resolving any conflicts, or modifying any of the original design.

#### 1.03 RELATED SECTIONS

- A. Prepared subbase is specified in another Division 31, Section "Earth Moving".
- B. Saw-cutting of edges of existing pavement is specified in site-clearing section.

#### 1.04 SUBMITTALS

- A. Material Certificates signed by material producer and Contractor, certifying that each material item complies with or exceeds specified requirements.

#### 1.05 PROJECT/SITE CONDITIONS

- A. Weather Limitations: Apply prime and tack coats when ambient temperature is above 50 deg F (10 deg C) and when temperature has not been below 35 deg F (1 deg C) for 12 hours immediately prior to application. Do not apply when base is wet or contains an excess of moisture.
- B. Construct hot-mixed asphalt surface course when atmospheric temperature is above 40 deg F (4 deg C) and when base is dry. Base course may be placed when air temperature is above 30 deg F (minus 1 deg C) and rising.

- C. Grade Control: Establish and maintain required lines and elevations.

#### 1.06 MATERIALS

- A. General: Use locally available materials and gradations that exhibit a satisfactory record of previous installations.
- B. Coarse Aggregate: Sound, angular crushed stone, crushed gravel, or properly cured crushed blast furnace slag, complying with ASTM D 692-88.
- C. Fine Aggregate: Sharp-edged natural sand or sand prepared from stone, properly cured blast furnace slag, gravel, or combinations thereof, complying with ASTM D 1073.
- D. Asphalt Cement: ASTM D 3381 for viscosity-graded material; ASTM D 946 for penetration-graded material.
- E. Prime Coat: Cut-back asphalt type, ASTM D 2027; MC-30, MC-70 or MC-250.
- F. Tack Coat: Emulsified asphalt; ASTM D 977.
- G. Subbase Reinforcement Fabric. Structural Geogrid BX 1200

#### 1.07 ASPHALT-AGGREGATE MIXTURE

- A. Provide plant-mixed, hot-laid asphalt-aggregate mixture complying with ASTM D 3515 and applicable Delaware Department of Transportation standards.

#### 1.08 TRAFFIC PAINT

- A. Traffic Paint: Apply traffic paint for striping and other markings with mechanical equipment to produce uniform straight edges. Apply at manufacturer's recommended rates to provide a 15-mil minimum wet film thickness. All traffic striping is to conform to Delaware Department of Transportation standard specifications.

### PART 2 - EXECUTION

#### 2.01 SURFACE PREPARATION

- A. General: Remove loose material from compacted subbase surface immediately before applying prime coat.
- B. Proof-roll prepared subbase surface to check for unstable areas and areas requiring additional compaction.
- C. Notify Engineer of unsatisfactory conditions. Do not begin paving work until deficient subbase areas have been corrected and are ready to receive paving.

- D. Prime Coat: Apply at rate of 0.20 to 0.50 gal. per sq. yd., over compacted subgrade. Apply material to penetrate and seal, but not flood, surface. Cure and dry as long as necessary to attain penetration and evaporation of volatile.
- E. Tack Coat: Apply to contact surfaces of previously constructed asphalt or Portland cement concrete and surfaces abutting or projecting into hot-mixed asphalt pavement. Distribute at rate of 0.05 to 0.15 gal. per sq. yd. of surface.
- F. Allow to dry until at proper condition to receive paving.
- G. Exercise care in applying bituminous materials to avoid smearing of adjoining concrete surfaces. Remove and clean damaged surfaces.

## 2.02 PLACING MIX

- A. General: Place hot-mixed asphalt mixture on prepared surface, spread, and strike off. Spread mixture at minimum temperature of 225 deg F (107 deg C). Place areas inaccessible to equipment by hand. Place each course to required grade, cross-section, and compacted thickness.
- B. Paver Placing: Place in strips not less than 10 feet wide, unless otherwise acceptable to Engineer. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete the base course for a section before placing surface course.
- C. Immediately correct surface irregularities in finish course behind paver. Remove excess material forming high spots with shovel or lute.
- D. Joints: Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density, and smoothness as other sections of hot-mixed asphalt course. Clean contact surfaces and apply tack coat.

## 2.03 ROLLING

- A. General: Begin rolling when mixture will bear roller weight without excessive displacement.
- B. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
- C. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling and repair displaced areas by loosening and filling, if required, with hot material.
- D. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been evenly compacted.
- E. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained 95 percent laboratory density.

- F. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot-mixed asphalt. Compact by rolling to specified surface density and smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

#### 2.04 FIELD QUALITY CONTROL

- A. General: Test in-place hot-mix asphalt courses for compliance with requirements for thickness and surface smoothness. Repair or remove and replace unacceptable paving as directed by Engineer.
- B. Thickness: In-place compacted thickness tested in accordance with ASTM D 3549 will not be acceptable if exceeding following allowable variations:
  - 1. Base Course: Plus or minus ½ inch.
  - 2. Surface Course: Plus or minus 1/4 inch.
- C. Surface Smoothness: Test finished surface of each hot-mixed asphalt course for smoothness, using 10-foot straightedge applied parallel with and at right angles to centerline of paved area. Surfaces will not be acceptable if exceeding the following tolerances for smoothness:
  - 1. Base Course Surface: 1/4 inch.
  - 2. Wearing Course Surface: 3/16 inch.
- D. Check surface areas at intervals as directed by Engineer.

END OF SECTION 321216

## SECTION 321313 – CONCRETE PAVING

### PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the Work specified in this Section.

#### 1.02 SECTION INCLUDES

- A. Refer to Scope Information Sheets for this contract bound in the Project Manual. The Scope Information Sheets describe generally the work included in each contract, but the work is not necessarily limited to that described.
- B. Concrete steps, pads, curbs, and landings.

#### 1.03 RELATED DOCUMENTS

- A. The Delaware Department of Transportation Standard Specifications for Road and Bridge Construction is hereby incorporated into this section and all requirements set forth there, shall be adhered to.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Section 312000 - "Earth Moving" for subgrade preparation, grading and subbase course outside the building area.
- C. The Contractor shall coordinate all construction documents related to work specified herein; where conflicts arise between these specifications and the design drawings, the more stringent shall apply. The Contractor is advised to contact the Architect with any questions prior to resolving any conflicts, or modifying any of the original design.

#### 1.04 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, joint systems, curing compounds, dry-shake finish materials, and others if requested by Architect.
- C. Design mixes for each class of concrete. Include revised mix proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
- D. Laboratory test reports for evaluation of concrete materials and mix design tests.

- E. Material certificates in lieu of material laboratory test reports when permitted by Architect. Material certificates shall be signed by the manufacturer and the Contractor certifying that each material item complies with or exceeds requirements. Provide certification from admixture manufacturers that chloride content complies with requirements.

#### 1.05 QUALITY ASSURANCE

- A. Concrete Standards: Comply with provisions of the following standards, except where more stringent requirements are indicated.
  - 1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
  - 2. ACI 318, "Building Code Requirements for Reinforced Concrete."
  - 3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."
  - 4. Delaware Department of Transportation Standard Specifications.
- B. Concrete Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
- C. Concrete Testing Service: Engage a qualified independent testing agency to perform materials evaluation tests and to design concrete mixes.
- D. Seal all concrete surfaces with concrete sealer conforming to ASTM C309.

### PART 2 - PRODUCTS

#### 2.01 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other acceptable panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
  - 1. Use flexible or curved forms for curves of a 100-foot or less radius.

#### 2.02 REINFORCING MATERIALS

- A. Reinforcing Bars and Tie Bars: ASTM A 615, Grade 60, deformed.
- B. Welded Steel Wire Fabric: ASTM A 185.
  - 1. Furnish in flat sheets, not rolls, unless otherwise acceptable to Architect.
- C. Deformed-Steel Welded Wire Fabric: ASTM A 497.
- D. Fabricated Bar Mats: Welded or clip-assembled steel bar mats, ASTM A 184. Use ASTM A 615, Grade 60 steel bars, unless otherwise indicated.
- E. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 60. Cut bars true to length with ends square and free of burrs.

- F. Supports for Reinforcement: Chairs, spacers, dowel bar supports and other devices for spacing, supporting, and fastening reinforcing bars, welded wire fabric, and dowels in place. Use wire bar-type supports complying with CRSI specifications.
  - 1. Use supports with sand plates or horizontal runners where base material will not support chair legs.

#### 2.03 CONCRETE MATERIALS

- A. Concrete materials to be used in project shall comply fully with the requirements of the DelDOT Standard specifications.
- B. Portland Cement: ASTM C 150, Type I.
  - 1. Use one brand of cement throughout Project unless otherwise acceptable to Architect.
- C. Fly Ash: ASTM C 618, Type F.
- D. Normal-Weight Aggregates: ASTM C 33, Class 4, and as follows. Provide aggregates from a single source.
  - 1. Maximum Aggregate Size: 1-1/2 inches.
  - 2. Do not use fine or coarse aggregates that contain substances that cause spalling.
  - 3. Local aggregates not complying with ASTM C 33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to Architect.
- E. Water: Potable.

#### 2.04 ADMIXTURES

- A. Provide concrete admixtures that contain not more than 0.1 percent chloride ions.
- B. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- C. Water-Reducing Admixture: ASTM C 494, Type A.

#### 2.05 CURING MATERIALS

- A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- B. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
  - 1. Waterproof paper.
  - 2. Polyethylene film.
  - 3. White burlap-polyethylene sheet.

#### 2.06 CONCRETE MIX

- A. Prepare design mixes for each type and strength of normal-weight concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use a qualified independent testing agency for preparing and reporting proposed mix designs.
  - 1. Do not use the Owner's field quality-control testing agency as the independent testing agency.
  - 2. Limit use of fly ash to 25 percent of cement content by weight.
- B. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:
  - 1. Compressive Strength (28-Day): 4000 psi.
  - 2. Compressive Strength (28-Day): 3500 psi.
  - 3. Maximum Water-Cement Ratio at Point of Placement: 0.45.
  - 4. Slump Limit at Point of Placement: 3 inches.
- C. Adjustment to Concrete Mixes: Mix design adjustments may be requested by the Contractor when characteristics of materials, project conditions, weather, test results, or other circumstances warrant.

## 2.07 CONCRETE MIXING

- A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94.
  - 1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

## PART 3 - EXECUTION

### 3.01 SURFACE PREPARATION

- A. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.
- B. Remove loose material from compacted subbase surface immediately before placing concrete.

### 3.02 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for paving to required lines, grades, and elevations. Install forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.
- B. Check completed formwork and screeds for grade and alignment to following tolerances:
  - 1. Top of Forms: Not more than 1/8 inch in 10 feet.
  - 2. Vertical Face on Longitudinal Axis: Not more than 1/4 inch in 10 feet.

- C. Clean forms after each use and coat with form release agent as required to ensure separation from concrete without damage.

### 3.03 PLACING REINFORCEMENT

- A. General: Comply with Delaware Department of Transportation Standard Specifications for placing reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities or replace units as required before placement. Set mats for a minimum 2-inch overlap to adjacent mats.

### 3.04 JOINTS

- A. General: Construct contraction, construction, and isolation joints true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to the centerline, unless indicated otherwise.
  - 1. When joining existing paving, place transverse joints to align with previously placed joints, unless indicated otherwise.
- B. Contraction Joints: Provide weakened-plane contraction joints, sectioning concrete into areas as shown on Drawings. Construct contraction joints for a depth equal to at least 1/4 of the concrete thickness, as follows:
  - 1. Tooled Joints: Form contraction joints in fresh concrete by grooving and finishing each edge of joint with a radiused jointer tool.
  - 2. Inserts: Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strips into fresh concrete until top surface of strip is flush with paving surface. Radius each joint edge with a jointer tool. Carefully remove strips or caps of two-piece assemblies after concrete has hardened. Clean groove of loose debris.
- C. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than ½ hour, unless paving terminates at isolation joints.
  - 1. Provide preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless indicated otherwise. Embed keys at least 1-1/2 inches into concrete.
  - 2. Continue reinforcement across construction joints unless indicated otherwise. Do not continue reinforcement through sides of strip paving unless indicated.
  - 3. Provide tie bars at sides of paving strips where indicated.
  - 4. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.

3.05 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. Remove snow, ice, or frost from subbase surface and reinforcing before placing concrete. Do not place concrete on surfaces that are frozen.
- C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.
- D. Comply with requirements of the Delaware Department of Transportation for measuring, mixing, transporting, and placing concrete.
- E. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- F. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- G. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete complying with ACI 309R.
  - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcing, dowels, and joint devices.
- H. Screed paved surfaces with a straightedge and strike off. Use bull floats or darbies to form a smooth surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces prior to beginning finishing operations.
- I. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete.
- J. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
- K. Cold-Weather Placement: Comply with provisions of ACI 306R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - 1. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture

temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.

2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

L. Hot-Weather Placement: Place concrete complying with ACI 305R and as specified when hot weather conditions exist.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F (32 deg C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

### 3.06 CONCRETE FINISHING

A. Float Finish: Begin floating when bleed water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Finish surfaces to true planes within a tolerance of 1/4 inch in 10 feet as determined by a 10-foot-long straightedge placed anywhere on the surface in any direction. Cut down high spots and fill low spots. Refloat surface immediately to a uniform granular texture.

1. Broom Finish: Brush across concrete, perpendicular to line of traffic, to provide a uniform finish.

B. Final Tooling: Tool edges of paving, gutters, curbs, and joints formed in fresh concrete with a jointing tool to radii as shown on the plans. Repeat tooling of edges and joints after applying surface finishes. Eliminate tool marks on concrete surfaces.

### 3.07 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with the recommendations of ACI 306R for cold weather protection and ACI 305R for hot weather protection during curing.

B. Evaporation Control: In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before floating.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with the following materials:
  - a. Water.
  - b. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with a 12-inch lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

### 3.08 TRAFFIC PAINT

- A. Traffic Paint: Apply traffic paint for striping and other markings with mechanical equipment to produce uniform straight edges. Apply at manufacturer's recommended rates to provide a 15-mil minimum wet film thickness. All traffic striping is to conform, at a minimum, to the design drawings.

### 3.09 FIELD QUALITY CONTROL TESTING

- A. Employ a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement as follows:
  1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
    - a. Slump: ASTM C 143; one test at point of placement for each compressive-strength test but no less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.
    - b. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test but no less than one test for each day's pour of each type of air-entrained concrete.
    - c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
    - d. Compression Test Specimens: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless directed otherwise. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
    - e. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd. but less than 25 cu. yd., plus one set for each additional 50 cu. yd. Test one specimen at 7 days, test two specimens at 28 days, and retain one specimen in reserve for later testing if required.
  2. When total quantity of a given class of concrete is less than 50 cu. yd., Architect may waive strength testing if adequate evidence of satisfactory strength is provided.
  3. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

4. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.

B. Test results will be reported in writing to Architect, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in paving, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day and 28-day tests.

### 3.10 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective, or does not meet the requirements of this Section.
- B. Drill test cores where directed by Architect when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with Portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep concrete paving not more than two days prior to date scheduled for Substantial Completion inspections.

END OF SECTION 321313

## SECTION 321823 - TENNIS COURT SURFACE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 Specifications sections apply to work of this section.

#### 1.2 SUMMARY

- A. The Contractor shall provide all labor, transportation, tools, equipment, materials, supervision, etc., required to reconstruct and/or resurface tennis courts, in accordance with the plans and with these specifications.

#### 1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Asphaltic concrete paving.
- B. Saw cutting of edges on one existing tennis court for demolition.

#### 1.4 PRODUCT HANDLING

- A. Delivery of Materials: Deliver in manufacturer=s sealed containers with labels legible and intact. Information on label shall include: manufacturer=s name, type of materials and stock number (specification number).
- B. Storage of Materials: Store only approved materials on project site. Remove unapproved materials immediately.

#### 1.5 QUALITY ASSURANCE

- A. Acceptable Manufacturers: California Products Corporation or approved equal. Substitutes must be approved by the Engineer. Specifications of product must be provided with technical data and/or lab tests to ensure that a substitute product can be compared to California Products surfacing materials.
- B. All work and materials for paving shall be in accordance with Delaware DOT Standard Specifications. Laser-controlled grading and paving equipment can be required and is recommended to assure planarity and a quality job. Tennis court paving and surfacing shall meet the construction standards and guide specifications prescribed by the United States Tennis Court and Track Builders Association.
- C. Installer Qualifications: Contractor installing this work shall be engaged regularly in the construction and surfacing of tennis courts. Contractor shall use only foremen and workers who have specific experience in the construction of tennis courts. Contractor shall provide list of tennis courts completed and client names and telephone numbers upon request.

- D. Owner's Right to Test Materials: The Owner reserves the right to require contractor to test materials delivered to the job site in unopened drums and after dilution and mixing prior to application. Such testing shall be by an independent laboratory of the Owner's choice to assure that the materials meet the standards set by this specification and the cost of testing shall be borne by Contractor.
- E. Surfacing system shall be asbestos free. Contractor must complete and sign an asbestos free affidavit before final inspection. Failure to do so constitutes noncompliance with these specifications.
- F. MSDS Documentation: Upon request, Contractor must be able to provide Material Safety Data Sheet documentation for all materials used to satisfy contract.
- G. Submission of Substitute Materials: If other than products specified, the Contractor shall submit at least ten (10) working days prior to the bid date a complete typewritten list of all such proposed substitutions together with sufficient data, drawings, samples, literature, and other detailed information as will demonstrate to the satisfaction of the Owner that the proposed substitute material is equal in quality and utility to that originally specified.
- H. Submittal Requirement: Contractor must deliver materials to job site in unopened drums and supply Owner with list of batch numbers from the manufacturer for the various materials.

## 1.6 SUBMITTALS

- A. Product Data: Include material descriptions.
- B. Shop Drawings: Dimensions of courts, construction details, color sample sheet, location of court and foul area colors.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Products specified are as manufactured by California Products, 264 Brookway Road, Merion Station, PA 19066, Phone 215-664-3822 (plant phone 800-225-1141) and shall conform to the product specification. Products of other manufacturers shall be accepted as equal, subject to the approval of the Engineer.

### 2.2 MATERIALS

- A. Patching Mix (Court Patch Binder): For use in cracks, holes, depressions (bird baths) and other imperfections in the surface. This material will be used in accordance with manufacturer's specifications with regard to sand sizes, prime coats, and depth of depression, hole, or crack.
- B. Crack Filler: For use in fine cracks and for minor cosmetic thin repairs and fills prior to filler course.

- C. 100% Acrylic Filler Course (Acrylic Resurfacer): The filler course shall be California Acrylic Resurfacer or an approved equal and consist of a 100% acrylic emulsion binder containing no vinyl copolymerization constituent and no asbestos fillers. The product shall contain no less than 4% attapulgite and have a pigment-volume concentration not to exceed 9.5%.
1. California Acrylic Resurfacer
    2. Percent solids by weight (minimum) 26.7
    3. Percent solids by volume (minimum) 22.9
    4. Weight per gallon (minimum) 8.7 - 8.9 lbs.
  2. Court Patch Binder
    - a. Percent solids by weight (minimum) 46.5
    - b. Percent solids by volume (minimum) 44.0
    - c. Weight per gallon (minimum) 8.7 - 8.9 hours
  3. Crack Filler
    - a. Percent solids by weight (minimum) 85.6
    - b. Percent solids by volume (minimum) 73.6
    - c. Weight per gallon (minimum) 15 lbs.
- D. Job-mixed Fortified Plexipave is a field-mixed combination of California Products Corporation's Plexichrome and Plexipave Color Base or approved equal blended in accordance with the manufacturer's Specification Number 10.12 and shall consist of lightfast mineral oxide pigments and fillers, uniformly dispersed in a nonoxidizing 1005 acrylic base.
1. Plexichrome: A 100% acrylic emulsion binder containing no vinyl copolymerization constituent. It is totally asbestos free and contains no less than 8% by weight chrome Oxide Green pigment (other colors and their pigments correspond) and has a pigment volume concentration not exceeding 35%.
    - a. Percent solids by weight (minimum) 36.5
    - b. Percent solids by volume (minimum) 23.8
    - c. Weight per gallon 10.0 - 10.2 lbs.
  2. Plexipave Color Base: A 100% acrylic emulsion binder containing no vinyl copolymerization constituent. It is totally asbestos free and contains on more than 63% Silica Sand (highly graded and rounded) and no more than 10% Aluminum Silicates. Pigment volume concentration does not exceed 76%.
    - a. Percent solids by weight (minimum) 74
    - b. Percent solids by volume (minimum) 58.6
    - c. Weight per gallon 13.1 - 14.1 lbs.

3. Storage Stability: After 30 days storage in a sealed container at normal temperatures (50 degrees F to 90 degrees F) the product shall not become hard-packed nor show signs of mold growth or spoilage.
4. Weathering: After 1000-hour accelerated weathering, the product shall not develop checks, cracks, blisters, and shall not excessively fade when compared with a standard.
5. Water Resistance: After 24 hours soaking in distilled water (70 degrees F to 80 degrees F) the film shall not blister or show signs of re-emulsification.
6. Application Properties: The product, when diluted to proper consistency, shall be capable of being applied with 50 durometer squeegees over clean, dry surfaces, at temperatures between 50 degrees F and 100 degrees F.

E. Hi-Hide Plexicolor Line Paint (or approved equal):

1. The paint shall be 100% acrylic emulsion type containing no alkyds, butadiene styrene or vinyls, and shall be thinned with water only. The paint shall also be suitable for the addition of reflectance-type glass spheres at the time of application.
2. All materials used in the manufacture of the paint shall be of good commercial quality, entirely suitable for the purpose intended under normal conditions of use. For white line paint, the opaque portion of the pigment shall be rutile titanium dioxide and vehicle shall consist of 100% acrylic polymer dispersed in water together with the minimum amounts of necessary additives, such as pigment, dispersants, anti-foaming agents, and preservatives, but no driers shall be used.
3. The paint shall meet a minimum requirement of total solids (percent by weight of paint) of 52.5% and a maximum pigment content (percent by weight of paint) of 39.4%. The white paint shall contain not less than 26% per gallon of Type I rutile titanium dioxide. Pigment volume concentration not to exceed 39.55% a minimum fineness of grind of 4 and a viscosity (krebs units) of 70 minimum and 85 maximum as required. The paint shall brush easily and have good flowing, leveling, and spreading characteristics and shall be suitable for application by spray equipment.
4. The paint shall meet the following Solvent Resistance Test:
  - a. Use a sample of unreduced paint for a draw-down of 0.0003 inch wet film thickness on glass and air dry for 24 hours. Remove the dried paint film in sheets from the glass and weigh out one gram. Place one gram of white paint film (or yellow paint film) in a 50 millimeter beaker and add 20 grams of Toluol (TT-T-548A). The beaker shall be rotated periodically during test period. The paint film shall not crumple, cloud the liquid, or otherwise disintegrate in the liquid within 48 hours and the Toluol shall remain clear and colorless throughout the test. Failure of the film to pass this test shall disqualify the product. Procedures for all other tests shall be as described in TT-P-0019A.

5. The paint shall be suitable for use over all types of asphaltic surfaces, and when applied over emulsified asphalt surface it shall not cause lifting, crazing, peeling, or other damage to the base.

### PART 3 - EXECUTION

#### 3.1 SURFACE PREPARATION

- A. Asphalt patching shall be cured for a minimum of 14 days.
- B. The application contractor of the color finish shall then remove by brush, vacuum, or blower (as appropriate in each area for safety and convenience) all dust, dirt, imbedded soil and will mechanically wash areas not easily cleaned. Tree stains and rosins shall be removed. Surface shall be clean, sound, free of grease, oils, and other foreign materials. Follow manufacturer=s recommendations for acceptable cleaning products.
- C. Edges adjacent to buildings, curbing and landscaping not to be coating with this color finish system shall be adequately masked with tape or otherwise protected during these applications. The contractor shall also erect suitable temporary barriers to protect the coatings during drying and curing periods. Mixing with clean fresh water shall only be done at the job site. Spreading rates are based upon material prior to mixing with water as directed. Only small amounts are required (approximately 5 gal./30 gal. drum) and should be used only if ambient and surface temperatures cause rapid drying while applying.

#### 3.2 COURT PATCH BINDER

- A. Use in cracks and depressions holding enough water to cover a five-cent piece with court patch binder patching mix. This step shall be accomplished prior to the squeegee application of acrylic resurfacer. The Contractor shall flood all the courts, then allow to drain. Define and mark all areas holding enough water to cover a nickel. After defined areas are dry, prime with tack coat mixture of 2 parts water/1 part court patch binder. Allow tack coat to dry completely. Spread court patch binder mix true to grade using a straight edge (never a squeegee) for strike off). Steel trowel or wood float the patch so that the texture matches the surrounding area. Never add water to mix. Light misting on surface and edges to feather in is allowed as needed to maintain workability. Allow to dry thoroughly and cure.
- B. Filler course shall be applied to the clean underlying surface in one application to obtain a total quantity of not less than 15-20 square yards per gallon based on the material prior to any dilution. Acrylic resurfacer may be used to precoat depression and crack/hole repairs to achieve better planarity prior to filler course application.
- C. For depressions up to 3/4" in thickness the following mix shall be applied by steel trowel or metal screed, filling the depression and bringing it to grade.

1. Thin Patches 1/4" or less: 100 lbs. #80-100 Mesh Silica Sand (dry), 3 gallons Court Patch Binder, 1 to 2 gallons Portland Cement (dry) (Minimum 12lbs., maximum 24 lbs. depending on temperature and humidity).
  2. Thick Patches 1/4" or greater: Use 60-80 mesh silica sand (dry).
- D. Mix in a clean mortar box or mortar mixer to a workable consistency. Court Patch Mix may be applied directly to the depressed area after thorough cleaning of the surface. The patch should be allowed to cure for 24 hours prior to the application of the Plexipave Color Surface System.
- E. Depressions in excess of 3/4" depth must receive multiple applications of Court Patch Mix, allowing 24 hours curing time between applications. Each application of Court Patch Mix must be feathered out to a fine edge. Any rough edges must be rubbed down with an abrasive rubbing stone to remove roughness.
- F. Do not use in temperatures below 55EF or when rain or high humidity is imminent. Ambient temperature must be 55EF and rising. Keep containers tightly closed when not in use. Do not apply if surface temperature is in excess of 140EF. DO NOT ADD WATER. KEEP FROM FREEZING. DO NOT STORE IN HOT SUN.

### 3.3 FORTIFIED PLEXIPAVE

- A. Over all asphalt surfaces three (3) squeegee coats of fortified plexipave shall be applied in succession as soon as the previous coat has dried according to manufacturer=s specifications. All work shall be done by experienced or carefully trained workers. The Contractor shall be accountable at all times for the amount of materials of each color used. Total quantity used for each coat shall be 0.07 to 0.05 gallons per square yard of area for a total of 0.15 to 0.23 gallons per square yard for three coats. Colors shall be as follows:
1. Tennis Courts
    - a. Main Play Area: Light Green
    - b. Foul Area: Florida Green (a dark green)
- B. Do not apply in temperature below 50EF, or when rain or high humidity is imminent. Do not apply if surface temperature is in excess of 140EF. Keep containers tightly closed when not in use.

### 3.4 HI-HIDE PLEXICOLOR LINE PAINT

- A. Paint all game lines as indicated on drawings according to manufacturer=s specifications.
- B. Playing lines shall be opaque white, with no bleed-through of surface color, straight, and of uniform width. No ragged edges will be accepted.
- C. Do not apply paint in temperatures below 50EF, or when rain is imminent.

- D. Apply paint in strict accordance to manufacturer's recommendations. Keep from freezing. Do not store in hot sun. Keep containers tightly closed when not in use.
- E. The Contractor shall arrange for a representative of the surfacing material manufacturer to be present at the start of the work to check installation conditions and instruct the applicators as to proper methods and procedures and also as may be necessary during the course of the work to ensure a satisfactorily completed installation. The application shall be done by thoroughly experienced and skillful workers, in strict accordance with the manufacturer's instructions.

