

City of Indianapolis

# Consolidated Civil and Criminal Courthouse

CJ4.1 - Foundations, Underground Utilities & Vapor Mitigation

Indianapolis, IN

*Schmidt Project No. 2017-178.CCC*

# Technical Specifications



**SCHMIDT**  
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**March 1, 2019**

# Technical Specifications for City of Indianapolis - Consolidated Civil and Criminal Courthouse

## CJ4.1 - Foundations, Underground Utilities & Vapor Mitigation

Schmidt Project No. 2017-178.CCC

Prepared For:

City of Indianapolis  
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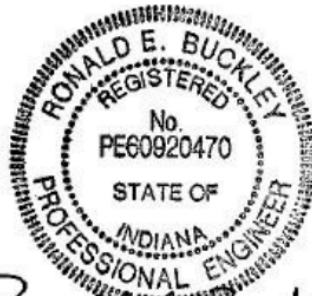
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March 1, 2019

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City of Indianapolis

# Consolidated Civil and Criminal Courthouse

CJ4.2 - Superstructure

Indianapolis, IN

*Schmidt Project No. 2017-178.CCC*

# Technical Specifications



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*July 16, 2019*

**Technical Specifications  
for**

**City of Indianapolis - Consolidated Civil and Criminal  
Courthouse**

**CJ4.2 - Superstructure**

*Schmidt Project No. 2017-178.CCC*

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NOT APPLICABLE

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NOT APPLICABLE

DIVISION 31 - EARTHWORK

NOT APPLICABLE

DIVISION 32 - EXTERIOR IMPROVEMENTS

NOT APPLICABLE

DIVISION 33 - UTILITIES

NOT APPLICABLE

SECTION 033000 - CAST-IN-PLACE CONCRETE

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 specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
  - 1. Footings.
  - 2. Foundation walls.
  - 3. Slabs-on-grade.
  - 4. Building frame members.
  - 5. Building walls.
- B. Related Sections include the following:
  - 1. Division 09 Sections relating to moisture requirements of floor finishes applied over concrete slabs.
  - 2. Division 31 Section "Earth Moving" for drainage fill under slabs-on-grade.
  - 3. Division 32 Section "Concrete Paving" for 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 with Shop Drawings:
  - 1. Product Data: For each type of product indicated.
  - 2. Shop Drawings:

- a. 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. Shop drawings shall be prepared in accordance with the following:
- 1) Beams and Walls: 1/4 inch scale elevations of all walls and beams shall be provided with all the reinforcing shown on the elevations, not scheduled.
  - 2) Slabs and mats: Reinforcing for all concrete slabs shall be shown on a plan drawing exclusively for this use. Reinforcing shall not be scheduled.
  - 3) Slabs and mats: A support system plan for all slabs shall be provided. Supports for slab top and bottom bars shall be shown in number and location. The maximum spacing of support bars shall be 4'-0". The maximum overhang beyond a support bar of slab bolster shall be 1'-0".
  - 4) Columns: Full height elevations for all columns shall be provided with all floor and foundation elevations marked.
  - 5) Bar bending diagrams shall be provided for all bent bars (within a submittal) in that same submittal.
  - 6) Sections of walls, beams, slabs, etc. shall be provided showing clearly bar positions and clearances to forms.
  - 7) On wall sections, indicate spacers used to maintain clearances for vertical wall steel.
  - 8) Beam bolsters and chairs shall be indicated as to sizes and spacing on the sections and elevations.
  - 9) Shop drawings shall include all details, sections, and installation instructions indicated on the structural drawings that are required by the Contractor to place the reinforcement without using the structural drawings.
- b. Submit the following regarding the mechanical tension butt splices, the end-bearing splices, dowel bar replacements, and rebar anchorage systems:
- 1) Shop drawings indicating fabrication and placement details per this section.
  - 2) Manufacturer's literature, product samples, and certified test reports substantiating compliance with the Specification.
- c. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.
- 1) Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.

d. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1) Location of construction joints is subject to approval of the Engineer of Record.

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.

#### 1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Qualification Data: For Installer, manufacturer, and testing agency.

C. 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.

D. 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. Fiber reinforcement.
6. Waterstops.
7. Curing compounds.
8. Floor and slab treatments.
9. Bonding agents.
10. Adhesives.
11. Vapor barriers.
12. Semirigid joint filler.
13. Joint-filler strips.
14. Repair materials.

E. Floor surface flatness and levelness measurements to determine compliance with specified tolerances.

F. Field quality-control test and inspection 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, as documented according to ASTM E 548.
  - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 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 one source, and obtain admixtures through one source from a single manufacturer.
- E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."
- F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
  - 1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
  - 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 to comply with requirements in Division 01 Section "Project Management and Coordination."

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