### 3.5 PLAYING LINES

- A. All lines shall be carefully laid out and defined on the surface by chalk markings and tape before being painted and shall be accurately painted within the limits shown on the plans. All surfaces shall be thoroughly cleaned before the lines are painted thereon. All lines shall be double coated, clear and distinct with sharply defined edges. Use of spraying equipment is not allowed. At least half hour shall elapse between the painting of the first and second coats. Unless otherwise indicated, the width of all lines of the courts will be painted two (2) inches wide.

### 3.6 CLEAN-UP

- A. General: Contractor shall remove all surface color materials from benches, backstops, fence posts, rails, chain link fencing, etc., and from dirt or grass areas outside of the slab.
- B. All cans, rags, rollers, brush handles, tape, etc. shall be cleaned up, removed from the site and disposed of by the Contractor.
- C. All excess materials shall be disposed of by the Contractor.

END OF SECTION

## SPORTS EQUIPMENT - SECTION 321824

### PART 1 - GENERAL

#### 1.1 GENERAL DESCRIPTION

- A. The work under this Section shall include all labor, material, equipment, and all else necessary for full compliance with the applicable drawings, specifications and other contract requirements as directed by the Engineer for the installation of the following:

- 1. Tennis Court Nets, Net Posts, and Footings.

#### 1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Excavating, Filling and Grading – Section 31 “Earth Moving”
- B. Bituminous Concrete Paving for Tennis Courts – Section 32 “Tennis Court Surface”

#### 1.3 QUALITY ASSURANCE

- A. Installer shall be a firm having a minimum of five (5) years successful experience in the installation of Sports Equipment similar to the size, scope and complexity of this project as shown and specified and who can demonstrate said experience through documented references.

#### 1.4 SUBMITTALS

- A. Manufacturer's Data & Shop Drawings
  - 1. Submit fabrication data, shop drawings and/or catalogue cuts for each manufactured site furnishing specified.
  - 2. Submit shop drawings for all custom site furnishings specified or illustrated on the drawings, for approval prior to fabrication.
  - 3. Shop drawings shall include, but not be limited to, depicting all materials and fastening methods, sizes and relationships as shown.

#### 1.5 COORDINATION

- A. Coordinate and cooperate with other Contractors to enable the work to proceed as rapidly and efficiently as possible.

## 1.6 SUBSTITUTION AND REJECTION

- A. The Owner reserves the right to reject material or work which does not conform to the Contract Documents. Rejected work shall be removed or corrected at the earliest possible time.

## 1.7 PROTECTION

- A. The Contractor shall be responsible for work until finally inspected and accepted. After delivery and before and after installation, protect work against theft, injury or damage.
- B. The Contractor shall protect work, equipment and material of all other trades from damage that might be caused by this work or workmen and shall pay for all such damage, should it occur.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. All Sports Equipment shall be new and in perfect condition. After award of the Contract, and prior to beginning the work, the Contractor shall submit for approval, two copies of the complete list of materials which he proposes to install. Quantities of materials and equipment need not be included. Deviations from the specifications shall not be allowed.

### 2.2 MATERIALS

- A. Tennis Net Fabric, Posts, and Footings.
  - 1. TN-50 manufactured by Douglas Industries, distributed by Recreation Resources, Kennett Square, PA Tel: 1-800-220-4402
  - 2. Tennis net shall be 42' x 3'-3", 3.5 mm braided polyethylene 1-3/4" square mesh, 320 lb. break strength. Double headband, 6.0 mm cable with 3300 lb. break strength, heavy duty brass grommets and reinforced vinyl bottom and side pockets and dowels. Provide 8 each.
  - 3. Tennis posts shall be Premier SQ-3" square manufactured by Douglas Industries, distributed by Recreation Resources, Tel: 1-800-220-4402. Provide four sets (8 posts).
    - a. Fabrication for net posts shall be forest green acrylic urethane over 11-gauge steel with chrome-plated handle and faceplate plus stainless steel screws. The wind gearing shall be rust resistant plated steel with a case hardened worm gear. Gear ratio shall be 30 to 1. Provide concrete footings 24" sq. by 42" long depth.
    - b. Provide center anchor strap of galvanized steel as per details. Brace shall be 1-1/2" x 3/16" flat galvanized steel with 3/8" diameter galvanized steel bolts. Length of bolts shall be determined on site. Provide

galvanized bolts and nuts as per manufacturer of tennis post and net to secure tennis net. Provide concrete footing 8" diameter by 42" long. Provide 8- each.

D. Miscellaneous Materials

1. Concrete Footings: Refer to Division 2, Section 02520 for concrete footings.

E. Warranty Period: 36 months.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine the subgrade, finished surfaces and installation conditions. Do not commence work until all unsatisfactory conditions are corrected.

3.2 LAYING OUT THE WORK

- A. The trade performing the work of this section assumes full and sole responsibility for the accuracy and correctness of all layouts, lines, levels, grades and other aspects of the work under this section. Layout all work in accordance with the requirements, therefore, as indicated in the drawings.

3.3 INSTALLATION

- A. Locate all sports equipment where indicated on the drawings and attach as detailed on the drawings and as elaborated upon in the specifications and in conformance with manufacturer's recommendation.
- B. Any item locations not specifically detailed in the Contract Documents shall be located at the direction of the Project Consultant.
- C. Clean and touch-up paint all abraded, welded and scratched surfaces with matching paint provided by each site furnishing manufacturer.

3.4 CLEANING

- A. Perform cleaning during installation of the work and upon completion of the work.
- B. Remove from the project site and excess material and equipment at the completion of the work of this section.
- C. Repair damage resulting from installation work.

END OF SECTION

## SECTION 322210 - EROSION AND SEDIMENT CONTROL

### PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 and 2 Specification sections apply to work of this section.

- B. State of Delaware Sediment And Stormwater Regulations, latest edition.
- C. State of Delaware Erosion and Sediment Control Handbook, July 1, 2005.

#### 1.2 SUMMARY

A. This Section includes the following:

- 1. Temporary erosion control devices required during construction.

B. Related Sections include the following:

- 1. Division 31 Section *Site Clearing* for site stripping, grubbing, stripping, and stockpiling topsoil and removal of above and below ground improvements.
- 2. Division 31 Section *Earth Moving* for excavation, grading, fill placement, and backfill of excavations with specified materials.

#### 1.3 DEFINITIONS (NOT USED)

#### 1.4 SUBMITTALS

A. Comply with Division 1 Section *Submittal Procedures*

B. For Approval:

- 1. Product Data: For the following:
  - a. Inlet Filter Protection and pre-fabricated silt fence.
  - b. Geotextile Fabrics
  - c. Erosion Control Matting (SC 150 BN)

C. For Information:

- 1. Materials test report: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
  - a. Classification according to ASTM of all stone and aggregate for use in erosion control devices such as stabilized construction entrances, rock check dams, and silt fence.

#### 1.5 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.

- B. General Intent: In accordance with State of Delaware, Section 1, Title 7, Delaware Code Chapter 40 "Erosion and Sediment Control Act," erosion and sediment control will be minimized during construction of the project by temporary and/or permanent stabilization by seeding and other controls to limit erosion. All erosion and sediment controls shall be constructed and installed as detailed on drawings and as per DNREC's Delaware Erosion & Sediment Control Handbook, July 1, 2005. As part of the base bid contract scope of work Contractor is responsible for installing additional Erosion & Sediment Control (ESC) measures as directed by Certified Construction Reviewer CCR and/or Engineer as construction progresses. The actual ESC measures shown on the plan are the minimum required to start work and install the proposed site improvements. As construction progresses additional ESC items may be required (i.e. dewatering bag, stone check dams, silt tubes, etc.) to comply with the State Sediment and Stormwater Regulations; these ESC items must be installed as directed by CCR and/or Engineer at no additional cost to owner. Contractor is also responsible for maintaining all ESC measures throughout duration of construction including re-seeding disturbed areas and repairing ESC items as directed by CCR and Engineer.
- C. Contractor is responsible for providing all required CCR Services and As-Built Services as specified on the Contract Documents and as required by DNREC.

#### 1.6 PROJECT CONDITIONS (NOT USED)

### PART 2 - PRODUCTS

- 2.1 SILT FENCE (must conform to DNREC ESC Handbook Standards, July 1, 2005):
- 2.2 STABILIZED CONSTRUCTION ENTRANCE (must conform to DNREC ESC Handbook Standards, July 1, 2005)
- A. Stone: Use 2" stone or recycled concrete equivalent
- B. Filter Fabric: Woven or non-woven fabric consisting only of continuous chain polymeric filaments or yarns of polyester. The fabric shall be inert to commonly encountered chemicals and hydrocarbons, and be mildew and rot resistant. Fabric shall be Trevira Spunbond 1135, Mirafi 600X or approved equivalent.

### PART 3 - EXECUTION

- 3.1 INSTALL EROSION CONTROL MEASURES in accordance with the latest issue of Delaware Erosion Control Handbook (effective July 1, 2005) and as shown on drawings.
- 3.2 SILT FENCE: Install in accordance with the latest issue of Delaware Erosion Control Handbook (effective July 1, 2005) and as shown on drawings. Maximum allowable slope length shall be per Delaware Erosion Control Handbook Standards and specifications for silt fence.
- A. Filter cloth to be fastened securely to fence posts with wire ties or staples.

1. Stake size, installation, spacing, and fabric overlap shall conform to the DNREC ESC Handbook details and specifications.
- B. Maintenance shall be performed as needed and material removed when “bulges” develop in the silt fence.

3.3 STABILIZED CONSTRUCTION ENTRANCE:

- A. Length: As required, but not less than 50 feet.
- B. Thickness: Not less than 6 inches.
- C. Width: 10 foot minimum, but not less than the full width at points where ingress or egress occurs.
- D. Surface Water: All surface water flowing or diverted toward construction entrances shall be piped across the entrance. If piping is impractical, a mountable berm with 5:1 slopes will be permitted.
- E. Maintenance: The entrance shall be maintained in a condition, which will prevent tracking or flowing of sediment onto public rights-of-way. This may require periodic top dressing with additional stone as conditions demand and repair and/or cleanout of any measures used to trap sediment. All sediment spilled, dropped, washed or tracked onto public rights-of-way must be removed immediately.
- F. Washing: Vehicle wheels shall be cleaned to remove sediment prior to entrance onto public rights -of-way. When washing is required, it shall be done on an area stabilized with stone and which drains into an approved sediment-trapping device.

END OF SECTION 322210

## SECTION 332510 WATER DISTRIBUTION

### 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 water-distribution piping and specialties outside the building for the following:

- 1. Combined water service and fire-service mains.

#### 1.3 DEFINITIONS

- A. Combined Water Service and Fire-Service Main: Exterior water piping for both domestic-water and fire-suppression piping.
- B. Fire-Service Main: Exterior fire-suppression-water piping.
- C. Fire-Suppression-Water Piping: Interior fire-suppression-water piping.
- D. Water-Distribution Piping: Interior domestic-water piping.
- E. Water Service: Exterior domestic-water piping.
- F. The following are industry abbreviations for plastic materials:
  - 1. PE: Polyethylene plastic.
  - 2. DIP: Ductile Iron Pipe.

#### 1.4 SUBMITTALS

- A. For approval:
  - 1. Pipe and Fittings.
  - 2. Gate Valves and accessories.
  - 3. Tapping Sleeves and Valves.
  - 4. Fire Hydrants.

#### 1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of piping and specialties and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- B. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

C. Piping materials shall bear label, stamp, or other markings of specified testing agency.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade.

F. Protect flanges, fittings, and specialties from moisture and dirt.

#### 1.7 PROJECT CONDITIONS

A. 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 Construction Manager and Owner not less than seven days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Construction Manager's and Owner's written permission.

#### 1.8 COORDINATION

A. Coordinate connection to water supply with Construction Manager.

## 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 Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified.
  2. Products: Subject to compliance with requirements, provide one of the products specified.
  3. 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.
  4. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

### 2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

### 2.3 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: C-900, with mechanical-joint, bell- and plain-spigot end.
1. Mechanical-Joint, Ductile-Iron Fittings: C-900, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - a. Glands, Gaskets, and Bolts: C-900, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Push-on-Joint, Ductile-Iron Pipe: Class 52, with push-on-joint, bell- and plain-spigot end unless grooved or flanged ends are indicated.
1. Push-on-Joint, Ductile-Iron Fittings: Class 52, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - a. Gaskets: Class 52, rubber.

### 2.4 GATE VALVES

- A. AWWA, Cast-Iron Gate Valves:
1. Manufacturers:
    - a. American Cast Iron Pipe Co.; American Flow Control Div.
    - b. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
    - c. Mueller Co.; Water Products Div.
    - d. McWane, Inc.; Clow Valve Co. Div.

- e. McWane, Inc.; Kennedy Valve Div.
  - f. McWane, Inc.; Tyler Pipe; Utilities Div.
  - g. NIBCO INC.
  - h. United States Pipe and Foundry Company.
2. Non-rising Stem Gate Valves 3 Inches (80 mm) and Larger: AWWA C509, resilient seated; bronze stem, iron body and bonnet with epoxy coated interior surfaces, iron disc with epoxy coating and replaceable steel reinforced rubber seat, double O-Ring seal stuffing box, 2" operating nut, open left, 200-psig (1380 kPa) working pressure, mechanical joint ends. Mueller A-2370-20, open left or approved equal.
  3. Valve Boxes: Cast-iron box having top section and cover with lettering "WATER," bottom section with base of size to fit over valve and barrel approximately 5 inches (124 mm) in diameter, and adjustable cast-iron extension of length required for depth of bury of valve. Mueller Type H10360, or approved equal.
  4. Provide one steel tee-handle operating wrench. Wrench shall have tee handle with one pointed end, stem of length to operate deepest valve, and socket-fitting valve-operating nut.

## 2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Tapping-Sleeve Assemblies: Comply with MSS SP-60. Include sleeve and valve compatible with drilling machine.
  1. Manufacturers:
    - a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
    - b. Mueller Co.; Water Products Div.
    - c. International Piping Services Company.
    - d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
    - e. McWane, Inc.; Kennedy Valve Div.
    - f. McWane, Inc.; M & H Valve Company Div.
    - g. United States Pipe and Foundry Company.
  2. Tapping Sleeve: Tapping sleeves shall be a Mueller mechanical joint tapping sleeve model H-615, or approved equal. The sleeve shall be a 2 piece bolted sleeve with flanged outlet for new branch connection. The outlet flange dimensions and drilling shall comply with ANSI B16.1, class 125. Sleeve shall be iron body with 3/4" NPT test plug and shall have a maximum working pressure of 200 psig.
  3. Tapping Valve: Tapping valves shall be a Mueller Double Disc tapping valve model H-667, or approved equal. The valve shall meet or exceed all applicable requirements of ANSI/AWWA C500 standards. The inlet flange shall comply with ANSI B16.1, class 125 drilling, the mechanical joint outlet shall comply with ANSI/AWWA C111 Standards. The valve shall have a bronze mounted iron body, be non-rising stem and have an O-ring sealed stuffing box. The disk assembly shall be a double disc parallel seat with four point wedging mechanism. A 2" square wrench nut shall be provided. The valve shall open left.

## 2.6 FREESTANDING FIRE HYDRANTS

- A. Dry-Barrel Fire Hydrants: Shall comply with ANSI/AWWA C502, shall be dry top design with O-ring sealed oil reservoir. Hydrant shall have a compression type main valve that closes with pressure, shall have a 5-1/4" main valve opening three way (two hose nozzles and one pumper nozzle), shall have a 200 psig maximum working pressure and a 400 psig maximum test pressure, the hydrant shall be Mueller Super Centurion A-423 or approved equal..

1. Manufacturers:

- a. American AVK Co.; Valves & Fittings Div.
- b. American Cast Iron Pipe Co.; American Flow Control Div.
- c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
- d. American Foundry Group, Inc.
- e. Mueller Co.; Water Products Div.
- f. McWane, Inc.; Clow Valve Co. Div.
- g. McWane, Inc.; Kennedy Valve Div.
- h. United States Pipe and Foundry Company.

## PART 3 - EXECUTION

### 3.1 EARTH MOVING

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

### 3.2 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.
- C. Do not use flanges, unions, or keyed couplings for underground piping.
- D. Flanges, unions, keyed couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- E. Underground Water-Service Piping: Use the following piping materials for each size range:

### 3.3 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:
1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.

### 3.4 PIPING INSTALLATION

- A. Install ductile-iron piping according to AWWA C600 and AWWA M41.

- B. Bury piping with depth of cover over top at least 42 inches.

### 3.5 ANCHORAGE INSTALLATION

- A. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
  - 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
- B. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

### 3.6 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

### 3.7 FIRE HYDRANT INSTALLATION

- A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. AWWA-Type Fire Hydrants: Comply with AWWA M17.

### 3.8 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: Test at not less than 1-1/2 times working pressure for 2 hours.
  - 1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
- C. Prepare reports of testing activities.

### 3.9 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
  - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
  - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or as described below:

- a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
  - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
  - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
  - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- B. Prepare reports of purging and disinfecting activities.
- C. After completing drinking fountain installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- D. Clean drinking fountains, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 332510

## SECTION 323113 - CHAIN-LINK FENCES AND GATES

### 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 the following:
  - 1. Chain-Link Fences: Industrial.
  - 2. Gates: Swing.
- B. Related Sections include the following:
  - 1. Division 31 Section "Earth Moving" for site excavation, fill, and backfill where chain-link fences and gates are located.
  - 2. Division 32 Section "Portland Cement Concrete Paving".

#### 1.3 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.
  - 1. Fence and gate posts, rails, and fittings.
  - 2. Chain-link fabric, reinforcements, and attachments.
  - 3. Gates and hardware.
- B. Shop Drawings: Show locations of fences, gates, posts, rails, tension wires, and details of gate swing. Indicate materials, dimensions, sizes, weights, and finishes of components. Include plans, gate elevations, sections, details of post anchorage, attachment, bracing, and other required installation and operational clearances.
- C. Samples for Initial Selection: Manufacturer's color charts or 6-inch (150-mm) lengths of actual units showing the full range of colors available for components with factory-applied color finishes.
- D. Samples for Verification: For each type of chain-link fence and gate indicated.
  - 1. Polymer-coated steel wire (for fabric) in 6-inch (150-mm) lengths.
- E. Qualification Data: For Installer.
- F. Field quality-control test reports.

G. Maintenance Data: For the following to include in maintenance manuals:

1. Polymer finishes.

#### 1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has at least three years experience and has completed at least five chain-link fences and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

1. Engineering Responsibility: Preparation of data for chain-link fences and gates, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

#### 1.5 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

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

1. Chain-Link Fences and Gates:

- a. Master Halco
- b. Sonco Worldwide.

B. Coat selvage ends of fabric that is metallic coated before the weaving process with clean protective coating.

#### 2.2 CHAIN-LINK FENCE FABRIC

A. General: Ten-foot tennis court fencing. Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with ASTM A 392, CLFMI CLF 2445, and requirements indicated below:

- 1. Steel Wire Fabric: Permafused II, polyolefin, color black, 9-gauge, coated wire with a diameter of 0.148 inch.
  - a. Mesh Size: 13/4 inch, twisted on top, knuckled on bottom.

b. Polymer Coating: ASTM D 668, Class 2b over metallic-coated steel wire.

1) Color: Black, complying with ASTM F 934.

2.3 FRAMING

A. Round member sizes are given in actual outside diameter (OD) to the nearest thousandth of inches. Round fence posts and rails are often referred to in ASTM standard specifications by nominal pipe sizes (NPS) or the equivalent trade sizes in inches. The following indicates these equivalents all measured in inches:

<u>Actual OD</u>	<u>NPS Size</u>	<u>Trade Size</u>
1.315	1	1-3/8
1.660	1-1/4	1-5/8
1.900	1-1/2	2
2.375	2	2-1/2
2.875	2-1/2	3
3.500	3	3-1/2
4.000	3-1/2	4
6.625	6	6-5/8
8.625	8	8-5/8

B. Group IA Round Posts: Standard weight (schedule 40) galvanized steel pipe conforming to ASTM F 1083 and ASTM F1043, according to heavy industrial requirements of ASTM F 669, Group IA, not less than 1.8 oz. of zinc per sq. ft. Type A coating inside and outside according to ASTM F 1234, as determined by ASTM A 90, and weights per foot as follows:

<u>Actual OD</u>	<u>Weight (lb/ft)</u>	<u>NPS Size</u>
1.315	1.68	1
1.660	2.27	1-1/4
1.900	2.72	1-1/2
2.375	3.65	2
2.875	5.79	2-1/2
3.500	7.58	3
4.000	9.11	3-1/2
6.625	18.97	6
8.625	28.55	8

C. Group 1C Round Posts: Cold-formed, electric-welded steel pipe conforming to heavy industrial requirements of ASTM F 1043, Group IC, with minimum yield strength of 50,000 psi, either protective coating system below and weights per foot as follows:

1. Coatings: Type B outside with a minimum of 0.9 oz. of zinc per sq. ft. after welding, a chromate conversion coating and a clear polymer overcoat. Type B inside with a minimum of 0.9 oz. of zinc per sq. ft.

<u>Actual OD</u>	<u>Weight (lb/ft)</u>	<u>NPS Size</u>
1.315	1.35	1
1.660	1.84	1-1/4
1.900	2.28	1-1/2
2.375	3.12	2

2.875	4.64	2-1/2
3.500	5.71	3
4.000	6.56	3-1/2

#### 2.4 INDUSTRIAL FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, ASTM F 1083 for Group IC round pipe, and the following:

1. Group: IA, round steel pipe, Schedule 40.
2. Fence Height: 10 feet for perimeter security fence.
3. Post Diameter and Thickness: According to ASTM F 1083.
4. Post Size and Thickness: According to ASTM F 1083, Schedule 40, Group 1A.
  - a. Line Post: 2.375 inches (60 mm), weight 3.65 lb/ft.
  - b. End, Corner and Pull Post: 2.875 inches (73 mm), weight 5.79 lb/ft.
  - c. Swing Gate Post: 3.500 inches outside diameter, according to ASTM F 1184.
    - 1) Openings up to 12 Feet (3.7 m): Steel post, 3.50-inch diameter.
5. Top Rail: 1.660 inches outside diameter.
6. Coating for Steel Framing:
  - a. Metallic Coating:
    - 1) Type A, consisting of not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating per ASTM A 123/A 123M.
    - 2) Type C, Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. (0.55-kg/sq. m) coating.
    - 3) Coatings: Any coating above.
  - b. Polymer coating over metallic coating for eight-foot fence, Permafused II polyolefin.
7. Aluminum Finish: Mill finish complying with ASTM B 429.

#### 2.5 TENSION WIRE

A. General: Provide horizontal tension wire at the following locations:

1. Location: Extended along top and bottom of fence fabric for 10-foot fence.

B. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire complying with ASTM A 817, ASTM A 824, and the following:

1. Metallic Coating: Type II, zinc coated (galvanized) by hot-dip or electrolytic process, with the following minimum coating weight:
  - a. Class 2: Not less than 2.0 oz./sq. ft. of uncoated wire surface for ten-foot fences.

- b. Matching chain-link fabric coating weight for 10-foot tennis court fence.

## 2.6 INDUSTRIAL SWING GATES

- A. General: Comply with ASTM F 900 for single and double swing gate types.
  - 1. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F 1043 and ASTM F 1083 for materials and protective coatings.
  - 2. Metal Pipe and Tubing: Aluminum. Comply with ASTM B 429 and ASTM F 1043 for materials and protective coatings.
- B. Frames and Bracing: Fabricate members from round, galvanized steel tubing with outside dimension and weight according to ASTM F 900 and the following:
  - 1. Gate Fabric Height: As shown on drawings.
  - 2. Leaf Width: Four feet.
  - 3. Frame Members:
    - a. Tubular Steel, 1.90 inches (48 mm) round.
- C. Frame Corner Construction:
  - 1. Welded, adjustable truss rods for panels 5 feet (1.52 m) wide or wider.
- D. Hardware: Latches permitting operation from both sides of gate, hinges, center gate stops and keepers for each gate leaf more than 5 feet (1.52 m) wide. Fabricate latches with integral eye openings for padlocking.

## 2.7 FITTINGS

- A. General: Comply with ASTM F 626.
- B. Post and Line Caps: Provide for each post.
  - 1. Line post caps with loop to receive tension wire or top rail.
- C. Rail and Brace Ends: Attach rails securely to each gate, corner, pull, and end post.
- D. Rail Fittings: Provide the following:
  - 1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches (152 mm) long.
  - 2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate rails in the fence line-to-line posts.
- E. Tension and Brace Bands: Pressed steel.
- F. Tension Bars: Steel, length not less than 2 inches (50 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

- G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.
- H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
  - 1. Standard Round Wire Ties: Same gauge as fence fabric twisted three times, for attaching chain-link fabric to posts, rails, and frames, matching coating and material of fabric, and complying with the following:
    - a. Hot-Dip Galvanized Steel: galvanized coating and PVC thickness matching coating thickness of chain-link fence fabric.
- I. Finish:
  - 1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. (366 g /sq. m) zinc.

## 2.8 CAST-IN-PLACE CONCRETE

- A. Materials: Portland cement complying with ASTM C 150, Type I aggregates complying with ASTM C 33, and potable water for ready-mixed concrete complying with ASTM C 94/C 94M. Measure, batch, and mix Project-site-mixed concrete according to ASTM C 94/C 94M.
  - 1. Concrete Mixes: Normal-weight concrete air entrained with not less than 3000-psi (20.7-MPa) compressive strength (28 days), 3-inch (75-mm) slump, and 1-inch (25-mm) maximum size aggregate.
- B. Materials: Dry-packaged concrete mix complying with ASTM C 387 for normal-weight concrete mixed with potable water according to manufacturer's written instructions.

## 2.9 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

## 2.10 POLYMER FINISHES

- A. Supplemental Color Coating: Provide fence components with polymer coating for 10-foot tennis court fence, Permafused II polyolefin, 6-mil – 10-mil thickness.
- B. Metallic-Coated Steel Tension Wire: PVC-coated wire complying with ASTM F 1664, Class 2b.

- C. Metallic-Coated Steel Framing and Fittings: Comply with ASTM F 626 and ASTM F 1043 for polymer coating applied to exterior surfaces and, except inside cap shapes, to exposed interior surfaces.
  - 1. Polymer Coating: Not less than 6-mil – 10-mil, Permafused II, polyolefin finish.
- D. Color: As selected by Architect from manufacturer's full range, complying with ASTM F 934.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance.
  - 1. Do not begin installation before final grading is completed, unless otherwise permitted by Architect.
  - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

### 3.3 INSTALLATION, GENERAL

- A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements specified.
  - 1. Install fencing on established boundary lines inside property line.

### 3.4 CHAIN-LINK FENCE INSTALLATION

- A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil. Place concrete footing below 3" bituminous court surface.
  - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
  - 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
    - a. Concealed Concrete: Top 2 inches (50 mm) below grade as indicated on Drawings to allow covering with surface material.

- C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.
- D. Line Posts: Space line posts uniformly at 10 feet o.c.
- E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Install braces at end and gate posts and at both sides of corner and pull posts.
  - 1. Locate horizontal braces at midheight of fabric 6 feet (1.83 m) or higher, on fences with top rail and at 2/3 fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
- F. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- (3.05-mm-) diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (610 mm) o.c. Install tension wire in locations indicated before stretching fabric.
  - 1. Bottom Tension Wire: Install tension wire within 6 inches (150 mm) of bottom of fabric and tie to each post with not less than same diameter and type of wire.
- G. Top Rail: Where shown on drawings, install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
- H. Bottom Rails: Where shown on drawings, install, spanning between posts.
- I. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1 inch between finish grade or surface and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- J. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches (380 mm) o.c.
- K. Tie Wires: Use wire of same gauge and material as fabric (9-gauge) proper length to firmly secure fabric to line posts and rails. Wrap wire around post a minimum of 360 degrees, and twist ends together per ASTM F 626 (manually fastened round tie wire). Twist ends of wire three times to minimize hazard to individuals and clothing, and remove excess.
  - 1. Maximum Spacing: Tie fabric to line posts at 12 inches (300 mm) o.c. and to braces at 24 inches (610 mm) o.c.
- L. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

### 3.5 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.
- B. Excavation for Concrete Bases/Pads: Hand-excavate holes for bases/pads, in firm, undisturbed soil to dimensions and depths and at locations as required by gate-operator component manufacturer's written instructions and as indicated.
- C. Concrete Bases/Pads: Cast-in-place or precast concrete, see Drawings.

### 3.6 GROUNDING AND BONDING

- A. Fence Grounding: Install at maximum intervals of 1500 feet (450 mm) except as follows:
  - 1. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.
- B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.
- C. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
  - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
  - 2. Make connections with clean, bare metal at points of contact.
  - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  - 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
  - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

### 3.7 FIELD QUALITY CONTROL

- A. Grounding-Resistance Testing: Engage a qualified independent testing and inspecting agency to perform field quality-control testing.
  - 1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.

2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
3. Report: Prepare test reports certified by a testing agency of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

3.8 CLEANING

- A. Remove from the project site any excess material and equipment at the completion of the work of this section.

END OF SECTION

## SECTION 329200 - TURF AND GRASSES

### PART 1 - GENERAL

All permanent and temporary seeding mixes and mulching requirements will be as per DNREC Sediment and Stormwater regulations and the Delaware Erosion and Sediment Control Handbook dated July 1, 2005, and as detailed on the plans in the "Permanent Stabilization" and "Temporary Stabilization" specifications.

#### 1.01 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the Work specified in this Section.

#### 1.02 SECTION INCLUDES

- A. Refer to Scope Information Sheets for this contract bound in the Project Manual. The Scope Information Sheets describe generally the work included in each contract, but the work is not necessarily limited to that described.

#### 1.03 SUMMARY

- A. This Section includes the following:

1. Seeding.
2. Soil amendments.
3. Initial maintenance.
4. Warranties.

- B. Related Sections include the following:

1. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.

#### 1.04 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.
- D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

#### 1.05 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- C. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.
- D. Material Test Reports: For existing surface soil and imported topsoil.
- E. Maintenance Instructions: Recommended procedures to be established by the Owner for maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods.

#### 1.06 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment over the minimum of five years on projects of similar scope and size.
  - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
  - 1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

#### 1.08 SCHEDULING

- A. Planting Restrictions: Plant lawn seed mix during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
  - 1. Spring Planting: April 15 to May 30.
  - 2. Fall Planting: September 1 to October 15.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.09 LAWN MAINTENANCE

- A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:
  - 1. Seeded Lawns: 60 days from date of Substantial Completion and until minimum 90% germination.
    - a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.
- B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
  - 1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.
- C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches.
  - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
  - 2. Water seeded lawn at a minimum rate of 1 inch per week.
  - 3. Water every other day the second week with 1 inch of water; and
  - 4. Water the third week twice at ½ inch of water each time.
- D. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
  - 1. Mow grass at least three times.
  - 2. Mow grass 2 to 2-1/2 inches high.

1.010 SPECIAL PROJECT WARRANTY

- A. Warranty lawns through the specified maintenance period, and until final acceptance.

PART 2 - PRODUCTS

2.01 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species: State-certified seed of grass species, as follows:

- C. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
  - 1. DNREC Permanent Seeding Mix (See plans for mix design – Place seeding per DNREC specifications).
  - 2. DNREC Temporary Seeding Mix (See plans for mix design – Place seeding per DNREC specifications).

## 2.02 TOPSOIL

- A. Topsoil: pH range of 5.8 to 6.5, a minimum of 2 percent organic material content; free of stones 1 inch or larger in any dimension and meeting the following requirements.
  - 1. Size: 100 percent passing through a 3/4-inch sieve; 90 to 100 percent passing through a #4 sieve; and 0 to 100 percent passing through a #200 sieve.
  - 2. Sand Content: 2.000 mm to 0.05 mm, 40 to 50 percent.
  - 3. Silt Content: 0.05 mm to 0.005 mm, 30 to 40 percent.
  - 4. Clay Content: 0.005 mm and smaller, 10 to 30 percent.
  - 5. Topsoil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
    - a. Supplement with imported or manufactured topsoil from local off-site sources when onsite quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

## 2.03 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural limestone containing a minimum 90 percent calcium carbonate with a minimum of 10 percent magnesium. Apply a minimum of 50 pounds per 1,000 sq. ft.
- B. Aluminum Sulfate: Commercial grade, unadulterated.
- C. Perlite: Horticultural perlite, soil amendment grade.
- D. Sand: Clean, washed, natural or manufactured, free of toxic materials.

## 2.04 ORGANIC SOIL AMENDMENTS

- A. Peat: Finely divided so completely decomposed and free of fibers that its biological identity is lost. Provide in granular form, free of hard lumps and with a pH range suitable for intended use.
- B. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

## 2.05 FERTILIZER

- A. Phosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid and 20 percent potash having a formula 0-20-20, applied to lawn areas at the rate of 50 pounds per 1,000 sq. ft. of area.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Composition: 10 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight at 12 pounds per 1,000 sq. ft. in areas not hydromulched.
  - 2. For hydromulch mixtures: Kapco 38-0-0 urea form nitrogen fertilizer at the rate of ten pounds per 1,000 sq. ft.

#### 2.06 MULCHES

- A. Fiber Mulch: As per DNREC details.
- B. Tackifier: As per DNREC details.

#### 2.07 HYDROMULCH GRASS MIXTURE

- A. Provide hydromulch mixture according to the following formula:
  - 1. Grass seed mix specified at eight pounds per 1,000 sq. ft.
  - 2. Kapco 38-0-0 Urea Form nitrogen fertilizer at the rate of ten pounds per 1,000 sq. ft.
  - 3. Tackifier.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.02 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
  - 1. Protect adjacent and adjoining areas from hydroseeding overspray.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

#### 3.03 LAWN PREPARATION

- A. Limit lawn subgrade preparation to areas to be planted.

- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
  - 1. Apply 0-20-20 fertilizer at 50 pounds per 1,000 sq. ft.
  - 2. Spread topsoil, apply lime and fertilizer on surface, and thoroughly blend soil mix.
- C. Changed subgrades to be topsoiled. Spread topsoil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
  - a. Spread approximately one-half the thickness of topsoil over loosened subgrade. Spread remainder of topsoil.
  - b. Reduce elevation of planting soil to allow for soil thickness of any sod.
  - c. Spread lime, 0-20-20 and fertilizer, rototill into the top four inches of soil.
- D. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:
  - 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
  - 2. Loosen surface soil to a depth of at least of 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
    - a. Apply 0-20-20, lime, and other fertilizer directly to surface soil before loosening.
  - 3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
  - 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- E. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future. The maximum compaction for the lawn area is 80%.
- F. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- G. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

### 3.04 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
  - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
- B. Sow seed at the rate of 8 pounds per 1,000 sq. ft.

- C. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray.
- D. Protect seeded areas by spreading wood fiber mulch. Spread uniformly at a minimum rate of 60 pounds per 1,000 sq. ft. (2,600 pounds per acre) with tackifier to form a continuous blanket over seeded areas. Spread by hand, hydromulcher, or other suitable equipment.

### 3.05 HYDROSEEDING

- A. Presoak areas by water truck or other approved method to a depth of three inches immediately prior to hydromulch installation.
- B. Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
- C. Begin slurry preparation by adding water to the tank when the engine is at 1/2 throttle. When the water level has reached the height of the agitator shaft, and good recirculation has been established, add fertilizer to the mixture (the tank will be at least 1/3 filled with water at this time). Open the engine throttle to full speed when the tank is 1/2 filled with water, then add mulch by the time the tank is 2/3 to 3/4 full. At 3/4 full, add seed.
- D. Begin spraying immediately when the tank is full and slurry is mixed.
- E. Apply the slurry in a downward drilling motion via a fan stream nozzle ensuring that all of the components enter and mix with the soil to a depth of two inches.
- F. After planting operations are finished, clean all paved areas which have become strewn with soil or other material by sweeping and, if necessary, washing.
- G. Limitations: If slurry components are left for more than two hours in the hydromulch machine, add 50 percent more of the originally specified seed mix. Add 75 percent more of the original seed mix to any slurry mixture that has not been applied within six hours after mixing. If slurry mixture has not been applied within eight hours of mixing, it will be considered rejected. Dispose of such mixture off site at no extra cost to the Owner.

### 3.06 SATISFACTORY LAWNS

- A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. Bare spots will be reseeded until the grass is a close uniform stand.
- B. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.
- C. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

### 3.07 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

- B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.
- C. Remove erosion-control measures after grass establishment period.

END OF SECTION 329200

## SECTION – 334100 STORM DRAINAGE AND SANITARY SEWERAGE

### 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 gravity-flow storm drainage and sanitary sewer outside the building, with the following components:
  - 1. PVC storm and sanitary pipe and fittings
  - 2. RCP storm pipe and flared end section
  - 3. Cleanouts.
  - 4. Drains.
  - 5. Pre-cast concrete catch basins and manholes.
  - 6. Pre-cast concrete pond outlet structure

#### 1.3 DEFINITIONS

- A. RCP: Reinforced concrete pipe
- B. PVC: Polyvinyl chloride plastic.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, pipe joints shall be at least silt-tight, unless otherwise indicated.

#### 1.5 SUBMITTALS

- A. Product Data: For the following:
  - 1. RCP pipe and fittings.
  - 2. Cleanouts
  - 3. PVC SDR-26 piping and fittings
  - 4. Reinforced concrete flared end sections
  - 5. Storm and Sanitary structures (manholes, manhole seals, catch basins, etc.)
- B. Shop Drawings: For the following:
  - 1. Manholes: Include plans, elevations, sections, details, and frames and covers. Include design calculations, and concrete design-mix report for cast-in-place manholes.
  - 2. Catch Basins: Include plans, elevations, sections, details, and frames, covers, and grates.
  - 3. Junction Boxes: Include plans, elevations, sections, details, frames, and covers.
  - 4. HDPE to Concrete Connection: Provide ADS specifications or approved equal (as per drawing detail).

- C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- D. Field quality-control test reports.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.
- D. Handle catch basins according to manufacturer's written rigging instructions.

#### 1.7 PROJECT CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
  - 1. Notify Construction Manager no fewer than two days in advance of proposed interruption of service.
  - 2. Do not proceed with interruption of service without Construction Manager's written permission.

### 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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

#### 2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

#### 2.3 PE PIPE AND FITTINGS

- A. Corrugated PE Pipe and Fittings: AASHTO M 294M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
2. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

#### 2.4 PVC PIPE AND FITTINGS

- A. PVC Sewer Pipe and Fittings, 4" to 15" diameter: ASTM D 3034, SDR-26 with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.
- B. PVC Sewer Pipe and Fittings, 18" diameter and Larger: ASTM F 679, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

#### 2.5 CONCRETE PIPE AND FITTINGS

- A. Reinforced-Concrete Sewer Pipe (RCP) and Fittings: ASTM C 76, with bell-and-spigot ends and gasketed joints with ASTM C 443, rubber gaskets.

#### 2.6 NONPRESSURE-TYPE PIPE COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
  1. For Concrete Pipes: ASTM C 443, rubber.
  2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
  3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

#### 2.7 CLEANOUTS

- A. Gray-Iron Cleanouts (paved areas): ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
  1. Manufacturers:
    - a. Josam Company.
    - b. MIFAB Manufacturing, Inc.
  2. Top-Loading Classification(s): Heavy duty.
  3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
- B. PVC Cleanouts (lawn areas): Schedule-40 PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.
  1. Manufacturers:
    - a. IPS Corporation.
    - b. NDS Inc.

## 2.8 DRAINAGE STRUCTURES

- A. Standard Precast Concrete Manholes, Junction Boxes, and Catch Basins: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
1. Diameter: 48 inches minimum, unless otherwise indicated.
  2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
  3. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
  4. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
  5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
  6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
  7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
  8. Steps: Individual FRP steps wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 48 inches.
  9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
  10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
  11. Protective Coating: Plant-applied, SSPC-Paint 16, coal-tar 10-mil minimum thickness applied to exterior and interior surfaces.
  12. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

## 2.9 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
1. Cement: ASTM C 150, Type II.
  2. Fine Aggregate: ASTM C 33, sand.
  3. Coarse Aggregate: ASTM C 33, crushed gravel.
  4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water-cementitious materials ratio.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
  2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.
- C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water-cementitious materials ratio.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
  2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

## 2.10 PIPE OUTLETS

- A. Head Walls (N/A): Cast-in-place reinforced concrete, with apron and tapered sides.
- B. Riprap Stilling Basins (N/A): Place as per DNREC standards and drawing detail with rip-rap size and thickness as specified on drawings.
- C. Filter Stone: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.

## 2.11 STORMWATER INLETS

- A. Gutter Inlets: Made with horizontal gutter openings as per DeIDOT standards. Include heavy-duty frames and Type 3 Bicycle Safe grates.
- B. Combination Inlets: Made with vertical curb and horizontal gutter openings as per DeIDOT standards. Include heavy-duty frames and Type 3 Bicycle Safe grates.
- C. Frames and Grates: Heavy duty frames and Type 3 Bicycle Safe grates.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Division 2 Section "Earthwork."

### 3.2 PIPING APPLICATIONS

- A. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
  - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
    - a. Flexible or rigid couplings for same or minor difference OD pipes.
    - b. Unshielded, increaser/reducer-pattern, flexible or rigid couplings for pipes with different OD.
    - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
  - 2. Use pressure-type pipe couplings for force-main joints.
- B. Special Pipe Fittings: Use for pipe expansion and deflection. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
- C. Gravity-Flow, Nonpressure Sewer Piping: Use the following pipe materials for each size range:
  - 1. Reinforced-concrete sewer pipe and fittings, gaskets, and gasketed joints.
  - 2. PVC sewer pipe and fittings, gaskets, and gasketed joints (NPS 4 and NPS 6).

3. PVC sewer pipe and fittings, gaskets, and gasketed joints (NPS 8 to NPS 12).

### 3.3 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.
- F. Install gravity-flow, nonpressure drainage piping according to the following:
  1. Install piping pitched down in direction of flow, at minimum slope of 0.005 ft/ft, unless otherwise indicated on plans.
  2. Install PE corrugated sewer piping according to CPPA's "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."
  3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
  4. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

### 3.4 PIPE JOINT CONSTRUCTION

- A. Basic pipe joint construction is specified in Division 2 Section "Piped Utilities - Basic Materials and Methods." Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
- B. Join gravity-flow, nonpressure drainage piping according to the following:
  1. Join corrugated PE piping according to CPPA 100 and the following:
    - a. Use silttight couplings for Type 1, silttight joints.
    - b. Use soiltight couplings for Type 2, soiltight joints.
  2. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric gasket joints.
  3. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
  4. Join dissimilar pipe materials with nonpressure-type flexible or rigid couplings.

- C. Join dissimilar pipe materials with pressure-type couplings.

### 3.5 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
  - 1. Use Medium-Duty, top-loading classification cleanouts in **earth or unpaved/paved foot-traffic** areas.
  - 2. Use Heavy-Duty, top-loading classification cleanouts in loading/**vehicle-traffic service** areas.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep (or as per drawing detail). Set with tops 1 inch above surrounding earth grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

### 3.6 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections according to ASTM C 891.
- C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere, unless otherwise indicated.

### 3.7 CATCH BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

### 3.8 DRAIN INSTALLATION

- A. Install type of drains in locations indicated.
  - 1. Use Light-Duty, top-loading classification drains in [earth or unpaved foot-traffic areas.
  - 2. Use Medium-Duty, top-loading classification drains in paved foot-traffic areas.
  - 3. Use Heavy-Duty, top-loading classification drains in loading/vehicle-traffic service areas.
  - 4. Use Extra-Heavy-Duty, top-loading classification drains in [roads] <Insert area>.
- B. Embed drains in 6-inch minimum concrete around bottom and sides (see drawing detail).
- C. Fasten grates to drains if indicated.
- D. Set drain frames and covers with tops flush with pavement surface.
- E. Assemble trench sections with flanged joints.

- F. Embed trench sections in 6-inch minimum concrete around bottom and sides (see drawing detail).

### 3.9 STORM PIPE OUTLET INSTALLATION

- A. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

### 3.10 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318/318R.

### 3.11 STORMWATER INLET AND OUTLET INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Construct riprap of broken stone, as indicated.
- C. Install outlets that spill onto grade, anchored with concrete, where indicated.
- D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- E. Construct energy dissipaters at outlets, as indicated.

### 3.12 DRAINAGE SYSTEM INSTALLATION

- A. Assemble and install components according to manufacturer's written instructions.
- B. Install with top surfaces of components, except piping, flush with finished surface.
- C. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.

### 3.13 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."
- B. Connect force-main piping to building's storm drainage force mains specified in Division 22 Section "Facility Storm Drainage Piping." Terminate piping where indicated.
- C. Make connections to existing piping and underground manholes.
  - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
  - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
    - a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
    - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
  4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- D. Connect to sediment interceptors specified in Division 22 Section "Sanitary Waste Interceptors."
- E. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
    - a. Flexible couplings for same or minor difference OD pipes.
    - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
    - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
  2. Use pressure-type pipe couplings for force-main joints.
- 3.14 CLOSING ABANDONED STORM DRAINAGE SYSTEMS
- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
  2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:
1. Remove manhole or structure and close open ends of remaining piping.

2. Remove top of manhole or structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

- C. Backfill to grade according to Division 31 Section "Earth Moving."

### 3.15 IDENTIFICATION

- A. Materials and their installation are specified in division 2 Section "Earthwork." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use detectable warning tape over nonferrous piping and over edges of underground structures.

### 3.16 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
  - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
  - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
  - c. Crushed, broken, cracked, or otherwise damaged piping.
  - d. Infiltration: Water leakage into piping.
  - e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

### 3.17 CLEANING

- A. Clean interior of piping, flared end sections, and structures of dirt and superfluous materials as directed by CCR and Engineer.

END OF SECTION 334100

## SECTION 055000 - METAL FABRICATIONS

### 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. Steel framing and supports for operable partitions.
2. Steel framing and supports for overhead doors and grilles.
3. Steel framing and supports for countertops.
4. Steel framing and supports for mechanical and electrical equipment.
5. Steel framing and supports for applications where framing and supports are not specified in other Sections.
6. Elevator machine beams and hoist beams.
7. Steel shapes for supporting elevator door sills.
8. Shelf angles.
9. Metal ladders.
10. Ladder safety cages.
11. Alternating Tread Devices and pipe crossovers.
12. Structural-steel door frames.
13. Miscellaneous steel trim including steel angle corner guards and steel edgings.
14. Metal bollards.
15. Loose bearing and leveling plates for applications where they are not specified in other Sections.

- B. Products furnished, but not installed, under this Section:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

- C. Related Sections:

1. Division 03 Section "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Division 04 Section "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
3. Division 05 Section "Structural Steel Framing."
4. Division 05 Section "Metal Stairs."
5. Division 05 Section "Pipe and Tube Railings."

6. Division 05 Section "Decorative Metal Railings."

1.3 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
1. Nonslip aggregates and nonslip-aggregate surface finishes.
  2. Metal nosings.
  3. Paint products.
  4. Grout.
- B. Shop Drawings: Show fabrication and installation details for metal fabrications.
1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
- C. Samples for Verification: For each type and finish of extruded nosing.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  3. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication. Before installation, verify that miscellaneous braces, anchors, clips, etc. will not be exposed to view in finished construction.

## 1.8 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete where applicable. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

## PART 2 - PRODUCTS

### 2.1 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

### 2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304 .
- C. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- D. Steel Tubing: ASTM A 500, cold-formed steel tubing.
- E. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.
- F. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
  - 1. Size of Channels: 1-5/8 by 1-5/8 inches (41 by 41 mm) or as required for application.
  - 2. Material: Galvanized steel, ASTM A 653/A 653M, with G90 (Z275) coating; 0.108-inch (2.8-mm), 0.079-inch (2-mm), or 0.064-inch (1.6-mm) nominal thickness as required for application.
  - 3. Material: Cold-rolled steel, ASTM A 1008/A 1008M, commercial steel, Type B; 0.0966-inch (2.5-mm), 0.0677-inch (1.7-mm), or 0.0528-inch (1.35-mm) thickness as required for application; coated with rust-inhibitive, baked-on, acrylic enamel.
- G. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

## 2.3 NONFERROUS METALS

- A. Aluminum Plate and Sheet: **ASTM B 209** (**ASTM B 209M**), Alloy 6061-T6.
- B. Aluminum Extrusions: **ASTM B 221** (**ASTM B 221M**), Alloy 6063-T6.

## 2.4 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or **ASTM F 1941** (**ASTM F 1941M**), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
  - 1. Provide stainless-steel fasteners for fastening aluminum.
  - 2. Provide stainless-steel fasteners for fastening stainless steel.
- B. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
- C. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
  - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or **ASTM F 1941** (**ASTM F 1941M**), Class Fe/Zn 5, unless otherwise indicated.
  - 2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (**A1**) stainless-steel bolts, **ASTM F 593** (**ASTM F 738M**), and nuts, **ASTM F 594** (**ASTM F 836M**).
- E. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, **1-5/8 by 7/8 inches** (**41 by 22 mm**) by length indicated with anchor straps or studs not less than **3 inches** (**75 mm**) long at not more than **8 inches** (**200 mm**) o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

## 2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Division 09 painting Sections.

- C. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
  - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- F. Nonshrink, Metallic Grout: Factory-packaged, ferrous-aggregate grout complying with ASTM C 1107, specifically recommended by manufacturer for heavy-duty loading applications.
- G. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- H. Concrete: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of **3000 psi (20 MPa)**.

## 2.6 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. 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.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.

- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
  - 1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, **1/8 by 1-1/2 inches (3.2 by 38 mm)**, with a minimum **6-inch (150-mm)** embedment and **2-inch (50-mm)** hook, not less than **8 inches (200 mm)** from ends and corners of units and **24 inches (600 mm)** o.c., unless otherwise indicated.

## 2.7 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
  - 1. Fabricate units from slotted channel framing where indicated.
  - 2. Furnish inserts for units installed after concrete is placed.
- C. Fabricate supports for operable partitions from continuous steel beams of sizes recommended by partition manufacturer with attached bearing plates, anchors, and braces as recommended by partition manufacturer. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.
- D. Galvanize miscellaneous framing and supports where exposed to moisture or humidity.

## 2.8 METAL LADDERS

- A. General:
  - 1. Comply with ANSI A14.3 unless otherwise indicated.
  - 2. For elevator pit ladders, comply with ASME A17.1.
- B. Steel Ladders:

1. Space siderails **18 inches (457 mm)** apart unless otherwise indicated.
2. Space siderails of elevator pit ladders **12 inches (300 mm)** apart.
3. Siderails: Continuous, **3/8-by-2-1/2-inch (9.5-by-64-mm)** steel flat bars, with eased edges.
4. Rungs: **3/4-inch- (19-mm-)** minimum diameter steel bars.
5. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
6. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
7. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than **3/4 inch (19 mm)** in least dimension.
8. Support each ladder at top and bottom and not more than **60 inches (1500 mm)** o.c. with welded or bolted steel brackets.
9. Galvanize exterior ladders, including brackets and fasteners.
10. Shop prime interior ladders, including brackets and fasteners.

## 2.9 LADDER SAFETY CAGES

### A. General:

1. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless-steel fasteners.
2. Provide primary hoops at tops and bottoms of cages and spaced not more than **20 feet (6 m)** o.c. Provide secondary intermediate hoops spaced not more than **48 inches (1200 mm)** o.c. between primary hoops.
3. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless-steel fasteners unless otherwise indicated.

### B. Steel Ladder Safety Cages:

1. Primary Hoops: **1/4-by-4-inch (6.4-by-100-mm)** flat bar hoops.
2. Secondary Intermediate Hoops: **1/4-by-2-inch (6.4-by-50-mm)** flat bar hoops.
3. Vertical Bars: **3/16-by-1-1/2-inch (4.8-by-38-mm)** flat bars secured to each hoop.
4. Galvanize exterior ladder safety cages, including brackets and fasteners.
5. Shop prime interior ladder safety cages, including brackets and fasteners.

## 2.10 ALTERNATING TREAD DEVICES

### A. Alternating Tread Devices: Fabricate alternating tread devices to comply with ICC's International Building Code. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

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

- a. Lapeyre Stair Inc.
  - b. Schmidt Structural Products; a subsidiary of Penco Products, Inc.
  - c. Approved equal.
2. Fabricate from steel and assemble by welding or with stainless-steel fasteners.
- a. Treads: 13 Gauge AISI 1010/15 HRPO per ASTM A569 / A1011 grade 36 (or higher).
  - b. Landing & Foot Stampings: 11 Gauge AISI 1010/15 per ASTM A569 / A1011 grade 36 (or higher).
  - c. Top Landing Support Clips: L2 x 2 x 1/4" x 4" lg. with 5/8"  $\Phi$  round holes and 5/8" x 1" slot holes, ASTM A569/A1011 grade 36 (or higher)
  - d. Stringers:
    1. 2" x 1 3/4" x 11 Gauge U section; AISI 1010/15 per ASTM A569/A1011 grade 36 (or higher) for 56 degree stairs under 10 vertical feet and for 68 degree stairs under 12 vertical feet.
    2. 3" x 1 3/4" x 11 Gauge U section; AISI 1010/15 per ASTM A569/A1011 grade 36 or higher for 56 degree stairs over 10 vertical feet and for 68 degree stairs over 12 vertical feet.
  - e. Handrails: 1 1/2" OD x 0.095" AISI 1010/15 CS per ASTM A569/A1011 cold drawn, fully annealed tube per ASTM A513 grade 1008 or higher As-welded tubing or ASTM A500 Grade B.
3. Comply with applicable railing requirements in Division 05 Section "Pipe and Tube Railings."
- B. Galvanize exterior steel alternating tread devices, including treads, railings, brackets, and fasteners.
- C. Prime steel alternating tread devices, including treads, railings, brackets, and fasteners, with zinc-rich primer. Provide Polyester Powder coat finish.
- D. Provide sway bracing for alternating tread stairs in excess of a 15' vertical rise and support bracing at all platforms.
- E. Performance requirements as follows:
1. Alternating Tread Stair Treads: shall be capable of withstanding a single concentrated 1000 pound load without permanent deformation; or 100 pounds per square foot or 300 pounds on an area of 4 square inches without exceeding the allowable working stress of the material.
  2. Alternating Tread Stair Stringers: shall be capable of withstanding a single concentrated load of 1000 pounds at any point on the stair without permanent deformation; or a uniform live loading of 100 pounds per square foot applied in a downward direction to all

tread surfaces or a 300 pound load on an area of 4 square inches without exceeding the allowable working stress of the material.

#### 2.11 STRUCTURAL-STEEL DOOR FRAMES

- A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with **5/8-by-1-1/2-inch (16-by-38-mm)** steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than **10 inches (250 mm)** o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.
  - 1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.
- B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.
- C. Galvanize exterior steel frames.
- D. Shop prime interior steel frames.

#### 2.12 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
  - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize exterior miscellaneous steel trim.
- D. Shop prime miscellaneous steel trim.

#### 2.13 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 40 steel pipe.
  - 1. Fill bollards with concrete during installation and dome top.
- B. Fabricate sleeves for bollard anchorage from steel pipe or tubing with **1/4-inch- (6.4-mm-)** thick steel plate welded to bottom of sleeve. Make sleeves not less than **8 inches (200 mm)** deep and **3/4 inch (19 mm)** larger than OD of bollard.

- C. Fabricate internal sleeves for removable bollards from Schedule 40 steel pipe or **1/4-inch (6.4-mm)** wall-thickness steel tubing with an OD approximately **1/16 inch (1.5 mm)** less than ID of bollards. Match drill sleeve and bollard for **3/4 inch (19 mm)** steel machine bolt.
- D. Prime bollards with zinc-rich primer.

#### 2.14 ABRASIVE METAL NOSINGS

- A. Cast-Metal Units: Cast aluminum, with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Safety Tread Co., Inc.
    - b. Balco Inc.
    - c. Barry Pattern & Foundry Co., Inc.
    - d. Granite State Casting Co.
    - e. Safe-T-Metal Company, Inc.
    - f. Wooster Products Inc.
  - 2. Nosings: Cross-hatched units, **4 inches (100 mm)** wide with **1/4-inch (6-mm)** lip, for casting into concrete steps.
- B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- C. Drill for mechanical anchors and countersink. Locate holes not more than **4 inches (100 mm)** from ends and not more than **12 inches (300 mm)** o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.
  - 1. Provide two rows of holes for units more than **5 inches (125 mm)** wide, with two holes aligned at ends and intermediate holes staggered.
- D. Apply bituminous paint to concealed surfaces of cast-metal units.

#### 2.15 METAL DOWNSPOUT BOOTS

- A. Provide downspout boots made from cast iron, with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.
  - 1. Outlet: Vertical, to discharge into pipe.
- B. Prime cast iron downspout boots with zinc-rich primer.

2.16 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize plates.
- C. Prime plates with zinc-rich primer.

2.17 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than **8 inches (200 mm)** unless otherwise indicated.
- C. Galvanize loose steel lintels located in exterior walls.

2.18 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 strap anchors for embedding in concrete.

2.19 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.
- C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.20 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
  - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

- B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
- C. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
  - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

## 2.21 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: 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 exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
  - 1. Cast Aluminum: Heavy coat of bituminous paint.

### 3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

### 3.3 INSTALLING METAL BOLLARDS

- A. Fill bollards solidly with concrete and dome tops for drainage.
  - 1. Do not fill removable bollards with concrete.
- B. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete or in formed or core-drilled holes not less than **8 inches (200 mm)** deep and **3/4 inch (19 mm)** larger than OD of bollard. Fill annular space around bollard solidly with nonshrink, nonmetallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately **1/8 inch (3 mm)** toward bollard.
- C. Anchor internal sleeves for removable bollards in concrete by inserting into pipe sleeves preset into concrete. Fill annular space around internal sleeves solidly with nonshrink, nonmetallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately **1/8 inch (3 mm)** toward internal sleeve.
- D. Place removable bollards over internal sleeves and secure with **3/4-inch (19-mm)** machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. Owner will furnish padlocks.
- E. Fill bollards solidly with concrete, mounding top surface to shed water.
  - 1. Do not fill removable bollards with concrete.

### 3.4 INSTALLING NOSINGS

- A. Center nosings on tread widths unless otherwise indicated.
- B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

### 3.5 INSTALLING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
  - 1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.
  - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

### 3.6 ADJUSTING AND 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 (0.05-mm)** dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055000

## SECTION 055100 - METAL STAIRS

### 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. Preassembled steel stairs with concrete-filled treads.
2. Industrial-type stairs with steel grating treads.
3. Ornamental steel-framed stairs.
4. Steel tube railings attached to metal stairs.
5. Steel tube handrails attached to walls adjacent to metal stairs.

- B. Related Sections:

1. Division 03 Section "Cast-in-Place Concrete" for concrete fill for stair treads and platforms.
2. Division 05 Section "Metal Fabrications" for metal nosings installed at locations other than in metal stairs.
3. Division 05 Section "Pipe and Tube Railings" for pipe and tube railings not attached to metal stairs or to walls adjacent to metal stairs.
4. Division 06 Section "Miscellaneous Rough Carpentry" for wood blocking for anchoring railings.
5. Division 09 Section "Resinous Matrix Terrazzo Flooring" for terrazzo treads and landings for ornamental steel-framed stairs.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
  1. Uniform Load: 100 lbf/sq. ft. (4.79 kN/sq. m).
  2. Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
  3. Uniform and concentrated loads need not be assumed to act concurrently.

4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
  5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch (6.4 mm), whichever is less.
- C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
1. Handrails and Top Rails of Guards:
    - a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
    - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
    - c. Uniform and concentrated loads need not be assumed to act concurrently.
  2. Infill of Guards:
    - a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
    - b. Infill load and other loads need not be assumed to act concurrently.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For metal stairs and the following:
  1. Prefilled metal-pan stair treads.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer.
- B. Welding certificates.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.
  1. Preassembled Stairs: Commercial class for areas open to public use.

2. Industrial-Type Stairs: Industrial class for utility areas.
  3. Ornamental Stairs: Architectural class for lobby stairs.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

## 1.7 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

## PART 2 - PRODUCTS

### 2.1 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

### 2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513.
- C. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- D. Steel Bars for Grating Treads: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.
- E. Wire Rod for Grating Crossbars: **ASTM A 510** (ASTM A 510M).
- F. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

- G. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, **Grade 25 (Grade 170)**, unless another grade is required by design loads; exposed.

## 2.3 ABRASIVE NOSINGS

- A. Cast-Metal Units: Cast aluminum, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Safety Tread Co., Inc.
    - b. Balco Inc.
    - c. Barry Pattern & Foundry Co., Inc.
    - d. Granite State Casting Co.
    - e. Safe-T-Metal Company, Inc.
    - f. Wooster Products Inc.
  2. Configuration: Cross-hatched units, **3 inches (75 mm)** wide without lip.
- B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- C. Provide manufacturer's standard non-slip strip insert for resinous-matrix terrazzo stair treads.
- D. Apply bituminous paint to concealed surfaces of cast-metal units set into concrete.

## 2.4 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or **ASTM F 1941 (ASTM F 1941M)**, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.
- B. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or **ASTM F 1941 (ASTM F 1941M)**, Class Fe/Zn 5, unless otherwise indicated.
  2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group **1 (A1)** stainless-steel bolts, **ASTM F 593 (ASTM F 738M)**, and nuts, **ASTM F 594 (ASTM F 836M)**.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
  - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.6 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
  - 1. Join components by welding unless otherwise indicated.
  - 2. Use connections that maintain structural value of joined pieces.
  - 3. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.
- B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Weld connections to comply 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. Weld exposed corners and seams continuously unless otherwise indicated.
  5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint for areas exposed to public use and Type 3 welds: partially dressed weld with spatter removed for utility areas.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.
- H. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

## 2.7 STEEL-FRAMED STAIRS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Alfab, Inc.
  2. American Stair, Inc.
  3. Sharon Companies Ltd.
- B. Stair Framing:
1. Fabricate stringers of steel plates and channels.
    - a. Provide closures for exposed ends of channel stringers.
  2. Construct platforms of steel plate and channel headers and miscellaneous framing members as needed to comply with performance requirements.
  3. Weld stringers to headers; weld framing members to stringers and headers.
  4. Where stairs are enclosed by gypsum board or shaft-wall assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.
  5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.
- C. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than **0.067 inch (1.7 mm)**.
1. Steel Sheet: Uncoated cold-rolled steel sheet.
  2. Steel Sheet: Galvanized-steel sheet, where indicated.
  3. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.

4. At Contractor's option, provide stair assemblies with metal-pan subreads filled with reinforced concrete during fabrication.
  5. Provide subplatforms of configuration indicated or, if not indicated, the same as subreads. Weld subplatforms to platform framing.
- D. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."
1. Fabricate treads and platforms from welded or pressure-locked steel grating with openings in gratings no more than **3/4 inch (19 mm)** in least dimension.
  2. Surface: Dimpled.
  3. Finish: Galvanized.
  4. Fabricate grating treads with rolled-steel floor plate or cast abrasive nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.
  5. Fabricate grating platforms with nosing matching that on grating treads. Provide toeplates at open-sided edges of grating platforms. Weld grating to platform framing.

## 2.8 STAIR RAILINGS

- A. Steel Tube Railings: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads. See Drawings for configuration.
1. Rails and Posts: **1-1/2-inch- (38-mm-)** outside diameter handrails with **1-1/2-inch- (38-mm-)** outside diameter guardrails and **1-1/4-inch- (32-mm-)** square posts.
  2. Picket Infill: **1/2-inch- (13-mm-)** square pickets spaced less than **4 inches (100 mm)** clear.
  3. Bottom Rail at Pickets: **1/2-inch- (13-mm-)** by **1-1/4-inch- (32-mm-)** rectangular bottom rail spaced less than **4 inches (100 mm)** clear from top of stringer.
- B. Welded Connections: Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
1. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint for areas exposed to public use and Type 3 welds: partially dressed weld with spatter removed for utility areas.
- C. Form changes in direction of railings as follows:
1. By bending or by inserting prefabricated elbow fittings.
- D. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

- E. Close exposed ends of railing members with prefabricated end fittings.
- F. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is **1/4 inch (6 mm)** or less.
- G. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
  - 1. Connect posts to stair framing by direct welding unless otherwise indicated.
  - 2. For galvanized railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
  - 3. For nongalvanized railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.
- H. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

## 2.9 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal stairs after assembly.
- C. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
  - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
  - 2. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- E. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
  - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- F. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.
- G. Place and finish concrete fill for treads and platforms to comply with Division 03 Section "Cast-in-Place Concrete."
  - 1. Install abrasive nosings with anchors fully embedded in concrete. Center nosings on tread width.

#### 3.2 INSTALLING RAILINGS

- A. Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:
  - 1. Anchor posts to steel by welding directly to steel supporting members.
  - 2. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with postinstalled anchors and bolts.
- B. Attach handrails to wall with wall brackets. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt. Provide bracket with 2-1/4-inch (57.17-mm) clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as required to comply with performance requirements.

3.3 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with 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 (0.05-mm)** dry film thickness.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055100

## SECTION 055213 - PIPE AND TUBE RAILINGS

### 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. Steel pipe and tube railings attached to metal grating platforms, stairs, and walkways.

- B. Related Sections:

- 1. Division 05 Section "Metal Stairs" for steel tube railings associated with metal stairs.
  - 2. Division 05 Section "Metal Gratings" for metal grating platforms, stairs, and walkways.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:

- 1. Steel: 72 percent of minimum yield strength.

- B. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

- 1. Handrails and Top Rails of Guards:

- a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
    - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
    - c. Uniform and concentrated loads need not be assumed to act concurrently.

- 2. Infill of Guards:

- a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
    - b. Infill load and other loads need not be assumed to act concurrently.

- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
  - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Manufacturer's product lines of mechanically connected railings.
  - 2. Railing brackets.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified fabricator.
- B. Welding certificates.

#### 1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

#### 1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

#### 1.8 COORDINATION AND SCHEDULING

- A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items

with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

- B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Steel Pipe and Tube Railings:
    - a. Pisor Industries, Inc.
    - b. Wagner, R & B, Inc.; a division of the Wagner Companies.
    - c. Manufacturer of metal grating system provided in compliance with Division 05 Section "Metal Gratings".
    - d. Approved local fabricator or alternate manufacturer.

### 2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

### 2.3 STEEL AND IRON

- A. Tubing: ASTM A 500 (cold formed) or ASTM A 513.
- B. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
  - 1. Provide galvanized finish for interior and exterior installations and where indicated.
- C. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- D. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

## 2.4 FASTENERS

- A. General: Provide the following:
  - 1. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. Fasteners for Interconnecting Railing Components:
  - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
  - 2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
- D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
  - 1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or **ASTM F 1941 (ASTM F 1941M)**, Class Fe/Zn 5, unless otherwise indicated.
  - 2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group **1 (A1)** stainless-steel bolts, **ASTM F 593 (ASTM F 738M)**, and nuts, **ASTM F 594 (ASTM F 836M)**.

## 2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

- F. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
  - 1. Water-Resistant Product: At exterior locations and where indicated provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

## 2.6 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with either welded or nonwelded connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
  - 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 flux immediately.
  - 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
  - 1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

- J. Form changes in direction as follows:
  - 1. By bending or by inserting prefabricated elbow fittings.
- K. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- L. Close exposed ends of railing members with prefabricated end fittings.
- M. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is **1/4 inch (6 mm)** or less.
- N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
  - 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
- P. For removable railing posts, fabricate slip-fit sockets from steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.
  - 1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.
- Q. Guardrails: Provide continuous guardrails at all open sides of elevated walkways, stairs, platforms, and floors.
  - 1. Height: 42 inches (1067 mm) above adjacent walking surface.
- R. Handrails: Provide inset handrails at both sides of stairs and walking surface transitions.
  - 1. Height: 36 inches (914 mm) above adjacent walking surface.
  - 2. Diameter: 1-1/2 inches (38 mm) outside diameter.
- S. Toe Boards: Provide toe boards at railings around openings and at edge of open-sided walkways and platforms.
  - 1. Height: 4 inches (100 mm).

2.7 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.8 STEEL AND IRON FINISHES

- A. Galvanized Railings:
  - 1. Hot-dip galvanize interior and exterior steel and iron railings, including hardware.
  - 2. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
  - 1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
  - 2. Set posts plumb within a tolerance of **1/16 inch in 3 feet (2 mm in 1 m)**.
  - 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed **1/4 inch in 12 feet (5 mm in 3 m)**.
- C. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

### 3.3 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement.
  - 1. Provide for expansion movement where platforms or railings cross building expansion joints.

### 3.4 ANCHORING POSTS

- A. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
  - 1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.
- B. Install removable railing sections, where indicated, in slip-fit metal sockets.

### 3.5 ADJUSTING AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

### 3.6 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 055213

SECTION 071110 – UNDER SLAB VAPOR RETARDER

PART 1 - GENERAL

A. Products Supplied Under This Section

1. Vapor Barrier, seam tape, mastic, pipe boots, detail strip for installation under concrete slabs.

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. Vapor barrier/retarder and accessories for installation under concrete slabs on grade.

B. Related Sections:

1. Division 03 Section "Concrete" for installation of vapor retarder under concrete slabs on grade.
2. Division 07 Section "Building insulation" for vapor retarders in other construction.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM E 1745-97(2004) Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
2. ASTM E 154-99(2005) Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs.
3. ASTM E 96-05 Standard Test Methods for Water Vapor Transmission of Materials.
4. ASTM E 1643-98(2005) Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.

1.4 INFORMATIONAL SUBMITTALS

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

1. Manufacturer's samples and literature

2. Manufacturer's installation instructions for placement, seaming, and penetration boot installation.

#### 1.5 QUALITY ASSURANCE

1. Independent laboratory test results showing compliance with ASTM & ACI Standards.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect vapor retarder materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Reinforced Plastic Vapor Barrier/Retarder: ASTM E 96, Perm rating less than or equal to 0.012 perms (grains/(ft<sup>2</sup> /hr / in. Hg)), conforming to ASTM E 1745 Class A (Plastics), 15 mil or greater thickness.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Stego Industries LLC; Stego Wrap Vapor Barrier.
    - b. W.R. Meadows; Premoulded Membrane with Plasmatic Core.
    - c. Alumiseal; Zero-Perm.

#### 2.2 ACCESSORIES

- A. Seam Tape: ASTM E 96, Water Vapor Transmission Rate of 0.3 perms or lower.
- B. Vapor Proofing Mastic: ASTM E 96, Water Vapor Transmission Rate of 0.3 perms or lower.
- C. Penetration Boots: Construct penetration boots from vapor barrier material, pressure sensitive tape, and/or mastic per manufacturer's instructions.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Ensure that subsoil is approved by Architect and Geotechnical Engineer.

- B. Level and tamp or roll aggregate, sand, or tamped earth base.

### 3.2 INSTALLATION OF VAPOR BARRIER/RETARDER

- A. Installation shall be in accordance with ASTM E 1643.
- B. Comply with vapor barrier manufacturer's written instructions applicable to products and applications indicated.
  - 1. Unroll vapor barrier/retarder with the longest dimension parallel with the direction of the pour.
  - 2. Lap vapor barrier/retarder over footings and seal to foundation walls.
  - 3. Overlap joints 6 inches and seal with manufacturer's recommended tape.
  - 4. Seal all penetrations (including pipes) per manufacturer's instructions.
  - 5. No penetration of the vapor barrier/retarder is allowed except for reinforcing steel and permanent utilities.
  - 6. Repair damaged areas by cutting patches of vapor barrier/retarder, overlapping damaged area 6 inches, and taping all four sides with tape.

### 3.3 PROTECTION

- A. Protect installed vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where vapor barrier/retarder is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 071110

## SECTION 071416 - COLD FLUID-APPLIED WATERPROOFING

### 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. Single-component polyurethane waterproofing.
  - 2. Molded-sheet drainage panels.
- B. Location: waterproofing to be installed on below grade at exterior wall of Auditorium (wall located along column line 'DA') where interior floor is below grade (length of wall between column lines 'D3' and 'D6').

#### 1.3 ACTION SUBMITTALS

- A. 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.
- B. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
  - 1. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For waterproofing, based on evaluation of comprehensive tests performed by a qualified testing agency.
- C. Field quality-control reports.
- D. Warranty: Sample of special warranty.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that is approved or licensed by waterproofing manufacturer for installation of waterproofing required for this Project.
- B. Source Limitations: Obtain waterproofing materials, protection course 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, special details and flashings, installation procedures, testing and inspection procedures, and protection and repairs.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver liquid materials to Project site in original containers with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.
- 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, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.
  - 1. Do not apply waterproofing in snow, rain, fog or mist, or when such weather conditions are imminent during application and curing period.
- B. Maintain adequate ventilation during application and curing of waterproofing materials.

#### 1.8 WARRANTY

- A. Special Manufacturer's Warranty: Manufacturer's standard form in which waterproofing manufacturer and Installer agree to repair or replace waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.

1. Warranty does not include failure of waterproofing due to failure of substrate prepared and treated according to requirements or formation of new joints and cracks in substrate that exceed **1/16 inch (1.6 mm)** in width.
2. Warranty includes removing and reinstalling protection board..
3. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 SINGLE-COMPONENT POLYURETHANE WATERPROOFING

- A. Single-Component, Modified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Karnak Corporation; One-Kote System.
    - b. Meadows, W.R., Inc.; Sealtight Meadow-Pruf Seamless
    - c. Tremco Incorporated; Tremproof 60.

### 2.2 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials recommended by manufacturer to be compatible with one another and with waterproofing, as demonstrated by waterproofing manufacturer, based on testing and field experience.
- B. Primer: Manufacturer's standard, factory-formulated polyurethane or epoxy primer.
- C. Joint Reinforcing Strip: Manufacturer's recommended fiberglass mesh or polyester fabric.
- D. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing, complying with ASTM C 920 Type M, Class 25; Grade NS for sloping and vertical applications or Grade P for deck applications; Use NT exposure; and as recommended by manufacturer for substrate and joint conditions.
  1. Backer Rod: Closed-cell polyethylene foam.

### 2.3 PROTECTION COURSE

- A. Protection Course: Molded-polystyrene board insulation, ASTM C 578, Type I, **0.90-lb/cu. ft. (15-kg/cu. m)** minimum density, **1-inch (25-mm)** minimum thickness.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.
  - 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 D 4263.
  - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 SURFACE PREPARATION

- A. Clean and prepare substrate according to manufacturer's written recommendations. Provide clean, dust-free, and dry substrate for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage or overspray affecting other construction.
- C. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

#### 3.3 PREPARATION AT TERMINATIONS AND PENETRATIONS

- A. Prepare vertical and horizontal surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, and sleeves according to ASTM C 898 and manufacturer's written instructions.
- B. Prime substrate unless otherwise instructed by waterproofing manufacturer.
- C. Apply waterproofing in two separate applications, and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.
  - 1. Provide sealant cants around penetrations and at inside corners of deck-to-wall butt joints when recommended by waterproofing manufacturer.

#### 3.4 JOINT AND CRACK TREATMENT

- A. Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 898 and waterproofing manufacturer's written instructions. Remove dust and dirt from joints and cracks, complying with ASTM D 4258, before coating surfaces.
  - 1. Comply with ASTM C 1193 for joint-sealant installation.
  - 2. Apply bond breaker between sealant and preparation strip.

3. Prime substrate and apply a single thickness of preparation strip extending a minimum of **3 inches (75 mm)** along each side of joint. Apply waterproofing in two separate applications and embed a joint reinforcing strip in the first preparation coat.

### 3.5 WATERPROOFING APPLICATION

- A. Apply waterproofing according to ASTM C 89 and manufacturer's written instructions.
- B. Start installing waterproofing in presence of manufacturer's technical representative.
- C. Apply primer over prepared substrate.
- D. Unreinforced Waterproofing Applications: Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.
  1. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases, with an average dry film thickness of 60 mils.
  2. Apply waterproofing to prepared wall terminations and vertical surfaces.
  3. Verify film thickness of waterproofing every **100 sq. ft. (9.3 sq. m)**.
- E. Install protection course with butted joints over nominally cured membrane before starting subsequent construction operations.
  1. Board insulation may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer.

### 3.6 INSULATION INSTALLATION

- A. Install insulation panels over waterproofed surfaces. Cut and fit to within **3/4 inch (19 mm)** of projections and penetrations.
- B. On surfaces, set insulation units in adhesive applied according to manufacturer's written instructions. Use type of adhesive recommended in writing by insulation manufacturer.

### 3.7 FIELD QUALITY CONTROL

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

### 3.8 CURING, PROTECTION, AND CLEANING

- A. Cure waterproofing according to manufacturer's written recommendations, taking care to prevent contamination and damage during application stages and curing.
- B. Protect waterproofing from damage and wear during remainder of construction period.

- C. Protect installed board insulation from damage due to ultraviolet light, harmful weather exposures, physical abuse, and other causes. Immediately after installation, provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction.
- D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 071416

## SECTION 072100 - THERMAL INSULATION

### 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. Foam-plastic board insulation.
2. Nailable composite foam-plastic board insulation.
3. Glass-fiber board insulation.
4. Glass-fiber blanket insulation.
5. Vapor retarders.

- B. Related Sections:

1. Division 03 Section "Cementitious Wood Decking" for insulation in laminated decking panels.
2. Division 07 Section(s) "Under Slab Vapor Retarder" for vapor retarders specified to be installed below concrete slabs on grade.
3. Division 07 Section(s) "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing" for insulation specified as part of roofing construction.
4. Division 07 Section "Fire-Resistive Joint Systems" for insulation installed as part of a perimeter fire-resistive joint system.

#### 1.3 ACTION SUBMITTALS

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

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
- B. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

## 1.5 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
  - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
  - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.
  - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

## PART 2 - PRODUCTS

### 2.1 FOAM-PLASTIC BOARD INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
  - 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. Dow Chemical Company (The).
    - b. Johns Manville.
    - c. Owens Corning.
  - 2. Type IV, 25 psi (173 kPa).
  - 3. Roof Insulation: Obtain insulation board from source compatible with requirements of the roof membrane Manufacturer's roofing system warranty.
  - 4. Nailable Composite Foam-plastic Board Insulation: Same as Board Insulation above, with adhered facing of 7/16 inch (11 mm) minimum oriented-strand board (OSB) on one side, for use under shingles and other roofing materials specified for nail attachment.

- B. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

## 2.2 GLASS-FIBER BLANKET 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. CertainTeed Corporation.
  - 2. Johns Manville.
  - 3. Knauf Insulation.
  - 4. Owens Corning.
- B. Polypropylene-Scrim-Kraft-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type II (non-reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier).
- C. Reinforced-Foil-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

## 2.3 SLAG-WOOL/MINERAL-WOOL SOUND ATTENUATION BLANKET INSULATION

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Fibrex Insulations Inc.
  - 2. Owens Corning.
  - 3. Roxul Inc.
  - 4. Thermafiber.
- B. Unfaced, Mineral-Wool Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

## 2.4 VAPOR RETARDERS

- A. Reinforced-Polyethylene Vapor Retarders: Two outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nylon cord or polyester scrim and weighing not less than **25 lb/1000 sq. ft. (12 kg/100 sq. m)**, with maximum permeance rating of **0.0507 perm (2.9 ng/Pa x s x sq. m)**.
  - 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. Raven Industries Inc.; DURA-SKRIM 6WW.

- b. Reef Industries, Inc.; Griffolyn T-65.
- 2. Note: This product is not acceptable for use under concrete slabs on grade. See Division 07 Section "Under Slab Vapor Retarder" for product specification of vapor retarders installed under concrete slabs on grade.
- B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
- C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.
- D. Single-Component Nonsag Urethane Sealant: ASTM C 920, Type I, Grade NS, Class 25, Use NT related to exposure, and Use O related to vapor-barrier-related substrates.
- E. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.

## 2.5 INSULATION FASTENERS

- A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
  - 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. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
    - b. Gemco; Spindle Type.
  - 2. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square.
  - 3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation indicated.
- B. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) square or in diameter.
  - 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. AGM Industries, Inc.
    - b. Gemco.
  - 2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
    - a. Ceiling plenums.

- b. Attic spaces.
- C. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.
  - 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. AGM Industries, Inc.; TACTOO Adhesive.
    - b. Gemco; Tuff Bond Hanger Adhesive.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders, or that interfere with insulation attachment.

#### 3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- 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. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

#### 3.3 INSTALLATION OF BELOW-GRADE INSULATION

- A. On vertical surfaces, set insulation units using manufacturer's recommended adhesive or anchors according to manufacturer's written instructions.
  - 1. If not otherwise indicated, extend insulation a minimum of **24 inches (610 mm)** below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

1. If not otherwise indicated, extend insulation a minimum of **24 inches (610 mm)** in from exterior walls.

### 3.4 INSTALLATION OF CAVITY-WALL INSULATION

- A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately **24 inches (610 mm)** o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.
  1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Division 04 Section "Unit Masonry."

### 3.5 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Foam-Plastic Board Insulation: Seal joints between units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.
- C. Glass-Fiber or Mineral-Wool 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 (76-mm)** clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
  4. For metal-framed wall cavities where cavity heights exceed **96 inches (2438 mm)**, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
  5. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
    - a. Exterior Walls: Set units with facing placed toward interior of construction.
    - b. Interior Walls: Set units with facing placed toward areas of high humidity.
- D. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

### 3.6 INSTALLATION OF INSULATION FOR SOUND ATTENUATION

- A. Where glass-fiber blankets are indicated for sound attenuation, install blanket insulation for full height of partitions in thicknesses to match depth of studs. Extend insulation **48 inches (1219 mm)** across ceiling on either side of partitions.

### 3.7 INSTALLATION OF CURTAIN-WALL INSULATION

- A. Install board insulation in curtain-wall construction where indicated on Drawings according to curtain-wall manufacturer's written instructions.
  1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated between insulation and glass.
  2. Install insulation where it contacts perimeter fire-containment system to prevent insulation from bowing under pressure from perimeter fire-containment system.

### 3.8 INSTALLATION OF VAPOR RETARDERS

- A. Place vapor retarders on side of insulation towards interior. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives or other anchorage system as indicated. 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.
  1. Before installing vapor retarders, apply urethane sealant to flanges of metal framing including runner tracks, metal studs, and framing around door and window openings. Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Seal butt joints with vapor-retarder tape. Locate all joints over framing members or other solid substrates.
  2. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.
- 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.

3.9 INSTALLATION OF ROOF INSULATION

- A. Install board insulation in roof construction where indicated on Drawings according to roofing material manufacturer's written instructions.
  - 1. Attach insulation board to deck and substrate to comply with terms of roofing system warranties for each type of material.
  - 2. Install Nailable Composite Foam-plastic Board Insulation under shingles or other roofing materials requiring nailable substrate.

3.10 PROTECTION

- A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

## SECTION 099113 - EXTERIOR PAINTING

### 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 surface preparation and the application of paint systems on the following exterior substrates:
  - 1. Steel and iron.
  - 2. Galvanized metal.
- B. Related Sections include the following:
  - 1. Division 09 Section "Interior Painting" for surface preparation and the application of paint systems on interior substrates.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of topcoat product indicated.
- C. Samples for Verification: For each type of paint system and each color and gloss of topcoat indicated.
  - 1. Submit Samples on rigid backing, **8 inches (200 mm)** square.
  - 2. Step coats on Samples to show each coat required for system.
  - 3. Label each coat of each Sample.
  - 4. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
  - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
  - 2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

#### 1.4 QUALITY ASSURANCE

##### A. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

##### B. Mockups: Apply benchmark samples 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 specified in Part 3.
  - a. Other Items: Architect will designate items or areas required.
2. Final approval of color selections will be based on benchmark samples.
  - a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

##### A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

#### 1.6 PROJECT CONDITIONS

##### A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

##### B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

#### 1.7 EXTRA MATERIALS

##### A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.

1. Quantity: Furnish Owner with extra paint materials in quantities indicated below:

- a. Exterior Acrylic Paint: Two cases of each color applied.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Benjamin Moore & Co.
  - 2. Duron, Inc.
  - 3. ICI Devoe (Canada).
  - 4. M.A.B. Paints.
  - 5. PPG Architectural Finishes, Inc.
  - 6. Sherwin-Williams Company (The).
- B. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions, per Division 1.

### 2.2 PAINT, GENERAL

- A. Material Compatibility:
  - 1. Provide materials for use within each paint system that are 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, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. Colors: As selected by Architect from manufacturer's full range.

## 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 work.
- B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- C. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Beginning coating application constitutes Contractor's acceptance of substrates 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 plates, machined surfaces, and similar items already in place that 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.
  2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
  1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
- E. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

### 3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
  1. Use applicators and techniques suited for paint and substrate indicated.
  2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

- D. 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 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
  - 1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
  - 2. Testing agency will perform tests for compliance of paint materials with product requirements.
  - 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

### 3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. 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.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

### 3.6 EXTERIOR PAINTING SCHEDULE

- A. General: Provide the following paint systems for the various substrates indicated.
- B. Ferrous Metal:
  - 1. High Performance Acrylic Coating: 2 coats over primer.
    - a. Prime Coat: ICI/Devoe: 4160 Tak and Structural Primer.
    - b. First and Second Coats: ICI/Devoe: 4216 Lifemaster Pro.

C. Zinc-coated Metal:

1. High Performance Acrylic Coating: 2 coats over primer.
  - a. Prime Coat: ICI/Devoe: 4160 Tak and Structural Primer.
  - b. First and Second Coats: ICI/Devoe: 4216 Lifemaster Pro.

END OF SECTION 099113

## SECTION 142400 - HYDRAULIC ELEVATORS

### 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 hydraulic passenger elevators.
- B. Related Sections include the following:
  - 1. Division 2 Section "Earthwork" for excavation to accommodate plunger-cylinder assembly.
  - 2. Division 3 Section "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
  - 3. Division 4 Section "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry.
  - 4. Division 5 Section "Structural Steel" for the following:
    - a. Attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.
    - b. Divider beams.
    - c. Structural-steel shapes for subsills that are part of steel frame.
    - d. Hoist beams.
  - 5. Division 5 Section "Metal Fabrications" for the following:
    - a. Attachment plates and angle brackets for supporting guide-rail brackets.
    - b. Divider beams.
    - c. Structural-steel shapes for subsills and entrance frames.
    - d. Pit ladders.
    - e. Hoist beams.
  - 6. Division 9 Section "Painting" for field painting of hoistway entrances.
  - 7. Division 9 Section for finish flooring in elevator cars.
  - 8. Coordinate Electrical for smoke detectors in elevator lobbies to initiate emergency recall operation and heat detectors in shafts and machine rooms to disconnect power from elevator equipment before sprinkler activation and for connection to elevator controllers.
  - 9. Coordinate Electrical for telephone service to elevators.
  - 10. Coordinate Electrical for electrical service for elevators to and including fused disconnect switches at machine room door and standby power source, transfer switch, and connection from auxiliary contacts in transfer switch to controller.

### 1.3 DEFINITIONS

- A. Defective Elevator Work: Repeated operation or control system failures; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; the need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

### 1.4 SUBMITTALS

- A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information.
- B. Shop Drawings: Show plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment and signals. Indicate variations from specified requirements, maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
- C. Samples: For exposed finishes of cars, hoistway doors and frames, and signal equipment; 3-inch- (75-mm-) square samples of sheet materials; and 4-inch (100-mm) lengths of running trim members. When requested, submit color charts of exposed finishes for color selection.
- D. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.
- E. Maintenance Manuals: Include operation and maintenance instructions, parts listing with sources indicated, recommended parts inventory listing, emergency instructions, and similar information. Submit for Owner's information at Project closeout as specified in Division 1.
- F. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
- G. Qualification Data: For manufacturer.

### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
  - 1. Regularly engages in manufacturing, installing and servicing elevators of the type specified.
  - 2. Manufactures major elevator components in North America.
- B. Installer Qualifications: Elevator manufacturer or an experienced installer approved by elevator manufacturer who has completed elevator installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- C. Regulatory Requirements: In addition to local governing regulations, comply with applicable provisions in ASME A17.1, "Safety Code for Elevators and Escalators."

- D. Accessibility Requirements: In addition to local governing regulations, comply with Section 407 in ICC A117.1.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials, components and equipment in manufacturer's original protective packaging in a dry protected area.
- B. Handle materials in accordance with manufacturer's recommendations to prevent damage, soiling, or deterioration.

#### 1.7 COORDINATION

- A. Coordinate installation of sleeves, block outs, and items that are embedded in concrete or masonry for elevator equipment. Furnish templates and installation instructions and deliver to Project site in time for installation.
- B. Furnish well casing and coordinate delivery with related excavation work.
- C. Coordinate locations and dimensions of other work relating to hydraulic elevators including pit ladders, sumps, and floor drains in pits; entrance subsills; and electrical service, electrical outlets, lights, and switches in pits and machine rooms.

#### 1.8 WARRANTY

- A. Special Manufacturer's Warranty: Written warranty, signed by manufacturer agreeing to repair, restore, or replace defective elevator work within specified warranty period.
  - 1. Warranty Period: 2 (Two) year from date of Substantial Completion.

#### 1.9 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 24 months' full maintenance service by skilled employees of the elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Provide parts and supplies as used in the manufacture and installation of original equipment.
  - 1. Perform maintenance and non-emergency service during normal working hours.
  - 2. Include 24-hour-per-day, 7-day-per-week emergency callback service.
    - a. Response Time: 4 (Four) hours or less.
- B. Continuing Maintenance Proposal: Provide a continuing maintenance proposal from Installer to Owner, in the form of a standard 1 year (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: The design for hydraulic elevators is based on ThyssenKrupp Elevator Model Seville 35. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
1. Montgomery KONE Inc.
  2. Otis Elevator Co.
  3. Schindler Elevator Corp.
  4. Delaware Elevator
- B. Type: Hydraulically operated, conventional jack passenger elevator.

### 2.2 MATERIALS AND COMPONENTS

- A. General: Provide manufacturer's standard elevator systems. Where components are not otherwise indicated, provide standard components, published by manufacturer as included in standard preengineered elevator systems and as required for a complete system.
- B. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations. Provide either of the following:
1. Pump, with fan-cooled squirrel-cage induction motor, mounted under oil tank with vibration isolation mounts. Enclose pump and motor in prime-painted steel enclosure lined with 1-inch- (25-mm-) thick, glass-fiber insulation board.
  2. Submersible pump, with submersible squirrel-cage induction motor, suspended inside tank from vibration isolation mounts.
  3. Provide motor with wye-delta or solid-state starting.
- C. Hydraulic Silencers: Provide hydraulic silencer containing pulsation-absorbing material in a blowout-proof housing at pump unit.
- D. Piping: Provide size, type, and weight piping recommended by manufacturer, and provide flexible connectors to minimize sound and vibration transmissions from power unit.
- E. Hydraulic Oil: Provide hydraulic oil of proper grade in the quantity recommended by manufacturer.
1. Provide dielectric couplings between power unit and cylinder units.
  2. Casing for Underground Piping: PVC pipe complying with ASTM D 1785 joined with PVC fittings complying with ASTM D 2466 and solvent cement complying with ASTM D 2564.
- F. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work where installation of devices is specified in another Specification Section.

***Bid Pac A***

- G. Protective Cylinder Casings: HDPE pipe casings complying with ASME A17.1, of sufficient size to provide not less than 1-inch (25-mm) clearance from cylinder, and extending above pit floor.
- H. Car Frame and Platform: Formed or structural steel members, bolted or welded together.
  - 1. For freight elevators, provide special heavy-duty units where indicated for power truck loading, designed to withstand impacts and wheel loadings indicated.
- I. Finish Materials: Provide the following materials and finishes for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated:
  - 1. Plastic Laminate: High-pressure type complying with NEMA LD 3, Type HGP for postformed applications and Type HGS for flat applications; color, texture, and pattern as selected by Architect from plastic-laminate manufacturer's full range of products.

## 2.3 OPERATION SYSTEMS

- A. Passenger Elevators: Provide manufacturer's standard microprocessor operation system for each elevator or group of elevators as required to provide type of operation system indicated.
  - 1. Single Elevator: Provide "selective collective automatic operation" as defined in ASME A17.1.
- B. Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated.
  - 1. Standby Power Operation: On activation of standby power, cars are returned to a field programmable floor, the doors cycled, and the car parked with doors closed. The door open button is to remain active to allow passengers to exit the car. Only one car may be moved upward at a time, with priority given to loaded cars. If a car cannot be returned after two attempts, each of a preselected length of time, it is removed from the system. When all cars have been returned or removed from the system, one car is automatically placed in service. If car selected for service cannot operate within 60 seconds, the system removes that car from service and places another car in service. Cars can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located as directed by Owner. Manual operation causes automatic operation to cease.
  - 2. Battery-Powered Lowering: If power fails, cars that are at a floor remain at that floor, cycle their doors, and shut down with the doors closed. Cars that are between floors are lowered to a field programmable floor, cycle their doors, and shut down with the doors closed. Cars that are below the field programmable floor are lowered to the next lower floor, cycle their doors, and shut down with the doors closed. System includes rechargeable battery and automatic recharging system.
  - 3. Loaded-Car Bypass: When car load exceeds a predetermined weight, car will respond only to car calls, not to hall calls. Predetermined weight can be adjusted.
  - 4. Automatic Dispatching of Loaded Car: When car load exceeds a predetermined weight, doors will begin closing.

***Bid Pac A***

5. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight can be adjusted.
  6. Load-Weighing Device (Freight Elevators): When car load exceeds 80 percent of rated capacity, a signal light is lit in the car control station; when car load exceeds rated capacity, car will not respond to car or hall calls.
- C. Security Features: In addition to above operational features, provide the following security features, where indicated. Security features shall not affect emergency firefighters' service. The main landing will not be locked out from the car to allow access out of the building to the "security level".
1. Primary Function: Card reader operation.
  2. Secondary Function: Keyswitch Feature: Car and hall push buttons are activated and deactivated by security keyswitches. Key is removable only in deactivated position. Keyswitch to provide back-up mode of operation if card reader is deactivated.

2.4 SIGNAL EQUIPMENT

- A. General: Provide signal equipment for each elevator or group of elevators with hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements of acrylic or other permanent, non-yellowing translucent plastic.
- B. Car Control Stations: Provide manufacturer's standard semi-recessed car control stations. Mount in return panel adjacent to car door, if not otherwise indicated.
- C. Car Control Stations: Provide fully recessed car control stations with applied metal faceplates. Mount in return panel adjacent to car door, if not otherwise indicated.
  1. Include call buttons for each landing served and other buttons, switches, and controls required for specified car operation.
  2. Mark buttons and switches with manufacturer's standard identification for required use or function that complies with ASME A17.1.
  3. Mount controls at heights complying with ICC A117.1.
- D. Fire Department Communication System: Provide flush-mounted cabinet and telephone jack in each car and required conductors in traveling cable for fire department communication system specified on electrical drawings.
- E. Car Position Indicator: For passenger elevator cars, provide illuminated-signal type, digital-display type, or segmented type, located above car door or above car control station. Also provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served.
  1. Include travel direction arrows if not provided in car control station.
- F. Hall Push-Button Stations: Provide hall push-button stations at each landing for each elevator or group of elevators as indicated.

***Bid Pac A***

1. Provide units with flat faceplate for mounting with body of unit recessed in wall.
  2. Provide units with direction-indicating buttons; two buttons at intermediate landings; one button at terminal landings.
- G. Hall Lanterns: Provide units with illuminated arrows, but provide single arrow at terminal landings.
1. Provide units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing.
  2. Place lanterns either above or beside each hoistway entrance, unless otherwise indicated. Mount at a minimum of 72 inches (1829 mm) above finished floor.
  3. Place lanterns in both jambs of entrance frame for each elevator. Mount at a minimum of 72 inches (1829 mm) above finished floor.
    - a. At manufacturer's option, for single elevators or for only two cars in a group, lanterns may be located in car doorjambs instead of entrance jambs.
  4. With each lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
    - a. At manufacturer's option, audible signals may be placed on each car.
- H. Hall Position Indicators: Provide illuminated-signal type or digital-display type, located above each hoistway entrance at ground floor. Provide units with flat faceplate for mounting with body of unit recessed in wall.
1. Integrate ground-floor hall lanterns with hall position indicators.

## 2.5 DOOR REOPENING DEVICES

- A. Infrared Array: Provide door reopening devices with a uniform array of 40 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more of the light beams shall cause doors to stop and reopen.
1. Nudging Feature: After car doors are prevented from closing for a predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound. When the doors are released, the doors shall begin to close at reduced kinetic energy.

## 2.6 PASSENGER ELEVATOR CAR ENCLOSURES

- A. General: Provide manufacturer's standard steel-framed car enclosures with nonremovable wall panels, suspended ceiling, trim, accessories, access doors, doors, power door operators, sills (thresholds), lighting, and ventilation.
1. Resilient floor finish is specified in Section 096519.
  2. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to 1/2-inch (13-mm) fire-retardant-treated particleboard with plastic-laminate panel backing complying with NEMA LD 3, Type BKV and manufacturer's standard protective edge trim. Panels have a flame-spread rating of 25 or less, when tested according to ASTM E 84.

3. Fabricate car with recesses and cutouts for signal equipment.
4. Fabricate car door frame integrally with front wall of car.
5. Stainless-Steel Doors: Flush, hollow-metal construction, fabricated from stainless steel.
6. Sills:
  - a. Extruded metal, of grooveless type with door(s) guided from below; 1/4 inch (6.4 mm) thick. Provide satin finish on aluminum.
  - b. Sill-less construction, with flooring material extending up to the edge of the car platform without a visible sill component. Door(s) will be guided from below.
  - c. Extruded metal, with groove(s) in top surface, 1/4 inch (6.4 mm) thick. Provide satin finish on aluminum.
7. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic complying with flammability requirements.
8. Handrails: Manufacturer's standard handrails, of metal indicated.

## 2.7 PASSENGER HOISTWAY ENTRANCES

- A. General: Provide manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Provide frame size and profile to coordinate with hoistway wall construction.
- B. Materials and Fabrication: Provide manufacturer's standards but not less than the following:
  1. Enameled-Steel Frames: Formed steel sheet.
  2. Enameled-Steel Doors: Flush, hollow-metal construction.
  3. Sills:
    - a. Extruded metal, of grooveless type with door(s) guided from below; 1/4 inch (6.4 mm) thick. Provide satin finish on aluminum.
    - b. Sill-less construction, with flooring material extending up to the edge of the running clearance without a visible sill component. Door(s) will be guided from below.
    - c. Extruded metal, with groove(s) in top surface, 1/4 inch (6.4 mm) thick. Provide satin finish on aluminum.
  4. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

## 2.8 PASSENGER ELEVATORS

- A. Elevator
  1. Type: Under-the-car single cylinder.
  2. Rated Load: 3500 lb (1589 kg).
  3. Rated Speed: 125 fpm (0.64 m/s).
  4. Operation System: Selective collective operation.
  5. Auxiliary Operations:
    - a. Standby power operation.
    - b. Battery-powered lowering.
    - c. Independent service.

- d. Loaded-car bypass.
  - e. Automatic dispatching of loaded car.
  - f. Nuisance call cancel.
6. Security Features: Keyswitch feature and card reader operation.
  7. Car Enclosures: As follows:
    - a. Inside Width: 80 inches (2032 mm).
    - b. Inside Depth: 65 inches (1651 mm).
    - c. Inside Height: 94 inches (2388 mm).
    - d. Front Walls: Polished stainless steel with integral car door frames.
    - e. Car Fixtures: Polished stainless steel.
    - f. Side and Rear Wall Panels: Plastic laminate.
    - g. Reveals: Polished stainless steel.
    - h. Door Faces (Interior): Polished stainless steel.
    - i. Door Sills: Aluminum.
    - j. Ceiling: Luminous ceiling.
    - k. Handrails: Polished stainless steel, at side and rear walls.
    - l. Floor prepared to receive PVC tile (specified in Division 9 Section "Resilient Tile Flooring").
  8. Hoistway Entrances: As follows:
    - a. Width: 42 inches (1067 mm).
    - b. Height: 84 inches (2134 mm).
    - c. Type: Single-speed side sliding.
    - d. Frames: Stainless Steel, ASTM A 167, Type 302 or 304, with No. 4 satin finish .
    - e. Doors: Stainless Steel, ASTM A 167, Type 302 or 304, with No. 4 satin finish.
    - f. Sills: Aluminum.
  9. Hall Fixtures: Polished stainless steel.
  10. Additional Requirements: As follows:
    - a. Provide inspection certificate in each car, mounted under acrylic cover with polished stainless-steel frame.
    - b. Provide protective blanket hooks in all cars and two complete sets of full-height blankets.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Verify critical dimensions, and examine supporting structure and other conditions under which elevator work is to be installed. Proceed with installation only after unsatisfactory conditions have been corrected.
  1. For the record, prepare a written report, endorsed by Installer, listing dimensional discrepancies and conditions detrimental to performance.

### 3.2 INSTALLATION

- A. **Welded Construction:** Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.
- B. **Sound Isolation:** Mount rotating and vibrating equipment on vibration-isolating mounts designed to effectively prevent transmission of vibrations to structure and thereby eliminate sources of structure-borne noise from elevator system.
- C. **Install piping above the floor, where possible. Where not possible, install underground piping in Schedule 40 PVC pipe casing assembled with solvent-cement fittings.**
- D. **Lubricate operating parts of systems as recommended by manufacturers.**
- E. **Alignment:** Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with cars. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
- F. **Leveling Tolerance:** 1/4 inch (6 mm), up or down, regardless of load and direction of travel.
- G. **Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.**

### 3.3 FIELD QUALITY CONTROL

- A. **Acceptance Testing:** On completion of elevator installation and before permitting use (either temporary or permanent) of elevators, perform acceptance tests as required and recommended by ASME A17.1 and by governing regulations and agencies.
- B. **Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times tests are to be performed on elevators.**

### 3.4 ADJUSTING

- A. **Make necessary adjustments of operating devices and equipment to ensure elevator operates safely, accurately, and smoothly.**

### 3.5 DEMONSTRATION

- A. **Instruct Owner's personnel in proper use, operations, and daily maintenance of elevators. Review emergency provisions, including emergency access and procedures to be followed at time of operational failure and other building emergencies. Train Owner's personnel in procedures to follow in identifying sources of operational failures or malfunctions. Confer with Owner on requirements for a complete elevator maintenance program.**

***Bid Pac A***

- B. Make a final check of each elevator operation with Owner's personnel present and before date of Substantial Completion. Determine that operation systems and devices are functioning properly.

3.6 PROTECTION

- A. Temporary Use: Do not use elevators for construction purposes unless cars are provided with temporary enclosures, either within finished cars or in place of finished cars, to protect finishes from damage.
  - 1. Provide full maintenance service by skilled, competent employees of elevator Installer for elevators used for construction purposes. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Use same parts and supplies as used in the manufacture and installation of original equipment.
  - 2. Provide protective coverings, barriers, devices, signs, and other procedures to protect elevators. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so that no evidence remains of correction work. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

END OF SECTION 14240

## SECTION 221329 – DUPLEX GRINDER PUMP STATIONS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. Provide all labor, materials, equipment and services necessary for and incidental to, the complete and satisfactory installation of the complete factory-built and tested duplex grinder pump units, each consisting of a grinder pump core suitably mounted on an integral stand of stainless steel, special polyethylene tank, electrical quick disconnect (NEMA 6P), pump removal harness, discharge assembly/shut-off valve, anti-siphon valve/check valve assembly, electrical alarm assembly and all necessary internal wiring and controls, as specified herein and as shown on the Contract Drawings.

#### 1.2 MANUFACTURER

- A. Duplex grinder pump stations, complete with all appurtenances, form an integral system, and as such, shall be supplied by one grinder pump station manufacturer. The Contractor shall be responsible for the satisfactory operation of the entire system. The equipment specified shall be a product of a company experienced in the design and manufacture of grinder pumps for specific use in low pressure sewage systems. The Manufacturer shall submit detailed installation and user instructions for its product, submit evidence of an established service program including complete parts and service manuals, and be responsible for maintaining a continuing inventory of grinder pump replacement parts. The Manufacturer shall provide, upon request, a reference and contact list from ten of its largest contiguous grinder pump installations of the type of grinder pumps described within this specification.
- B. The Manufacturer of the duplex grinder pump station shall be Environmental One Corporation, Barnes, Vortech, or Proposed Alternate.
- C. Alternate Equipment: In the event that the Contractor proposes an Alternate to the specified Manufacturer, the Engineer recognizes that it will be difficult to conform to certain details of this Specification due to different manufacturing techniques or grinder pump station designs. If proposing an Alternate, the Contractor (supplier) must submit, a complete description of any changes that will be necessary to the system design, a complete submittal package, a system hydraulic analysis based on the proposed pump (including pipe sizes, flows, velocities, retention times and number and location of recommended valves and cleanouts, if any), a list of exceptions to this specification, and demonstration of compliance to Section 1.3 EXPERIENCE CLAUSE of this specification. The Contractor (supplier) must also complete a Manufacturer Disclosure Statement to provide a detailed description for all non-conforming aspects to the specification. This information must be submitted to the Engineer for approval of the alternate equipment being proposed and determination of compliance with these Contract Documents. If the equipment differs materially or differs from the dimensions given on

the Drawings, the Contractor (supplier) shall submit complete drawings showing elevations, dimensions, or any necessary changes to the Contract Documents for the proposed equipment and its installation. If approved, the Contractor (supplier) must make any needed changes in the structures, system design, piping or electrical systems necessary to accommodate the proposed equipment at the expense of the Contractor (supplier). The Engineer shall make final determination as to whether an alternate supplier is "equal".

### 1.3 EXPERIENCE CLAUSE

- A. All manufacturers proposing equipment for this project shall have at least 10 years of experience in the design and manufacture of units of identical size(s) and performance to the specified units. All manufacturers proposing equipment for this project must also have not less than 500 successful installations of low pressure sewer systems utilizing grinder pumps of like type to the grinder pumps specified herein. The Contractor (supplier) proposing alternate equipment shall also submit, as part of the bid schedule, an installation list with contact person(s), phone number(s) and date(s) of at least 10 installations of the type of pump specified herein that have been in operation for at least 10 years.

### 1.4 OPERATING CONDITIONS

- A. Equipment design, workmanship, testing and operation shall be as specified herein and as shown on the Contract Drawings.
- B. The pumps each shall be capable of delivering 15 GPM against a rated total dynamic head of 0 feet (0 PSIG), 11 GPM against a rated total dynamic head of 92 feet (40 PSIG), and 7.8 GPM against a rated total dynamic head of 185 feet (80 PSIG). The pump(s) must also be capable of operating at negative total dynamic head without overloading the motor(s). Under no conditions shall in-line piping or valving be allowed to create a false apparent head.

### 1.5 TRAINING

- A. Provide training for operation and maintenance of grinder sewage pumps.

### 1.6 QUALITY CONTROL

- A. Warranty: The grinder pump Manufacturer shall provide a part(s) and labor warranty on the complete station and accessories, including, but not limited to, the panel for a period of 24 months after project substantial completion. Any manufacturing defects found during the warranty period will be reported to the Manufacturer by the Owner and will be corrected by the Manufacturer at no cost to the Owner.

- B. **Warranty Performance Certification:** As a bid certification requirement, each bidder shall provide with their bid schedule a Warranty Performance Certification statement executed by the most senior executive officer of the grinder pump Manufacturer, which certifies a minimum of a 24-month warranty. They must further detail any exclusions from the warranty or additional cost items required to maintain the equipment in warrantable condition, including all associated labor and shipping fees, and certify that the Manufacturer will bear all costs to correct any original equipment deficiency for the effective period of the warranty. All preventive maintenance type requirements shall be included in this form as exclusions. These requirements include, but are not limited to, unjamming of grinder mechanism, periodic motor maintenance, and periodic cleaning of liquid level controls. Should the Contractor (supplier) elect to submit a performance bond in lieu of the experience clause outlined above, this Warranty Performance Certification shall also be used as a criterion to evaluate the Contractor's (supplier's) performance over the warranty period. A Warranty Performance Certification form is included with the bid schedule and must be completed and submitted as part of the bid package. Bids with incomplete forms or missing forms will be considered nonresponsive.

## PART 2 - MATERIALS

### 2.1 PUMP

- A. The pump shall be a custom designed, integral, vertical rotor, motor driven, solids handling pump of the progressing cavity type with a single mechanical seal. Double radial O-ring seals are required at all casting joints to minimize corrosion and create a protective barrier. All pump castings shall be cast iron, fully epoxy coated to 8-10 mil Nominal dry thickness, wet applied. The rotor shall be through-hardened, highly polished, precipitation hardened stainless steel. The stator shall be of a specifically compounded ethylene propylene synthetic elastomer. This material shall be suitable for domestic wastewater service. Its physical properties shall include high tear and abrasion resistance, grease resistance, water and detergent resistance, temperature stability, excellent aging properties, and outstanding wear resistance. Buna-N is not acceptable as a stator material because it does not exhibit the properties as outlined above and required for wastewater service.

### 2.2 GRINDER

- A. The grinder shall be placed immediately below the pumping elements and shall be direct-driven by a single, one-piece motor shaft. The grinder impeller (cutter wheel) assembly shall be securely fastened to the pump motor shaft by means of a threaded connection attaching the grinder impeller to the motor shaft. Attachment by means of pins or keys will not be acceptable. The grinder impeller shall be a one-piece, 4140 cutter wheel of the rotating type with inductively hardened cutter teeth. The cutter teeth shall be inductively hardened to Rockwell 50 – 60c for abrasion resistance. The shredder ring shall be of the stationary type and the material shall be white cast iron. The teeth shall be ground into the material to achieve effective grinding. The shredder ring shall have a staggered tooth pattern with only one edge engaged at a time, maximizing the cutting torque. These

materials have been chosen for their capacity to perform in the intended environment as they are materials with wear and corrosive resistant properties.

- B. This assembly shall be dynamically balanced and operate without objectionable noise or vibration over the entire range of recommended operating pressures. The grinder shall be constructed so as to minimize clogging and jamming under all normal operating conditions including starting. Sufficient vortex action shall be created to scour the tank free of deposits or sludge banks which would impair the operation of the pump. These requirements shall be accomplished by the following, in conjunction with the pump:
1. The grinder shall be positioned in such a way that solids are fed in an upward flow direction.
  2. The maximum flow rate through the cutting mechanism must not exceed 4 feet per second. This is a critical design element to minimize jamming and as such must be adhered to.
  3. The inlet shroud shall have a diameter of no less than 5 inches. Inlet shrouds that are less than 5 inches in diameter will not be accepted due to their inability to maintain the specified 4 feet per second maximum inlet velocity which by design prevents unnecessary jamming of the cutter mechanism and minimizes blinding of the pump by large objects that block the inlet shroud.
  4. The impeller mechanism must rotate at a nominal speed of no greater than 1800 rpm.
- C. The grinder shall be capable of reducing all components in normal domestic sewage, including a reasonable amount of "foreign objects," such as paper, wood, plastic, glass, wipes, rubber and the like, to finely-divided particles which will pass freely through the passages of the pump and the 1-1/4" diameter stainless steel discharge piping.

### 2.3 ELECTRIC MOTOR

- A. As a maximum, the motor shall be a 1 HP, 1725 RPM, 240 Volt 60 Hertz, 1 Phase, capacitor start, ball bearing, air-cooled induction type with Class F installation, low starting current not to exceed 30 amperes and high starting torque of 8.4 foot pounds. The motor shall be press-fit into the casting for better heat transfer and longer winding life. Inherent protection against running overloads or locked rotor conditions for the pump motor shall be provided by the use of an automatic-reset, integral thermal overload protector incorporated into the motor. This motor protector combination shall have been specifically investigated and listed by Underwriters Laboratories, Inc., for the application. Non-capacitor start motors or permanent split capacitor motors will not be accepted because of their reduced starting torque and consequent diminished grinding capability. The wet portion of the motor armature must be 300 Series stainless. To reduce the potential of environmental concerns, the expense of handling and disposing of oil, and the associated maintenance costs, oil-filled motors will not be accepted.

2.4 MECHANICAL SEAL

- A. The pump/core shall be provided with a mechanical shaft seal to prevent leakage between the motor and pump. The seal shall have a stationary ceramic seat and carbon rotating surface with faces precision lapped and held in position by a stainless steel spring.

2.5 TANK: POLYETHYLENE CONSTRUCTION

- A. The tank shall be made of rotational molded polyethylene with high environmental stress cracking resistance. All seams created during tank construction are to be thermally welded and factory tested for leak tightness. The tank wall and bottom must withstand the pressure exerted by saturated soil loading at maximum burial depth. All station components must function normally when exposed to 150 percent of the maximum external soil and hydrostatic pressure.
- B. The overall basin capacity shall be 476 gallons. The basin shall incorporate a tapered bottom with an inside diameter of no greater than 46 inches, reducing to a diameter no greater than 42 inches, to minimize the retained volume. The largest diameter must be no less than 50 inches and no greater than 52 inches.
- C. A station that is 77 inches tall shall have no greater than a 36 inch outside diameter flat fiberglass cover. The 77 inch tall station can be extended in 6 inch increments with normal cylindrical fiberglass extensions. Taller stations shall have an accessway with a shroud and domed cover. The accessway shall be an integral extension of the wetwell assembly and shall include a lockable cover assembly with integral vent providing low profile mounting and watertight capability. The cover shall be high density polyethylene, green in color, with a load rating of 150 lbs per square foot. To minimize the station's on-site footprint, the domed cover shall have an outside diameter of no greater than 30 inches. Accessway design and construction shall enable field adjustment of station height in 3-inch increments without the use of any adhesives or sealants requiring cure time before installation can be completed. Corrugated sections are to be made of a double-wall HDPE construction with the internal wall being generally smooth. Corrugations of the outside wall are to be of a minimum amplitude of 1-1/2 inch to provide necessary transverse stiffness. Any incidental sections of a single-wall construction are to be a minimum .250 inch thick. All seams created during tank construction are to be thermally welded and factory tested for leak tightness. The accessway wall must withstand the pressure exerted by saturated soil loading at maximum burial depth and must function normally when exposed to 150 percent of the maximum external soil and hydrostatic pressure.
- D. The tank and factory penetrations shall be factory tested and guaranteed to be watertight.
- E. Tank dimensions shall be as shown on the Contract Drawings.

## 2.6 DISCHARGE HOSE AND DISCONNECT/VALVE

- A. All discharge fittings and piping shall be constructed of polypropylene, EPDM or PVC. The discharge hose assembly shall include a shut-off valve rated for 200 psi WOG and a quick disconnect feature to simplify installation and pump removal. The bulkhead penetration shall be factory installed and warranted by the manufacturer to be watertight.

## 2.7 ELECTRICAL QUICK DISCONNECT

- A. The grinder pump core shall include a factory-installed NEMA 6P electrical quick disconnect (EQD) for all power and control functions. The EQD will be supplied with 32' total, 25' of useable, electrical supply cable (ESC) to connect to the alarm panel. The EQD shall require no tools for assembly, seal against water before the electrical connection is made, and include radial seals to assure a watertight seal regardless of tightening torque. Plug-type connections of the power cable onto the pump housing will not be acceptable due to the potential for leaks and electrical shorts. Junction boxes are not acceptable due to the large number of potential leak points. The EQD shall be so designed to be conducive to field wiring as required.

## 2.8 CHECK VALVE

- A. The pump discharge shall be equipped with a factory installed, gravity operated, flapper-type integral check valve built into the discharge piping. The check valve will provide a full-ported passageway when open, and shall introduce a friction loss of less than 6 inches of water at maximum rated flow. Moving parts will be made of a 300 Series stainless steel and fabric reinforced synthetic elastomer to ensure corrosion resistance, dimensional stability, and fatigue strength. A nonmetallic hinge shall be an integral part of the flapper assembly providing a maximum degree of freedom to assure seating even at a very low back-pressure. The valve body shall be an injection molded part made of an engineered thermoplastic resin. The valve shall be rated for continuous operating pressure of 235 psi. Ball-type check valves are unacceptable due to their limited sealing capacity in slurry applications.

## 2.9 ANTI-SIPHON VALVE

- A. The pump discharge shall be equipped with a factory-installed, gravity-operated, flapper-type integral anti-siphon valve built into the discharge piping. Moving parts will be made of 300 Series stainless steel and fabric-reinforced synthetic elastomer to ensure corrosion resistance, dimensional stability, and fatigue strength. A nonmetallic hinge shall be an integral part of the flapper assembly, providing a maximum degree of freedom to ensure proper operation even at a very low pressure. The valve body shall be injection-molded from an engineered thermoplastic resin. Holes or ports in the discharge piping are not acceptable anti-siphon devices due to their tendency to clog from the solids in the slurry being pumped. The anti-siphon port diameter shall be no less than 60% of the inside diameter of the pump discharge piping.

## 2.10 CORE UNIT

- A. The grinder pump station shall have an easily removable core assembly containing pump, motor, grinder, all motor controls, check valve, anti-siphon valve, electrical quick disconnect and wiring. The watertight integrity of the core unit shall be established by a 100% factory test at a minimum of 5 PSIG.

## 2.11 CONTROLS

- A. All necessary motor starting controls shall be located in the cast iron enclosure of the core unit secured by stainless steel fasteners. Locating motor starting controls in a plastic enclosure is not acceptable. Wastewater level sensing controls shall be housed in a separate enclosure from motor starting controls. Level sensor housing must be sealed via a radial type seal; solvents or glues are not acceptable. Level sensing control housing must be integrally attached to pump assembly so that it may be removed from the station with the pump and in such a way as to minimize the potential for the accumulation of grease and debris accumulation, etc. Level sensing housing must be a high-impact thermoplastic copolymer over-molded with a thermo plastic elastomer. The use of PVC for the level sensing housing is not acceptable.
- B. Non-fouling wastewater level controls for controlling pump operation shall be accomplished by monitoring the pressure changes in an integral air column connected to a pressure switch. The air column shall be integrally molded from a thermoplastic elastomer suitable for use in wastewater and with excellent impact resistance. The air column shall have only a single connection between the water level being monitored and the pressure switch. Any connections are to be sealed radially with redundant O-rings. The level detection device shall have no moving parts in direct contact with the wastewater and shall be integral to the pump core assembly in a single, readily-exchanged unit. Depressing the push to run button must operate the pump even with the level sensor housing removed from the pump.
- C. All fasteners throughout the assembly shall be 300 Series stainless steel. High-level sensing will be accomplished in the manner detailed above by a separate air column sensor and pressure switch of the same type. Closure of the high-level sensing device will energize an alarm circuit as well as a redundant pump-on circuit. For increased reliability, pump ON/OFF and high-level alarm functions shall not be controlled by the same switch. Float switches of any kind, including float trees, will not be accepted due to the periodic need to maintain (rinsing, cleaning) such devices and their tendency to malfunction because of incorrect wiring, tangling, grease buildup, and mechanical cord fatigue. To assure reliable operation of the pressure switches, each core shall be equipped with a factory installed equalizer diaphragm that compensates for any atmospheric pressure or temperature changes. Tube or piping runs outside of the station tank or into tank-mounted junction boxes providing pressure switch equalization will not be permitted due to their susceptibility to condensation, kinking, pinching, and insect infestation. The grinder pump will be furnished with a 6 conductor 14 gauge, type SJOW cable, pre-wired and watertight to meet UL requirements with a **FACTORY INSTALLED** NEMA 6P EQD half attached to it.

2.12 ALARM PANEL(S): MOD T260 DUPLEX

- A. Each grinder pump station shall include a NEMA 4X, UL-listed alarm panel suitable for wall or pole mounting. The NEMA 4X enclosure shall be manufactured of thermoplastic to ensure corrosion resistance. The enclosure shall include a hinged, lockable cover with padlock, preventing access to electrical components, and creating a secured safety front to allow access only to authorized personnel. The standard enclosure shall not exceed 12.5" W x 16" H x 7.5" D.
- B. The panel shall contain one 15-amp single pole circuit breaker for the alarm circuit and one 15-amp double pole circuit breaker per core for the power circuit. The panel shall contain a push-to-run feature, an internal run indicator, and a complete alarm circuit. All circuit boards in the alarm panel are to be protected with a conformal coating on both sides and the AC power circuit shall include an auto resetting fuse.
- C. The visual alarm lamp shall be inside a red, oblong lens at least 3.75" L x 2.38" W x 1.5" H. Visual alarm shall be mounted to the top of the enclosure in such a manner as to maintain NEMA 4X rating. The audible alarm shall be externally mounted on the bottom of the enclosure, capable of 93 dB @ 2 feet. The audible alarm shall be capable of being deactivated by depressing a push-type switch that is encapsulated in a weatherproof silicone boot and mounted on the bottom of the enclosure (push-to-silence button).
- D. The high-level alarm system shall operate as follows:
  - 1. The panel will go into alarm mode if either pump's alarm switch closes. During the initial alarm mode both pumps will run and the alarm light and buzzer will be delayed for a period of time based on user settings (default is 3-1/2 minutes). If the station is still in high-level alarm after the delay, the light and buzzer will be activated.
  - 2. The audible alarm may be silenced by means of the externally mounted push-to-silence button.
  - 3. The visual alarm remains illuminated until the sewage level in the wet well drops below the "off" setting of the alarm switch for both pumps.
- E. The entire alarm panel, as manufactured and including any of the following options shall be listed by Underwriters Laboratories, Inc.

2.13 SERVICEABILITY

- A. The grinder pump core, including level sensor assembly, shall have two lifting hooks complete with lift-out harness connected to its top housing to facilitate easy core removal when necessary. The level sensor assembly must be easily removed from the pump assembly for service or replacement. All mechanical and electrical connections must provide easy disconnect capability for core unit removal and installation. Each EQD half must include a water-tight cover to protect the internal electrical pins while the EQD is unplugged. A pump push-to-run feature will be provided for field trouble shooting. The

push-to-run feature must operate the pump even if the level sensor assembly has been removed from the pump assembly. All motor control components shall be mounted on a readily replaceable bracket for ease of field service.

#### 2.14 OSHA CONFINED SPACE

- A. All maintenance tasks for the grinder pump station must be possible without entry into the grinder pump station (as per OSHA 1910.146 Permit-required confined spaces). *“Entry means the action by which a person passes through an opening into a permit-required confined space. Entry includes ensuing work activities in that space and is considered to have occurred as soon as any part of the entrant’s body breaks the plane of an opening into the space.”*

#### 2.15 SAFETY

- A. The grinder pump shall be free from electrical and fire hazards as required in a residential environment. As evidence of compliance with this requirement, the completely assembled and wired grinder pump station shall be listed by Underwriters Laboratories, Inc., to be safe and appropriate for the intended use. UL listing of components of the station, or third-party testing to UL standard are not acceptable.
- B. The grinder pump shall meet accepted standards for plumbing equipment for use in or near residences, shall be free from noise, odor, or health hazards, and shall have been tested by an independent laboratory to certify its capability to perform as specified in either individual or low pressure sewer system applications. As evidence of compliance with this requirement, the grinder pump shall bear the seal of NSF International. Third-party testing to NSF standard is not acceptable.

### PART 3 - EXECUTION

#### 3.1 FACTORY TEST

- A. Each grinder pump shall be submerged and operated for 1.5 minutes (minimum). Included in this procedure will be the testing of all ancillary components such as, the anti-siphon valve, check valve, discharge assembly and each unit’s dedicated level controls and motor controls. All factory tests shall incorporate each of the above listed items. Actual appurtenances and controls which will be installed in the field shall be particular to the tested pump only. A common set of appurtenances and controls for all pumps is not acceptable. Certified test results shall be available upon request showing the operation of each grinder pump at two different points on its curve. Additional validation tests include: integral level control performance, continuity to ground and acoustic tests of the rotating components.
- B. The Engineer reserves the right to inspect such testing procedures with representatives of the Owner, at the Grinder Pump Manufacturer’s facility.

- C. All HDPE basins shall be factory leak tested to assure the integrity of all joints, seams and penetrations. All necessary penetrations such as inlets, discharge fittings and cable connectors shall be included in this test along with their respective sealing means (grommets, gaskets etc.).

### 3.2 CERTIFIED SERVICE PROGRAM

- A. The grinder pump Manufacturer shall provide a program implemented by the Manufacturer's personnel as described in this specification to certify the service company as an authorized serviced center. As evidence of this, the Manufacturer shall provide, when requested, sufficient evidence that they have maintained their own service department for a minimum of 10 years.
- B. As part of this program, the Manufacturer shall evaluate the service technicians as well as the service organization annually. The service company will be authorized by the Manufacturer to make independent warranty judgments. The areas covered by the program shall include, as a minimum:
  - 1. Pump Population Information — The service company will maintain a detailed database for the grinder pumps in the territory that tracks serial numbers by address.
  - 2. Inventory Management — The service company must maintain an appropriate level of inventory (pumps, tanks, panels, service parts, etc.) including regular inventory review and proper inventory labeling. Service technicians will also maintain appropriate parts inventory and spare core(s) on service vehicles.
  - 3. Service Personnel Certification — Service technicians will maintain their level-specific certification annually. The certifications are given in field troubleshooting, repair, and training.
  - 4. Service Documentation and Records — Start up sheets, service call records, and customer feedback will be recorded by the service company.
  - 5. Shop Organization — The service company will keep its service shop organized and pumps will be tagged with site information at all times. The shop will have all required equipment, a test tank, and cleaning tools necessary to service pumps properly.

### 3.3 DELIVERY

- A. All grinder pump core units, including level controls, will be delivered to the job site 100 percent completely assembled, including testing, ready for installation. Grinder pump cores will be shipped separately from the tanks. Installing the cores and discharge piping/hose into the tanks is the only assembly step required and allowed due to the workmanship issues associated with other on-site assembly. Grinder pump cores must be boxed for ease of handling.

### 3.4 INSTALLATION

- A. Earth excavation and backfill are specified under Earthwork Section, but are also to be done as a part of the work under this section, including any necessary sheeting and bracing.
- B. The Contractor shall refer to the front end specifications for the dewatering requirements.
- C. The grinder pump stations shall not be set into the excavation until the installation procedures and excavation have been approved by the Owner's Representative.
- D. Remove packing material. User instructions **MUST** be given to the Owner. Hardware supplied with the unit, if required, will be used at installation. The basin shall be supplied with inlet grommet (s) for connecting the incoming sewer line as shown on the Contract Drawings. The basin may not be dropped, rolled or laid on its side for any reason.
- E. Installation shall be accomplished so that 1" to 4" of accessway, below the bottom of the lid, extends above the finished grade line. The finished grade shall slope away from the unit. The diameter of the excavated hole must be large enough to allow for the concrete anchor.
- F. A 6" inch (minimum) layer of naturally rounded aggregate, clean and free flowing, with particle size of not less than 1/8" or more than 3/4" shall be used as bedding material under each unit.
- G. A concrete anti-flotation collar, as designed by manufacturer, shall be required and shall be pre-cast to the grinder pump or poured in place. Design shall be certified by a licensed engineer in State of Delaware. Each grinder pump station with its pre-cast anti-flotation collar shall have a minimum of three lifting eyes for loading and unloading purposes.
- H. If the concrete is poured in place, the unit shall be leveled, and filled with water, to the bottom of the inlet, to help prevent the unit from shifting while the concrete is being poured. The concrete must be manually vibrated to ensure there are no voids. If it is necessary to pour the concrete to a level higher than the inlet piping, an 8" sleeve is required over the inlet prior to the concrete being poured.
- I. The electrical enclosure shall be furnished, installed and wired to the grinder pump station by the Contractor. An alarm device is required on every installation, there shall be **NO EXCEPTIONS**. It will be the responsibility of the Contractor to coordinate with the Owner/Engineer to determine the optimum location for the alarm panel.
- J. The Contractor shall mount the alarm device in a conspicuous location, as per national and local codes. The alarm panel will be connected to the grinder pump station by a length of 6-conductor type TC cable. The power and alarm circuits must be on separate power circuits. The grinder pump stations will be provided with 32' total, 25' of useable, electrical supply cable to connect the station to the alarm panel. This cable shall be supplied with a **FACTORY INSTALLED** EQD half to connect to the mating EQD half on the core.

3.5 BACKFILL REQUIREMENTS

- A. Backfilling shall be in accordance with Section 312000 Earthwork.

3.6 START-UP AND FIELD TESTING

- A. The Manufacturer shall provide the services of qualified factory trained technician(s) who shall inspect the placement and wiring of each station, perform field tests as specified herein, and instruct the Owner's personnel in the operation and maintenance of the equipment before the stations are accepted by the Owner.
- B. All equipment and materials necessary to perform testing shall be the responsibility of the Installing Contractor. This includes, as a minimum, a portable generator and power cable (if temporary power is required), water in each basin (filled to a depth sufficient to verify the high level alarm is operating), and opening of all valves in the system. These steps shall be completed prior to the qualified factory trained technician(s) arrival on site.
- C. Upon completion of the installation, the authorized factory technician(s) will perform the following test on each station:
  - 1. Make certain the discharge shut-off valve in the station is fully open.
  - 2. Turn ON the alarm power circuit and verify the alarm is functioning properly.
  - 3. Turn ON the pump power circuit. Initiate the pump operation to verify automatic "on/off" controls are operative. The pump should immediately turn ON.
  - 4. Consult the Manufacturer's Service Manual for detailed start-up procedures.
- D. Upon completion of the start-up and testing, the Manufacturer shall submit the start-up authorization form describing the results of the tests performed for each grinder pump station. Final acceptance of the system will not occur until authorization forms have been received for each pump station installed and any installation deficiencies corrected.

3.7 OPERATION AND MAINTENANCE

- A. **MANUALS:** The Manufacturer shall supply four copies of Operation and Maintenance Manuals to the Owner.

END OF SECTION 221329

## SECTION 221330 – VORTEX SANITARY SEWERAGE PUMPS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. Provide all labor, materials, equipment and services necessary for and incidental to, the complete and satisfactory installation of the submersible vortex sewage pumps for Pump Station #3 as specified herein and as shown on the Contract Drawings. Note that the entire pump station shall be a prepackaged system with the pumps and all appurtenances to the station (interior piping, valves, wet well, guiderail, supports, etc.) being provided by a sole source.
- B. The pumps shall be the responsibility of the pump station equipment supplier.

#### 1.2 SUBMITTALS

- A. Product Data: For submersible sewage pumps. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- 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. Dimensioned outline plan and elevation drawings of components specified.
  - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Certified Pump Tests: Certified pump tests of each unit furnished shall be provided. The pumps shall be tested in accordance with the standards of the Hydraulic Institute. The pumps shall be fully tested at the manufacturer's plant before shipment. Tests shall consist of instantaneous readings of head, capacity, efficiency and brake horsepower, at such conditions of head and capacity to properly establish the performance curve. Flow measurements shall be made with a venturi meter. Certified copies of test reports shall be submitted to the Engineer. The standards of the Hydraulic Institute shall govern all procedures and calculations for these tests. Proof of meter set-up and reports shall be submitted to the Engineer. The performance curve sheets are to include "Head", "Capacity", "Brake Horsepower" and "Net Positive Suction Head Required".

#### 1.3 MANUFACTURER'S CERTIFICATE

- A. Submit manufacturer's certificate for submersible sewage pumps.

#### 1.4 TRAINING

- A. Provide training for operation and maintenance of submersible sewage pumps.

### PART 2 - MATERIALS

#### 2.1 GENERAL

- A. Furnish and install 2 submersible vortex wastewater pumps suitable for continuous duty operation underwater without loss of water-tight integrity to a depth of 65 feet. Each pump shall be equipped with a 15 HP submersible electric motor, connected for operation on 460 volts, 3 phases, 60 hertz. The motor and pump shall be designed, manufactured, and assembled by the same manufacturer.
- B. Pump system design shall include a guide rail system be such that the pump will be automatically connected to the discharge piping when lowered into place on the discharge connection. The pump shall be easily removable for inspection or service, requiring no bolts, nuts, or other fasteners to be disconnected, or the need for personnel to enter the wet well.
- C. Pumps shall be Fluid Handling Model# 80DVCF611, as manufactured by EBARA International Corporation, Flygt, Wilo, or approved equal.

#### 2.2 PUMP CHARACTERISTICS

- A. Pumps shall conform to the following requirements:

- Number of units: 2
- Design Flow: 141 gpm
- Design TDH: 77 gpm
- RPM: 1,800
- Voltage/HZ: 460V/60
- Phase: 3

#### 2.3 PUMP CONSTRUCTION

- A. All major parts of the pumping unit(s) including casing, impeller, motor frame and discharge elbow shall be manufactured from gray cast iron, ASTM A-48 Class 30. Casing shall have smooth surfaces devoid of blow holes or other casting irregularities. Casing design shall be centerline discharge with a large radius on the cut water to prevent clogging. Units shall be furnished with a discharge elbow and 125 lb. flat face ANSI flange. All exposed bolts and nuts shall be 304 stainless steel. All mating surfaces of major components shall be machined and fitted with NBR O-rings where watertight sealing is required. Machining and fitting shall be such that sealing is accomplished by automatic compression of O-rings in two planes and O-ring contact is made on four

surfaces without the requirement of specific torque limits. Internal and external surfaces are prepared to SPPC-VISI-SP-3-63 then coated with a zinc-chromate primer. The external surfaces are then coated with a H.B. Tnemecol 46-465 Coal Tar paint.

- B. Impeller shall be a recessed, semi-open vortex, multi-vane design. The impeller design shall include back pump out vanes to reduce the pressure and entry of foreign materials into the mechanical seal area. The inlet edge of the impeller vanes shall be angled toward the impeller periphery so as to facilitate the release of objects that might otherwise clog the pump. Impellers shall be direct connected to the motor shaft with a slip fit, key driven, and secured with an impeller bolt.
- C. Double mechanical seals operating in an oil bath shall be provided on all units. The oil filled seal chamber shall be designed to prevent over-filling and include an anti-vortexing vane to insure proper lubrication of both seal faces. Lower face materials shall be silicon carbide vs. silicon carbide, upper faces carbon vs. ceramic, NBR elastomers, and 304SS hardware. Seal system shall not rely on pumping medium for lubrication.

## 2.4 MOTOR CONSTRUCTION

- A. The pump motor shall be an air filled induction type with a squirrel cage rotor, shell type design, built to NEMA MG-1, Design B specifications. Stator windings shall be copper, insulated with moisture resistant Class F insulation, rated for 311 F. The stator shall be dipped and baked three times in Class F varnish and heat shrunk fitted into the stator housing. Rotor bars and short circuit rings shall be manufactured of cast aluminum. Motor shaft shall be one piece AISI403 material, rotating on two permanently lubricated ball bearings designed for a minimum B-10 life of 60,000 hours. Motor service factor shall be 1.15 and capable of up to 20 starts per hour. The motor shall be designed for continuous duty pumping at a maximum sump temperature of 104 F. Voltage and frequency tolerances shall be a maximum 10/5% respectively. Junction area shall include a terminal board for power connections on all three (3) phase units. Motor protection shall be provided by an auto-cut device located directly over the windings to provide protection from single phasing, low voltage, phase imbalance, locked rotor, and no load or run dry conditions. Motor shall be non-overloading over the entire performance curve and be able to operate at full load intermittently while unsubmerged without damage to the unit.
- B. Power cable jacket shall be manufactured of an oil resistant chloroprene rubber material, designed for submerged applications. Cable shall be watertight to a depth of at least 65 feet. Cable entry shall be composed of a one piece, vulcanized, three way mechanical sealing system with a thick molded shoulder with increasing cable diameters to resist fatigue from bending forces. The molded shoulder, acts as the primary and secondary sealing points. This system shall also prevent leakage into the motor housing due to capillary action through the insulation if the cable is damaged or cut. A metallic plate shall be utilized to clamp the entry system to the motor housing. Strain relief shall be accomplished by clamping and attaching the cable with chain to the motor housing.

## 2.5 GUIDE RAIL SYSTEM

- A. Two (2) 304SS schedule 40 guide rails shall be provided and sized to mount directly to the quick discharge connector, QDC, at the floor of the wetwell and to a guide rail bracket at the top of the wetwell below the hatch opening. Intermediate guide brackets are recommended for rail lengths over 15 feet.
- B. The QDC shall be manufactured of cast iron, ASTM A48 Class 30. It shall be designed to adequately support the guide rails, discharge piping, and pumping unit under both static and dynamic loading conditions with support legs that are suitable for anchoring it to the wetwell floor. The face of the inlet QDC flange shall be perpendicular to the floor of the wetwell. The discharge flange of the QDC shall conform to ANSI B16.1 Class 125.
- C. An integral self-aligning sliding bracket shall be provided. Sealing of the pumping unit to the QDC shall be accomplished by a single, linear, downward motion of the pump. The entire weight of the pump unit shall be guided to and wedged tightly against the inlet flange of the QDC, making metal to metal contact with the pump discharge forming a seal without the use of bolts, gaskets or O-rings.
- D. A stainless steel lifting chain of adequate length for removing and installing the pump unit is recommended. The chain shall have a round link with a 2-1/4" inside diameter every two feet. This link will allow for a sliding pinch bar through the link to pick the chain, more than once if necessary, at multiple intervals during pump removal and installation.

## 2.6 TESTING

Tests shall be performed on the motor as follows:

- A. The field tests shall be made by the Contractor under the direct supervision of a qualified factory trained engineer, and in the presence of, and as directed by the Engineer. The Contractor shall provide, calibrate and install all temporary gauges and meters, shall make necessary tapped holes in the pipes, and install all temporary piping and wiring required for the field tests.
- B. The field tests shall determine the head, discharge flow and overall efficiency characteristics of each pumping unit and in addition, shall demonstrate that under all conditions of operation each unit:
  - Has not been damaged by transportation or installation.
  - Has been properly installed.
  - Has no mechanical defect.
  - Is in proper alignment.
  - Has been properly connected.
  - Is free of overheating of any parts.
  - Is free of all-objectionable vibration and noise.
  - Is free of overloading of any parts.

2.7 CONTROLS

- A. The pumps shall be controlled as specified and as shown on the Pump Station Drawings. See specification Section 221335 for required sewage pumping system operations descriptions for Pump Station #3.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install the pumps and appurtenances in accordance with the manufacturer's recommendations.

3.2 SPARE PARTS

- A. The following spare parts shall be provided for EACH pump:
  - 1. One complete set of mechanical seals.
  - 2. One complete set of impeller and casing wear rings.
  - 3. One complete set of bearings.
  - 4. One O-Ring set.

END OF SECTION 221330

## SECTION 221332 – PUMP STATION EQUIPMENT AND FIBERGLASS WET WELL

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. Provide all labor, materials, equipment and services necessary for and incidental to, the complete and satisfactory installation of the fiberglass wet well and other equipment for Pump Station #3 as specified herein and as shown on the Contract Drawings. Note that the entire pump station shall be a prepackaged system with the pumps and all appurtenances to the station (interior piping, valves, wet well, guiderail, supports, etc.) being provided by a sole source.

#### 1.2 RELATED SECTIONS

- A. Section 221330 – Vortex Sanitary Sewerage Pumps
- B. Section 221335 – Integrated Pump Control System

#### 1.3 SUBMITTALS

- A. Shop Drawings: The Contractor shall furnish the Owner/Engineer, for approval, copies of detailed shop drawings showing outline and dimensions of all equipment specified herein and as shown on the Contract Drawings.

If for the equipment proposed by the Contractor, any structure changes are required, the Contractor shall prepare and submit for approval, complete drawings showing all necessary changes and all such changes shall be made at the Contractor's expense.

- B. Material List: Accompanying the Shop Drawings, the Contractor shall submit an equal number of copies of a complete list of all materials and equipment proposed to be furnished and installed under this Division, giving Manufacturer's name, catalog number and catalog cut for each item, where applicable.
- C. Other Submittals: Complete bound instructions manuals shall be furnished.

#### 1.4 GUARANTEES

- A. The Contractor shall guarantee that the equipment furnished, including all accessories and appurtenances is of the correct design, capacity and construction to operate satisfactorily in the installation and type of service for which it is to be used.

## 1.5 TRAINING

- A. Provide training for operation and maintenance of all equipment included in this section.

## PART 2 - MATERIALS

### 2.1 FIBERGLASS WET WELL

- A. General: Unless otherwise indicated, the plastics terminology used in this standard shall be in accordance with the definitions given in American Society for Testing and Materials (ASTM) Designations D3753-99.
- B. Materials:
  - 1. Resin: The resin used shall be of a commercial grade and shall either be evaluated as a laminate by test or determined by previous service to be acceptable for the environment.
  - 2. Reinforcing Material: The reinforcing material shall be a commercial grade of glass fiber having a coupling agent which will provide a suitable bond between the glass reinforcement and the resin.
  - 3. Laminate: The laminate shall consist of an inner surface, an interior layer, and an exterior layer of laminate body.
  - 4. Inner Surface: The inner surface shall be free of cracks and crazing with a smooth finish. This may be a gelcoat surface or reinforced with glass surface veil.
  - 5. Interior Layer: A minimum of 0.100 inch of the laminate next to the inner surface shall be reinforced with not less than 20 percent nor more than 30 percent by weight of noncontinuous glass strands having fiber lengths from 0.5 to 2.0 inches.
  - 6. Exterior Layer: The exterior layer of body of laminate shall be of construction suitable for the service intended and contain sufficient glass by weight to provide the aggregate strength necessary to meet the tensile and flexural requirements. The exterior surface shall be relatively smooth with no exposed fibers or sharp projections. Hand work finish is acceptable, but enough resin shall be present to prevent fiber show.
  - 7. Tank Wall: The tank wall must be designed to withstand wall collapse based on the assumption that saturated soil exerts hydrostatic pressure of 120 pounds per cu. ft. The tank wall laminate must be constructed to withstand or exceed two times the actual imposed loading on any depth of basin. Stress calculations must be submitted verifying the results obtained using 120 pounds per cu. ft. hydrostatic pressure and two times actual imposed loading on any depth basin. Depth of bury to be specified on purchase order with wall thickness calculated and guaranteed by the Manufacturer. Tank wall shall have a minimum wall thickness of 5/16".

8. Tank Bottom: The tank bottom must be constructed suitable for the service designated by the Engineer. Under totally water submerged conditions, the center deflection of any empty tank bottom must be less than 3/8 inch as not to interfere with bottom pump mounting requirements and rail systems. Tank bottom shall have a steel insert to assist with deflection.
9. Appearance: The finished laminate shall be as free as commercially practicable from visual defects such as foreign inclusions, dry spots, air bubbles, pinholes, dimples, and delaminations.
10. Basin: The pump basin shall be a 72-inch inside diameter by the height as shown on the contract drawings. The bottom of the basin shall be reinforced with a fiberglass plate extending beyond the basin diameter for anchoring to a concrete pad. Pump mounting studs will be attached to this plate and installed in pump basin.
11. Anti-float: Design of fiberglass anti-float ring shall be the responsibility of the manufacturer and shall be submitted as part of the shop drawings. Design shall be certified by licensed engineer in the State of Delaware.
12. The basin shall be manufactured by AK industries or equal.

C. Wet Well Accessories

1. Aluminum Hatches: Aluminum hatches shall be provided by the fiberglass basin manufacturer. Aluminum hatches shall be constructed of 1/4" aluminum diamond plate on a 1/4" - 2"x2" aluminum angle frame. Hatch shall have aluminum hold open bars and stainless steel hinges. Hatch handles shall be nylon. Aluminum hatches shall be sized as shown on the Contract Drawings.
2. Float Bracket: The fiberglass basin shall be provided with a stainless steel float bracket capable of holding four floats as shown on the Contract Drawings. The float bracket shall be mounted to the interior of the fiberglass basin.
3. Penetrations:

Penetrations for the vent through the wet well wall shall be done with an Adaptaflex Fitting provided by the basin manufacturer.

Penetrations for the pump discharge and the gravity drain from vault shall be a female by female stainless steel full coupling provided by the basin manufacturer.

Penetrations for electrical conduit shall be a nylon plastic full coupling provided by the basin manufacturer.

Penetrations for the gravity sewers shall be cast iron inlet hubs provided by the basin manufacturer.

4. Pump Base Connection

The basin shall be provided with GA duplex basin studs for connection of the discharge pump bases.

D. Backfill

Backfill shall be in accordance with Section 312000 Earthwork.

2.2 ODOR CONTROL SYSTEM – PASSIVE

- A. The odor control system shall be a passive system which operates by the displacement of air from the incoming waste water flow. It shall consist of a preassembled Schedule 40 barrel, vent and cap with a stainless steel canister.
- B. The vent shall consist of a flange suitable for bolting the vent to the structure opening, the main barrel that conducts the air flow from the structure to the vent head, and a vent head consisting of an exhaust screen and a properly sized cap. The free area of the exhaust screen exposed to the atmosphere shall equal or exceed the free area of the screen which is internal in the vent, and in addition shall be equal to or exceed the amount of free area required to pass the required volume of air at a maximum external pressure of .25” through the main barrel of the vent.
- C. Cap shall be secured to the vent assembly with quick lock insert pins and shall be easily removable for inspection and cleaning of the vent when required. All vent materials shall be gray schedule 40 or 80 PVC.
- D. The canister shall be constructed of stainless steel. The canister shall have a stainless steel lid secured by a stainless steel lever actuated clamp. The free area of the exhaust screen exposed to the atmosphere shall be stainless steel and have an open free area not less than 48%. The lid shall be easily removed by releasing the one piece snap lock lever clamp allowing for maintenance and replacement of the carbon without requiring removal and handling of the cartridge. The canister shall be supplied with activated carbon for removal of H<sub>2</sub>S gas.
- E. The Passive Canister and Vent shall be model 6” BVC618 and 6” BVC618F as manufactured by EZ Vent or equal, suitable for handling a wastewater flow of 141 gpm.

2.3 VALVES

- A. Isolation valves and check valves shall be placed on the discharge line of each pump.
- B. Check valves shall be located between the shutoff valve and the pump. Isolation valves and check valves shall be suitable for the material being handled and be capable of withstanding normal pressure and water hammer.
- C. Isolation valves shall be 200F Flanged Cast Iron Gate Valve as manufactured by Matco-Norca, or approved equal.

- D. Check valves shall be 120WC Cast Iron Swing Check Valve as manufactured by Matco-Norca, or approved equal.

#### 2.4 MAGNETIC FLOW METER

- A. The magnetic flow meter shall be furnished at location as shown on the Contract Drawings.
- B. The magnetic flow meter shall be of the pulsed DC excitation type designed specifically for raw sewage applications and shall be microprocessor based. It shall produce an output signal and indication directly proportional and linear with the liquid flow rate. An integral display shall be provided.
- C. There shall be a 4-20 mA output signal that will be conveyed to the pump station control panel for monitoring and recordation.
- D. Manufacturers shall have supplied magnetic flow meters in similar wastewater applications for at least five years and shall provide suitable references if required. Meters shall be warranted against defective workmanship for a period of two years from the date of shipment.
- E. The magnetic flow meter shall be Sitrans F M MAG 5100 W, as manufactured by Siemens, or approved equal.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install of all equipment shall be in strict accordance with the manufacturer's recommendations as approved by the Owner. Furnish services of the manufacturer's technical representative to supervise the initial phase of setting and aligning of the equipment; and after the installation is completed for start-up, testing and to instruct the Owner in proper maintenance.
- B. Upon completion of the work and prior to its acceptance by the Owner, make all required field tests.

END OF SECTION 221332

## SECTION 221335 – INTEGRATED PUMP CONTROL SYSTEM

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. Provide all labor, materials, equipment and services necessary for and incidental to, the complete and satisfactory installation of the preconfigured fully integrated digital pump control system for controlling two (2) TVDs (Torque Vector Drives) for Pump Station #3, as specified herein and as shown on the Contract Drawings.
- B. The pump control panel and drive panels shall be setup, adjusted, and tested by the manufacturer or authorized manufacturer's representative.
- C. All the panels and the HMI (human machine interface) shall communicate digitally via a RS232 serial link.
- D. The control panel shall be the responsibility of the pump station equipment supplier.

#### 1.2 SUBMITTALS

- A. Submittal packages including drawings shall be furnished for Engineer's approval. These packages shall consist of elementary power and control wiring diagrams and include outline drawings as well as complete BOM (Bill of Materials). The enclosure drawings shall include front and side views of the enclosures with overall dimensions, and general component arrangement of the subplate. Standard catalog specification sheets showing voltage, horsepower and maximum current ratings shall be furnished as part of the submittal package.

#### 1.3 WARRANTY

- A. An 24-month parts warranty shall be provided on materials and workmanship from the date of purchase, or 12 months from the date of startup, whichever occurs first.
- B. Warranty work will only be performed by the manufacturer or the manufacturer's authorized service representative.

#### 1.4 QUALITY ASSURANCE

- A. The manufacturer of the panels shall be a UL508 (or equivalent) certified facility.
- B. All panels shall be designed, constructed and tested in accordance with NEMA, IEC and UL508A standards.

- C. Prior to shipment or at start-up, the pump control system shall be functionally tested as a complete system with motors connected to ensure proper sequencing and operation. All display screens and controls shall be tested to insure proper operation. Documentation of test results shall be furnished at the Engineers' request.

#### 1.5 TRAINING

- A. Provide training for operation and maintenance of the pump control system.

#### 1.6 QUALITY CONTROL

- A. The manufacturer of the panels shall be a UL508 (or equivalent) certified facility.
- B. All panels shall be designed, constructed and tested in accordance with NEMA, IEC and UL508A standards.
- C. Prior to shipment or at start-up, the pump control system shall be functionally tested as a complete system with motors connected to ensure proper sequencing and operation. All display screens and controls shall be tested to insure proper operation. Documentation of test results shall be furnished at the Engineers' request.

### PART 2 - PRODUCTS

#### 2.1 RECOMMENDED SOURCES FOR PUMP CONTROL SYSTEM COMPONENTS

- A. Terminal Strips: Weidmuller Z Series, or equal.
- B. Human Machine Interface: Monotouch HMI, or equal.
- C. Local Logic Unit:
  - 1. AT2K: Toshiba T1 (TDR116S6S) micro PLC, or equal.
- D. Digital Transducers: BihlerTech, Inc. P40P Series, or equal.
- E. Adjustable Speed Drives: Toshiba S11, G9, H9, or AS1 Series, or equal.

### PART 3 - SYSTEM OPERATION

#### 3.1 GENERAL

- A. Operation of the pumps shall be controlled by the direct manipulation of motor torque. Speed control shall not be an acceptable alternative.

- B. All control of the lift station operations shall be completely integrated through a central processing LLU (Local Logic Unit) as described below, including the following:

- Level Measurement
- TVD(s)/ Pump Control
- Alarms and Error Codes
- Corrective functions
- Auto Dialer control
- Flow (from remote flow meter)

- C. The controller shall be user selectable to reverse the pump(s) impeller for 2.5 seconds at 150% of motor rated torque each startup, if so designated by the operator.
- D. The control system shall be able to determine whether a pump failure is due to loss of power at the TVD or due to TVD fault/ trip and it shall cause an error code to be displayed. In the case of TVD fault/ trip, the pump shall remain off until serviced. In the event of loss of power or communication error to the TVD, the controller shall attempt to re-start the TVD every time in its sequence.

### 3.2 LEVEL SETTING

- A. The pump operation levels shall be settable through the HMI. The pump operation levels shall be Low Level Off, Normal Pump Start, Second Pump Start, and High Level Alarm. Once the parameters have been selected the LLU shall use these settings to operate the pump(s).
- B. The control system shall have a settable P.I.D. hold point. The P.I.D. hold point shall adjust the torque input to the TVD's thereby maintaining a constant wet well level while simultaneously trimming the torque setting to find the BEP for the required flow rate.

### 3.3 NORMAL: STATION OPERATION AND ALTERNATION

- A. Upon power up, the LLU shall load the initial saved values and the program from EEPROM. The LLU shall check the calibration signal from the digital transducer to make sure it is within operational parameters. If the transducer is functioning properly, the system shall wait until the level measurement switch is in transducer mode to start the compressor sequence. If the transducer is not functioning properly the system shall automatically change to float switch mode, and set an error code. Once the LLU detects the level measurement switch is in transducer mode, and the compressor switches are in the ON position, the first compressor shall be started. If the pressure doesn't rise within 3 seconds, the second compressor shall be activated, and the first compressor error code shall be displayed.
- B. The LLU shall have an internal seven- (7) day memory storage capacitor. This shall insure that no information shall ever be lost in the event of a momentary power failure. The LLU shall have no user serviceable parts, and shall have no battery backup that may

require future service. The transducer shall send a digital signal to the LLU in 10ths of an inch every scan. The transducer range shall be 0 to 100 inches of water.

- C. The TVDs shall operate in a continuously alternating sequence and shall recognize if it has 1 or 2 pumps on line.
- D. In PID the first time the level reaches the first pump start, pump 1 shall operate and the logic control shall automatically alter the pump torque thereby allowing the pump to operate at the most efficient point of the curve. If the level continues to rise after TVD #1 is at its maximum torque setting pump 2 shall come on line and monitor all two pumps.
- E. If the level continues to rise with all two (2) pumps running and it reaches the high level alarm set point, and remains there for five (5) minutes, the high water alarm shall be activated and an error code shall be displayed.
- F. All pump(s) shall operate until the level has been decreased to the Low Level Off set point programmed, at which time all pumps shall drop out, and normal pump rotation shall resume.
- G. The next time that the level reaches the level for first pump start pump 2 shall operate, and follow the same sequence as described above.
- H. In the event of a TVD(s) tripping from motor internal thermal overload, the pump shall be temporarily removed from active service and the lift station shall operate in Simplex mode and display an error code corresponding to this condition. Once the pump has been manually reset it shall be returned to service. Returning the pump to service shall re-initiate duplex operation automatically.
- I. In the event that a seal failure is detected from a pump(s), a “Non-Fatal” error code shall be displayed and the pump will remain in service.
- J. The operator shall have the option of taking one (1) pump off line and operating the system as a simplex lift station without any changes in hardware or software.

### 3.4 OPERATION MODES

- A. P.I.D. Operation: The lift station shall be capable of wet-well learning without software changes. The wet-well learning mode shall be capable of activation with a switch change by the operator. In this mode, the wet well shall be held at the P.I.D. Hold Point specified by the operator and shall be capable of change through the HMI. The controller shall not just follow influent flow. The internal algorithm shall predict and move the torque setting in front of flow so as to not have the TVD “Hunt”.
- B. Emergency Mode (Float Switch Operation): If the LLU does not get a proper signal from the transducer, the system shall automatically switch to the emergency mode, float switch operation, and shall set an error code on the display. The physical float switches shall only operate if the automated level measurement system is not functioning properly or is

in the off position. This shall assure the operator that the lift station shall always remain in operation.

1. The physical float switches for the lift station shall operate in a normal fashion when activated. Float 1 shall be the pump shut off float, float 2 shall be the normal level float and float 3 shall be the second pump start, and float 4 shall be the high level alarm float. When the float switches are active, the pumps shall run at full torque control, as described previously when on line.
2. When the PLC receives a proper signal from the transducer, the system shall automatically switch back to normal mode.

### 3.5 ALARMS AND ERROR CODES

- A. All alarms and error codes shall be displayed through the HMI and shall be controlled through the LLU.
- B. The HMI will show the current error and three previous errors for ease of error interpretation and troubleshooting.
- C. Listed below are the minimum alarms and error codes

Digital Transducer Primary Failure  
4-20Ma Analog Signal Primary Failure  
0-10Vdc Analog Signal Primary Failure  
Float Switch 1 Failure  
Float Switch 2 Failure  
Float Switch 3 Failure  
Float Switch 4 Failure  
Compressor one failure  
Compressor two failure  
Air Line Fault  
High Water  
TVD 1 Trip  
TVD 2 Trip  
TVD 1 Not Responding  
TVD 2 Not Responding  
Pump 1 Seal Fail  
Pump 2 Seal Fail  
Pump 1 Internal Thermal Overload  
Pump 2 Internal Thermal Overload  
Pump 1 Running Dry  
Pump 2 Running Dry  
Send Buffer Error  
Receive Buffer Error  
LU RAM Error

- D. The high water alarm shall reset itself if the condition is corrected.

- E. All error codes whether in controller or TVD shall be given a three digit code upon display. When this code is entered into PLC it will, in English, describe the error and advice corrective action.

### 3.6 TVD COMMUNICATIONS

- A. All communications between the pump control panel and the TVDs will be digital via a 4 wire/2 wire RS485 link.

## PART 4 - PUMP CONTROL PANEL

### 4.1 GENERAL

- A. The components of the pump control panel shall be designed to be modular, easily replaceable, and provide the maximum reliability possible. The components of the pump control panel shall provide a standardized control system for pump stations utilizing TVDs.
- B. The control system shall communicate with the TVDs via RS-485 bus, no equivalent. The controls shall be a completely integrated solid state pump station management control system specifically designed for the municipal and industrial markets. The complete control package shall be a standard product of a single manufacturer. The management system shall continually monitor the flow of two (2) pumps and alter the pump(s) curve for either set point on/ off or to maintain a constant level in the wet well under varying flow conditions. The pump station control panel must use less than 0.5 amps including linear compressors. It shall eliminate motor inrush at startup, allow the number of pump starts per hour to be limit-less and allow the wet well size to be reduced to the physical dimensions of the pumping equipment itself. After completion of set up, change of power supply phase shall not change pump rotation.

### 4.2 CONTROL PANEL CONSTRUCTION

- A. Enclosure
  - 1. The control equipment shall be completely housed in one (1) NEMA 4X enclosure sized to fit into the existing control enclosure. The enclosure shall be rated for indoor and outdoor applications. The molded fiberglass polyester must have outstanding chemical and temperature resistance and must exhibit weatherability and physical properties. The enclosure shall have a foam-in-place gasket, which shall assure a watertight and dust-tight seal. All major components shall be identified and labeled. All connection terminals shall be labeled.
  - 2. The human machine interface shall be installed in the control enclosure door.
- B. Selection Switches

1. The control panel shall have no physical selector switches.
2. All controls (switches, settings, alarms, error codes, pilot lights, pump controls, level measurement, flow measurement, etc.) shall be accessed through the human machine interface.

#### 4.3 LEVEL CONTROL

- A. Level measurement shall be performed by an intrinsically safe pneumatically calibrated direct digital or optional analog transducer system. It shall have one (1) direct digital differential pressure transducer. Digital transducer shall not be affected by electrical noise and shall not require shielded wiring. As an option, analog transducers that use a voltage or current signal can also be used. The digital transducer shall utilize two (2) linear motor compressors with a rated constant running life of a minimum of 40,000 hours each. The compressors shall run as a main compressor and a back-up compressor. The transducer shall transmit a minimum digital signal at all times to allow for the LLU to monitor proper operation thereof.
- B. The level measurement system shall be direct inputs to the local logic unit, and shall have a routine to monitor the transducer and, in the event of a failure, be capable of switching to physical float switch mode at which time the TVDs will be brought to full torque and operate as a standard duplex or triplex lift station.

#### 4.4 FLOW MONITORING

- A. The remote flow meter output shall be transmitted by analog (4-20 mA) signal to the manufacturer supplied pump station control panel. The control panel will be configured to record and display both the flow rate and the totalized flow volume. Engineering units and totalizer multiplier shall be displayed with each line of data. A forward, reverse and net flow totalizer shall be incorporated within the flow transmitter. An operator shall have the option of scrolling between each of the three totalizers for the preferred display.

#### 4.5 LOGIC CONTROL

- A. Local Logic Unit: The LLU (Local Logic Unit) shall be capable of continuously monitoring up to two (2) high-speed digital pulse inputs. The logic program will be stored in non-volatile EEPROM. The LLU shall be upgradable and with the upgrade, may be expandable, via Bus communication, to 72 I/O. It shall be capable of operation in an ambient temperature range of -0 to 55 degrees C and 20 to 95% non-condensing humidity. The LLU must have surge resistance of 5kV (1.2 \* 50) micro seconds, and be self-cooling.
- B. Program Storage Module: The Panel shall include a self-contained Program Storage Module (EEPROM module). This module shall contain a copy of the program and shall give the operator the option of being able to purchase and replace the LLU from any

supplier and reload the logic program for the panel. Also, this module shall allow for quick and easy upgrades, if necessary, to the logic control program.

C. Human Machine Interface: The HMI (human machine interface) shall allow setting and display of all system operation parameters. It shall operate at 24 V DC.

1. The HMI shall allow setting of the following:

- Low Level Pump Off
- Normal Level Set Point
- Second Pump Set Point
- High Level Alarm Set Point
- P.I.D. Hold Point
- Pump Seal Fail Logic, N/O or N/C
- Pump Internal Thermal Logic, N/O or N/C
- Minimum Run Torque Percentage - 1 Pump Running
- Minimum Run Torque Percentage - 2 Pumps Running
- Maximum Torque Below \_ Hertz
- Minimum Torque Percentage - All drives
- Maximum Hertz- All pumps Reverse pumps on start - on/off
- 5 Minute off for pumps in hand position - on/off
- Auto Trim or P.I.D mode
- All P.I.D parameters

2. All controls (switches, settings, alarms, error codes, pilot lights, pump controls, level measurement, etc.) shall be accessed through the human machine interface.

- Pump 1; Online/ Offline, On/ Off, Trip, AMPS, RPM, Torque
- Pump 2; Online/ Offline, On/ Off, Trip, AMPS, RPM, Torque
- Run Hours each pump
- Run Hours two pumps operating
- Cumulative Run Time all pumps
- Bar graph station well level
- Error codes & descriptions as defined in the TVD manual

D. Allocation for Dial-up Alarm System: The LLU shall have the capability to provide the following to an optional autodialer.

1. Eight (8) dry contacts (NO/NC) integrated into the management system allocated for operating an Auto-Dialer system. Integrated into the controls there shall be a two- (2) minute time delay between an alarm condition and the starting of the dialer. Delay shall be changeable via software alteration if required by the Engineer or the Owner.

2. The eight (8) dry contacts shall be for Non-Fatal Fault, Pump 1 Run, Pump 2 Run, High Water Alarm, Pump 1 Failure, and Pump 2 Failure.

## PART 5 - ADJUSTABLE TORQUE DRIVES AND PANELS

### 5.1 DESCRIPTION

- A. This specification covers AC Voltage Source PWM Type Variable Torque Inverter Drives in the power range from 56KVA to 400KVA. All drives shall be furnished by the same manufacturer.
- B. The TVD will be powered from a 460 Volt, three-phase, 60 HZ bus, with maximum voltage variation of  $\pm 10\%$  and maximum frequency fluctuation of  $\pm 2\text{HZ}$ . (380V-415V/50Hz also available) The TVD shall be capable of operation on a system with 5% Total Harmonic Distortion (THD) present. The TVD output voltage will be varied proportionally to the output frequency to maintain a constant V/Hz up to the nominal 60 hertz. Above 60 hertz, the output voltage shall be constant.
- C. The TVD shall be suitable for operating standard NEMA Design B motors. The drive shall be a minimum 6 pulse design. The design will incorporate three distinct diode bridges configured in a series connection. The series connection will provide continued balance of the bridges to insure the harmonic litigation remains consistent throughout the life of the drive. The input to the diode bridges will be a full phase shifting isolation transformer with multiple secondaries. Designs that provide parallel connected diode bridges or designs incorporating an autotransformer will not be acceptable. The variable frequency drive system shall also include a filter network and a transistorized inverter section. The TVD manufacturer will also manufacture the Transistors used in the inverter section of the drive. The output will be a sinusoidal wave, pulse width modulated (PWM) voltage wave form for reduced harmonic heating in the motor.

### 5.2 TVD QUALITY ASSURANCE

- A. The manufacturer of the TVD shall have had at least 5 years' experience in furnishing similar size and type TVD systems. Upon request provide a list of installations of such systems giving size, type and date of installation. The manufacturer shall meet the quality and program requirements of ISO 9001.
- B. The complete variable torque drive assembly shall be listed and labeled for the purpose for which it is used by Underwriters Laboratories Inc.

### 5.3 RATINGS

- A. Service Conditions:
  - 1. Input Power: 400-460VAC, plus 10 percent, minus 10 percent, 3 phase, 60 Hz, plus 2, minus 2 Hz.
  - 2. Ambient Temperature: -10 to 40°C (14 to 104°F)
  - 3. Storage Temperature: -20 to 60°C (4 to 140°F)

4. Relative Humidity: 0 to 95% Non-Condensing
  5. Vibration: Acceleration at 0.6 G maximum (10-55 Hz). Amplitude at 0.1mm maximum (50-100 Hz).
  6. Altitude: 0 to 3300 Ft (0 to 1000 M)
- B. The TVD power rating will be 13.75 KVA minimum for operation of a 15 HP motor driving a centrifugal load with a torque versus speed characteristic proportional to the square of the speed ratio of operating speed over motor full load speed. The motor will have 3 poles operating at approximately 1760 RPM at 60 HZ and full rated load. The TVD shall be capable of operating with an output frequency speed range of 10 to 60 HZ. The operating speed range for this application will be 760 RPM to 1760 RPM based on the load performance and system requirements. The drive shall be capable of 100% full load continuous output with 120% overload rating for sixty (60) seconds.
- C. In the event of a sustained power loss, the control shall shut down safely without component failure. Upon return of utility power, the system shall be capable of automatically returning to normal operation. In the event of a momentary power loss, the control shall shut down safely without component failure. Upon return of power, the system shall automatically return to normal operation. The drive shall be capable of starting into a rotating motor in either direction without damage to connected equipment.
- D. Minimum drive efficiency for NEMA 1 assemblies: 95.0 percent or better at motor base speed and rated torque. Losses shall include all control power and cooling system losses associated with the drive as well as the input phase shifting transformer.
- E. Displacement power factor: 95 percent or higher throughout the entire operating speed range, measured at drive input terminals.
- F. Output frequency drift: No more than plus or minus 0.5 percent of maximum frequency.
- G. Power transistors to be Insulated Gate Bipolar Transistors (IGBT's) with a PIV rating of 1200 volts minimum.

#### 5.4 TVD CONSTRUCTION

- A. Each drive shall be designed for stand-alone operation. Multiple drive units shall not utilize shared components. The drive shall be housed in a free standing, front accessible, general purpose indoor enclosure rated NEMA 1. Cabinets shall be single or multi-bay, sheet steel with hinged doors. Doors will have concealed hinges with lockable through-the-door handle operator mechanism. Optional enclosure styles for drives rates 60HP through 400HP shall be available for NEMA TYPE 12.
- B. Provisions shall be made for top or bottom entry/exit of incoming line power cables, outgoing load cables and control wiring.
- C. Addition of a Bypass circuit will increase the width of the drive package.

1. Each TVD shall have a molded case, circuit breaker type main power disconnect switch, with an external operating handle. The circuit breaker shall have a minimum short circuit rating of 25,000 amperes RMS symmetrical interrupting capacity and shall be labeled in accordance with UL Standard 489.

## 5.5 CONTROL WIRING

- A. Wiring: 600 volt, stranded copper. 90 degrees C color coded insulation, minimum size No. 16 AWG (120VAC control power only).
- B. Identification and termination: Crimp type wire lugs with sleeve type markers at each termination point. Provide numbered terminal blocks for external connections.
- C. Control power: Provide a 120VAC, fused, control power transformer for cooling fans and external control circuits when required. All control circuits shall be isolated from power circuits.

## 5.6 LOCAL OIS

- A. Provide a door-mounted digital keypad/display, capable of controlling the drive and setting the drive parameters. The digital keypad will be a 2 line backlit LCD display with 20 characters per which will normally display:
  1. Frequency in Hertz.
  2. Control mode - manual or automatic.
  3. Real time and date.
  4. KW.
- B. The digital keypad shall allow operators to enter exact numerical settings in English engineering units. A user menu shall be provided as a guide to parameter settings. These parameters shall be adjustable for specific project application requirements on site. All setup operations and adjustments will be digital, stored in non-volatile (EEPROM) memory. No analog or potentiometer adjustments will be allowed. The variables stored in EEPROM shall be transferable to new and spare boards. As a standard feature, these variables shall be protected from unauthorized tampering, revision, or adjustment by a personal lockout code.
- C. The digital keypad shall have 20 keys to provide easy programming of the drive. These keys shall include:
  1. Up and Down arrow keys to increase or decrease output frequency or data values.
  2. Monitor key for selection of control mode.
  3. Run and Stop keys for starting and stopping in the manual mode.

4. Fault clear/enter keys for quick reset of fault conditions and entry of changes.
  5. Program key to enter the program mode and adjust parameters.
  6. Remote/Local keys for speed control in the monitor mode.
  7. Auto/Manual keys for run mode control in the program mode.
  8. 0 through 9 number keys to access specific parameters. These keys eliminate scrolling through many program features to find a specific value.
- D. All keypad digital illustrations shall be in English. The display shall be capable of illustrating 50 past faults.

## 5.7 FEATURES

- A. An RS485 communication interface shall be installed on each TVD.
- B. Provide the following short circuit and input protection:
1. High speed current limiting fuses rated 200,000 AIC, specifically designed for solid state applications.
  2. Solid state instantaneous overcurrent trip set at 180%.
  3. Undervoltage protection with automatic restart.
- C. Provide the following internal protective features:
1. Transient surge protection using metal oxide varistors (MOV's).
  2. Transistor overtemperature and overcurrent protection.
  3. Current limit comparator circuit to automatically phase back the output current and frequency to prevent excessive currents from damaging motor insulation.
  4. DC bus fuse protection.
  5. DC bus overvoltage trip.
- D. Provide the following output protective features.
1. Inverse time motor overload protection. Adjustable from 10% to 100%.
  2. Static overspeed protection.
  3. Stall protection on overload with inverse time overcurrent trip. Current limit shall be adjustable from 10% to 215%.
  4. Protection against opening or shorting of motor leads.

5. Critical frequency avoidance circuit. Three set points selectable from 0 to maximum frequency. Band width of set points to be adjustable from 0-30HZ.
- E. For test purposes, it shall be possible to run the drive with no load (the motor is disconnected from the drive output).
- F. Fault protection: The following conditions shall cause an orderly TVD shutdown and lockout:
  1. Overcurrent at startup.
  2. Instantaneous overcurrent.
  3. Over temperature of TVD or external fault.
  4. Ground fault.
  5. Blown input fuse.
  6. Control power supply failure.

#### 5.8 FACTORY TESTS AND DEMONSTRATIONS

- A. Upon completion of manufacture and assembly, the drives shall be subjected to a complete factory test to demonstrate compliance with specified features and characteristics. Factory tests and demonstrations shall be provided and coordinated with the Construction Manager. The Owner at his option shall be able to witness factory testing of his unit, with factory coordination.
- B. The testing procedure shall be the manufacturer's standard procedure to assure maintenance free service. The Construction Manager shall be given a 5 day notice prior to the start of factory testing for the Owner's representative to witness the testing.
- C. All equipment, devices, instrumentation, and personnel required to perform the factory tests shall be supplied by the manufacturer. Upon satisfactory completion of the test, the Contractor shall upon request submit two (2) certified copies of the test report to the Construction Manager. Component failure during testing will require repeating any test associated with the failure or modified components to demonstrate proper operation.

END OF SECTION 221335

## SECTION 330100 - SANITARY SEWER PRESSURE PIPE

### 1. GENERAL

- A. This item shall consist of installing and testing sanitary force mains of polyvinyl chloride (PVC) and high density polyethylene (HDPE), fittings and appurtenances as shown on the Plans and in accordance with these Specifications.
- B. Any damage resulting from improper storage, handling, installation, care of the equipment during installation or testing shall be the sole responsibility of the Contractor.
- C. Leaks and defects shall be repaired or otherwise remedied by the Contractor at no expense to the Owner and to the complete satisfaction of the Engineer, at whatever time they become apparent prior to the expiration of the guarantee period under this contract.
- D. If at any time before the expiration of the guarantee period under this Contract, any defects are found in any of the pipes or appurtenances, the Contractor shall cause the same to be removed and replaced by proper materials and workmanship, without extra compensation for the labor, equipment and material required even though such injury or damage may not have been due to any act, default or negligence on the part of the contractor. All materials shall be carefully examined by the Contractor for defects prior to installation and any found defective shall be rejected for use.
- E. The excavation in which appurtenances are being placed shall be kept free from water and no joint shall be made under water. Water shall not be allowed to rise in the excavation until the joint material has received its set. The greatest care shall be used to secure watertightness and to prevent damage to, or disturbing of, the joints during the refilling process, or at any time. After appurtenances have been installed and the joints have been made, there shall be no walking on or working over them except such as may be necessary in tamping, until there is a covering at least two feet in depth over their top.

### 2. MATERIALS

- A. Polyvinyl Chloride (PVC) Pipe:
  - 1. Polyvinyl chloride (PVC) pipe, used for force main and pump station 3 construction, shall equal or exceed the requirements of ASTM D 3034 latest version and shall conform to Schedule 80 pressure pipe specifications, and the minimum pipe stiffness, as tested in accordance with ASTM D 2412 latest version, shall be 45 psi when measured under 5 percent deflection at 73 degrees Fahrenheit.

- a. 4 inch Schedule 80 PVC will be used for the force main at Pump Station #3 as specified on the drawings.
  2. PVC pipe fittings shall utilize an elastometric O-ring gasketed joint assembly in accordance with the manufacturer's recommendations.
  3. Pipe shall be manufactured with integral wall bell and spigot joints in standard lengths not exceeding twenty (20) feet.
  4. Polyvinyl Chloride wye branches, T-wye branches, pipe stoppers and other fittings shall be manufactured in accordance with the same specifications and shall have the same thickness, depth of socket, and annular space as the pipe. Wye and T-wye branches shall be complete pipe sections. Saddles will not be permitted for use in new construction.
  5. PVC pipe shall be delivered and stockpiled in unit pallets. Store pipe on flat surface. No stacking of pallets or random lengths above 5 feet in height will be allowed. If pipe in stockpiled for more than 30 days prior to installation in the trench, it must be suitably covered with reflective materials to protect the pipe from ultra-violet rays emanating from sunlight. Do not use plastic sheets. Allow for air circulation under covering.
  6. Bowed sections of pipe will be unacceptable and installation of pipe which has bowed, whether or not the bow has been corrected, will not be allowed.
- B. High Density Polyethylene (HDPE) Pipe:
1. High density polyethylene (HDPE) pipe used for force main construction, shall be PE3408 HDPE meeting cell classification 345444C or 345444E per the requirements of ASTM D 3350 latest version and shall be listed in the name of the pipe and fitting manufacturer in the Plastics Pipe Institute TR-4, Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fittings Compounds, with a standard HDB rating of 160 psi at 73° F. Pipe and fittings shall be from the same manufacturer.
    - a. 1.5 and 2 inch HDPE DR-11 pipe will be used for the force main at Pump Station #1 and #2 respectively as specified on the drawings.
  2. Pipe shall be manufactured in accordance with ASTM F714 or ASTM D 3035 latest versions and shall be so marked.
- C. Plug Valves

1. General: Plug valves shall be eccentric resilient-faced plug valve suitable for buried service, as manufactured by the DeZurik Unit of General Signal Corp. or an approved equal. The valve shall be suitable for tight closure with pressure on either side of the plug.
2. Buried valves shall have mechanical joint ends. The plug seat shall have an overlay of mechanical nickel, fusion-bonded Nylon II, or other suitable material on all surfaces in contact with the plug face. The port area of the valve shall not be less than 100% of the pipe area. The upper trunnion shall be sealed with either permanent "O"-ring type seals, or packing held in place by an adjustable packing gland. Packing shall be replaceable without disassembly of operator or valve. The upper and lower journals shall be fitted with replaceable permanently lubricated stainless steel sleeve type bearings.
3. Plug valves shall be buriable gear actuated valves operated with extended 2-inch nut actuator.
4. All plug valves shall be furnished with buried service type gear operators. Buried valves shall be furnished with a valve box and an extension stem securely fastened to the operator to position a 2-inch square operating nut welded to the top of the stem within 12 inches of the ground surface. Spacer discs or rods shall be installed in the valve box as required to center the extension stem. Extension stem shall be of the size recommended by the valve manufacturer.
5. The exterior of the valve, operator, and extension stem shall be bituminous coated unless otherwise noted.

D. Check Valves

1. The check valve at the end of the proposed 4" FM shall be a rubber flapper swing check valve, placed in a standard manhole upstream of the plug valve.
2. The check valve shall have a heavily constructed iron body and cover, conforming to ASTM A126 Grade B for cast iron or ASTM A536 for ductile iron. The body shall be long pattern design (not Wafer), with integrally cast-on end flanges. The rubber flapper shall be Buna-N having an O-ring seating edge and be internally reinforced with steel.
3. Flapper to be captured between the body and the body cover in a manner to permit the flapper to flex from closed to full open position during flow through the valve. Flapper shall be easily removed without need to remove the valve

from the line. Check valve to have full pipe size flow area. Seating surface to be on a 45 degree angle requiring the flapper to travel only 35 degree from closed to full open position, for minimum head loss and non-slam closure.

4. Valve exterior to be painted Universal Metal Primer for high resistance to corrosion.
5. The manufacturer shall have been regularly engaged in the design and manufacture of Rubber Flapper Swing Check Valves for at least five years and shall provide suitable references if required.
6. Valve to be APCO Series 100 Rubber Swing Check Valve, as manufactured by Valve & Primer Corporation, or approved equal.

E. Concrete:

1. All concrete for manhole slabs and cradles, flow channels, encasement, blocking, etc., shall have a minimum compressive strength of 3,000 psi at 28 days. Type II Portland Cement shall be used.

F. Pipeline Detection System:

1. Pipeline detectable tape shall be installed continuously above all non-metal piping. The tape shall be installed directly above each pipeline and twelve (12) inches from the ground surface.
2. The tape shall be Lineguard Type III Detectable Tape as manufactured by Lineguard Inc., of Wheaton, Illinois, or equal. The tape shall be a minimum of three (3) inches wide, green in color, imprinted with the words "CAUTION-SEWER LINE BELOW" and be capable of detection with inductive method.
3. Copper (number 12) wire shall be installed directly on top of all pipe and run continuous along the pipe into the manhole and extend to the top of each manhole. Wrap excess wire around top rung of manhole ladder.

G. Signs:

1. The Contractor shall place "Caution" signs along the force main per Delaware Department of Transportation Traffic Controls for Streets and Highway Construction, Maintenance Utilities and Emergency Operations.

H. Submittals:

Shop drawings of the force main items shall be required. They shall include, but not be limited to

1. Pipe, (type and test certification); fittings
2. Concrete mix design
3. Type II cement certification
4. Force Main Cleanouts
5. Stone and borrow certifications
6. Detectable tape
7. Copper detection wire

3. CONSTRUCTION METHODS

A. Installing Pipe and Fittings:

1. PVC and HDPE pipe and fittings shall be installed according to the requirements of ASTM D 3034 and ASTM D 3350 latest versions, as specified herein or indicated on the drawings, and per manufacturer's recommendation.
2. Pipe and fittings shall be carefully handled and lowered into the trench. Stone bedding shall be placed to top of pipe with 6" minimum stone bedding under pipe, compacted to 90% Proctor density, placed in 6" lifts. Additional stone as ordered by Engineer.
3. Use lubricant specified by the pipe manufacturer for proper pipe joint installation.
4. Special care shall be taken to insure that the pipes are well bedded on a solid foundation, and any defects due to settlement shall be made good by the Contractor at his own expense. Bell holes shall be dug sufficiently large to insure the making of proper joints. Geotextile fabric to encase stone bedding completely (bottom, sides and top).
5. Proper and suitable tools and appliances for the safe and convenient handling and installation of pipes and fittings shall be used. Adequate care shall be taken

to prevent the pipe wall from being damaged, and any wall damage shall be repaired to the satisfaction of the Engineer by the Contractor.

6. Pipe and fittings shall be thoroughly cleaned before they are laid and shall be kept clean until the acceptance of the completed work. At the close of each work day the end of the pipe line shall be tightly closed with an expansion type stopper or plug so that no dirt or other foreign substance may enter the line, and this stopper or plug shall be kept in place until pipe installation is again resumed.
  7. The excavation in which pipe is being laid shall be kept free from water and no joint shall be made under water. Water shall not be allowed to rise in the excavation until the joint material has received its set. Adequate care shall be used to secure watertightness and to prevent damage to, or disturbing of, the joints during the refilling process, or at any time. After pipes have been laid and the joints have been made, there shall be no walking on or working over them except such as may be necessary in tamping, until there is a covering at least two feet depth, over their top.
  8. No pipe shall be installed upon a foundation into which frost has penetrated, nor at any time when the Project Representative shall deem that there is danger of the formation of ice or the penetration of frost at the bottom of the excavation, unless all required precautions as to the minimum length of open trench and promptness of refilling are observed.
  9. Whenever a pipe requires cutting to fit in the line or to bring it the required location, the work shall be done in a satisfactory manner so as to leave a smooth end. No springing of bell and spigot joints, to effect a change in direction will be permitted.
  10. In joining pipe and fittings, the Contractor shall exercise particular care to insure that the outside of the spigot and inside of the bell are entirely free of oil, tar and greasy substances to insure a tight fit.
  11. Minimum depth of cover for any force main shall be 36" measured from the top of the pipe to the final grade above the pipe.
  12. Contractor shall backfill all trenches at the end of each day. No trench shall be left open overnight.
- B. Connection to existing manholes:
1. Connection to existing manholes shall be made at such points and of such form,

dimensions and elevations as indicated on the Contract Drawings or as the Engineer shall require.

4. ACCEPTANCE TESTING

A. Description

1. The Contractor shall furnish all labor, tools, material, including water, and equipment, including pumps, compressors, stopwatch, gauges, and meters, subject to the approval of the Owner for testing in accordance with these Specifications.

B. Testing Procedure for Force Mains

1. Any defective work, which shows up while conducting tests or before conditional acceptance, shall be replaced or repaired by the CONTRACTOR at his own cost and expense. Any leaks occurring after conditional acceptance but before final acceptance due to either blown joints or cracked pipe or fittings, shall be repaired by the Contractor at his own expense.
2. Test Restrictions:
  - a. All tests shall be conducted in the presence of the Project Inspector.
  - b. Testing of all pressure pipes shall be conducted in accordance with AWWA C605 or AWWA C906 latest versions hydrostatic testing requirements.
  - c. Test pressure shall be 75 psi.
  - d. The hydrostatic pressure test shall have at least a 15-minute duration.
  - e. Test pressure shall not vary by more than 5 psi for the duration of the test.
  - f. Valves shall not be operated in either direction at a differential pressure exceeding the rated valve working pressure. The test pressure shall not exceed the rated pressure of the valves when the pressure boundary of the test section includes closed, resilient-seated gate valves or butterfly valves.

3. Pressurization

- a. After the pipe has been laid, all newly laid pipe or any valved section thereof shall be subjected to a hydrostatic pressure of at least 75 psi for at least a 15-minute duration. Each valved section of pipe shall be slowly filled with water, and the specified test pressure (based on the elevation of the highest point of the line or section under test and corrected to the elevation of the test gauge) shall be applied by means of a pump connected to the pipe. Valves shall not be operated in either the opening or closing direction at differential pressures above the rated pressure. It is good practice to allow the system to stabilize at the test pressure before conducting the leakage test.
- b. Before applying the specified test pressure, air shall be expelled completely from the section of piping under test. If permanent air vents are not located at all high points, corporation cocks shall be installed at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, the corporation cocks shall be removed and plugged or left in place as directed by the Engineer.
- c. All exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damage or defective pipe, fittings, valves, hydrants, or joints that are discovered following the pressure test shall be repaired or replaced with sound material, and the test shall be repeated until satisfactory results are obtained.
- d. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within 5 psi (34.5 kpa) of the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall not be measured by a drop in pressure in a test section over a period of time.
- e. No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = \frac{SD\sqrt{P}}{133,200}$$

Where:

L = allowable leakage, in gallons per hour  
S = length of pipe tested, in feet  
D = nominal diameter of the pipe, in inches  
P = average test pressure during the leakage test, in pounds per square inch (gauge)

4. Acceptance of Installation

- a. Acceptance shall be determined on the basis of allowable leakage. If any test of laid pipe discloses leakage greater than that specified above, repairs or replacements shall be accomplished as directed by the engineer.
- b. All visible leaks are to be repaired regardless of the amount of leakage.

C. Defects to be Made Good

1. If, at any time before the expiration of the guarantee period under this contract, any broken pipe, or any other defects are found in any of the lines or in any of the appurtenances, the Contractor shall cause the same to be removed and replaced by proper material and workmanship. All materials shall be carefully examined by the Contractor for defects prior to installation, and any found defective shall be rejected for use.

END OF SECTION 330100

## SECTION 330200 – SANITARY SEWER MANHOLES AND MISCELLANEOUS STRUCTURES

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. The work proposed under this heading involves sanitary sewer manholes and miscellaneous structures of concrete or brick masonry built to the shapes and dimensions shown in the Details and at the locations indicated on the Contract Drawings or as directed by the Engineer.

### PART 2 - MATERIALS

#### 2.1 PRECAST MANHOLES

- A. Precast reinforced concrete risers, eccentric cones and bases shall be as detailed on the drawings and in conformance with ASTM Designation C 478. Joints between riser sections shall be fitted with an "O" ring rubber gasket, meeting the requirements of ASTM Designation C 443. Minimum diameter of manholes shall be 42" inches. Minimum access diameter shall be 24 inches, unless otherwise noted on plans. Butyl tape shall be used to deal the joints between riser sections.
- B. All pipe-to-manhole connections shall be made by means of an integrally cast flexible connector which shall be A-Lok flexible manhole gasketed as manufactured by A-Lok Corp., Trenton, New Jersey, or equal.

#### 2.2 MANHOLE STEPS

- A. Manhole steps shall be made of 3/8 inch diameter (No. 3) steel reinforcing bars, ASTM Designation A 615, Grade 60, encased in polypropylene plastic. Manhole steps shall have notched tread ridge with retainer lug on each side. Manhole steps shall be OSHA approved and as manufactured by M.A. Industries, Inc., Peachtree City, Georgia, ICM, Inc., Jacksonville, Arkansas, or equal.
- B. Steps shall be cast in place during manufacture of precast bases, risers, and eccentric top sections. Embedment length shall be suitable for minimum 5-inch thick walls.

#### 2.3 MANHOLE FRAME AND COVER

- A. Material for frames and covers shall be in accordance with the "Standard Specifications for Gray Iron Castings" ASTM Designation A 48 for Class No. 30. The manhole frame and cover shall be as on the Contract Drawings.

#### 2.4 MANHOLE INSERTS

- A. Watertight manhole inserts shall be made of noncorrosive materials only and shall be constructed so that the manhole cover can be removed without damage to the integral air and vacuum relief valves. The units shall be Model #MEC 4 as manufactured by Methods Engineering Corp., or equal.

#### 2.5 CONCRETE

- A. All concrete for manhole base slabs and cradles, flow channels, encasement, blocking, etc., shall have a minimum compressive strength of 3,000 psi at 28 days. Type II Portland Cement shall be used.

#### 2.6 BRICK

- A. All brick shall conform to the "Standard Specifications for Sewer Brick" ASTM Designation C 32, Grade SS, except that the maximum absorption for the average of five bricks shall not exceed 10 percent; and the individual brick maximum shall not exceed 14 percent.
- B. The Contractor shall furnish five (5) bricks of the character he proposed using at least one week before any bricks are delivered for use.

#### 2.7 MOTAR

- A. Cement shall be in accordance with the "Standard Specifications for Portland Cement" ASTM Designation C 150 for Type II.
- B. Sand shall be composed of sharp, angular, silicious grains, coarse, or graded from fine to coarse with the coarsest grains predominating, and sensibly free from clay, loam, dirt, mica, organic matter, or other impurities. Sand containing more than 5 percent by weight of foreign material shall not be used. This limit may be changed for special classes of work if hereinafter specified. Sand exhibiting more than an acceptable amount of fine matter or impurities may be required to be washed after delivery on the work or shall be rejected altogether. The Contractor shall submit samples of the sand he proposes to use. These shall be retained in the office of the Town as a standard for comparison during the progress of the work, and all sand used shall be equal in quality to the accepted samples. Sand for mortar shall be screened to reject all particles of a greater diameter than 1/4 inch and shall not contain more than 5 percent by weight of a very fine material.
- C. Unless hereinafter specified otherwise, all mortar shall be composed of cement and sand of the character above specified. The proportion by volume shall be one part of cement to two of sand. One volume of cement shall be 94 pounds net. One volume of sand shall be 0.9 cubic feet, the sand not being packed more closely and by throwing it into a box in the usual way. Mortar shall be fresh mixed in small batches for the work in hand. Tight boxes or platforms made for the purposes shall be used. The sand and cement shall be thoroughly mixed dry, in the proper proportion, until uniform color has been produced, whereupon a

moderate dose of water shall be added, so as to produce a stiff paste of the proper consistency.

- D. Sand obtained from the excavation shall not be used.

### PART 3 - EXECUTION

#### 3.1 CONSTRUCTION METHODS

##### A. Precast Manholes

1. Precast reinforced concrete base and riser sections shall be as manufactured by Atlantic Concrete Products Company, Virginia Precast Corporation, or equal.
2. Manholes installed within the sewer distributor system shall conform to the requirements as specified on the Contract Drawings.
3. Interior and exterior joint spaces of all manhole risers shall be filled prior to application of the exterior waterproofing. The interior joint shall be mortared. Joints between riser sections shall be fitted with an "O" ring rubber gasket, meeting the requirements of ASTM Designation C-443. Butyl tape shall be installed on the outside of manhole barrel seams.
4. Lifting holes in the walls of precast reinforced concrete risers will be allowed but shall be plugged with rubber stoppers and grouted flush with face or manhole wall after installation of manhole riser sections. Not more than two holes shall be cast in the walls of each riser section for the purpose of handling.
5. The exterior surface of all precast manholes shall receive a minimum two coat application of a 68 percent solids coal tar type protective coating. The total average dry film thickness shall measure 24 mils with no single measurement to be less than 20 mils. Surfaces shall be prepared in accordance with the manufacturer's instructions and coatings applied in the field in a manner acceptable to the Town. The coating material shall be Bitumastic Super Service Black manufactured by Koppers Co., Inc., Pittsburgh, Pennsylvania, Tar-Jet Super Black XX-32-B-22 manufactured by Pennsbury Coatings Corp., New Britain, Pennsylvania, or equal.

##### B. Brick Structures and Manholes

1. All brick shall be laid by competent mechanics, and any workmen not deemed to be such by the Town shall be removed from the work at once.
2. All brick shall be laid in a full bed of mortar with all vertical and horizontal joints filled solid with mortar.
3. Joints shall be not less than 3/8-inch or more than 1/2-inch wide except as otherwise specified.

4. No brick work shall be laid when the temperature is below 40 degrees or when the indications are for lower temperatures within 24 hours. The Contractor shall take such measures as may be approved to prevent brick work from being exposed to freezing temperatures for a period of not less than five days after laying.
  5. The outside of all brick work shall be pargetted with cement mortar 1/2-inch thick. No backfill shall be accomplished around any brick structures within 48 hours after the completion of all brick work. Two coats of the coal tar type protective coating (minimum 24 mils total thickness) shall be applied after mortar coating has cured.
  6. Channels for receiving and passing water shall be formed in the bottom of manholes as shown or directed. All such channels shall be lined with brick or split pipe. Channels shall slope smoothly and evenly from the main pipe entering the manhole to the outlet pipe. Brick channels for future extensions shall be built into manholes where shown on the Plans or where directed by the Developer's Engineer. Rubber gaskets approved by the Town shall be used to seal the pipe at all connections to the manholes. All manholes shall be watertight.
  7. For manholes constructed at the site, 1500 psi non-shrink grout shall be used to seal between the manhole and pipe.
  8. Wider or deeper foundations than shown on the detailed drawings for manholes shall be built of concrete masonry, wherever directed. Manholes shall be built as pipe laying progresses, and the Town may stop work entirely on laying pipe until the manhole just passed has been completed.
- C. Manholes shall be set on a base of a minimum of 6" stone, Del. No. 57, as specified in Section 813 of Delaware Department of Transportation Standard Specifications for Road and Bridge Construction.

### 3.2 ACCEPTANCE TESTING

- A. It shall be the Contractor's responsibility to examine all completed manholes to ensure that they are laid to the proper alignment and grade and free from foreign material. After this has been done to the satisfaction of the Inspection agency, he will order tests to be made on all portions of the sewers built under the Contract. The Contractor shall cooperate and furnish all materials and labor necessary to perform the manhole tests as specified herein.
- B. Manholes shall be tested using one of the following testing procedures:
  1. **Prior to Backfilling:** Manholes shall be vacuum tested in accordance with ASTM C-1244 prior to the placement of backfill. After acceptance of the manhole test, backfilling operations shall be done as to not shift or move the manhole. The Town shall reserve the right to require vacuum testing after backfilling should any shift or movement of the manhole occur.

2. After Backfilling: All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole. The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations. A vacuum of 4 in. of Hg. shall be drawn on the manhole and the vacuum shall not drop below 3.5 in. of Hg. for a duration of five (5) minutes providing that dewatering is still taking place. If dewatering has stopped and the ground water table has returned to the seasonal elevation, the Engineer will need to be notified prior to testing to determine the correct vacuum test value. If the manhole fails the test, the manhole shall be repaired by an approved method until a satisfactory test is obtained.
3. If the contractor chooses the vacuum test prior to backfilling and the manhole is hit or shifts during backfill, the inspector can request that the manhole be re vacuum tested using the after backfilling procedure at no additional cost to the Owner.

C. Defects to be Made Good

1. If, at any time before the expiration of the guarantee period under this contract, any defects are found in any of the appurtenances, the Contractor shall cause the same to be removed and replaced by proper material and workmanship. All materials shall be carefully examined by the Contractor for defects prior to installation, and any found defective shall be rejected for use.

END OF SECTION 330200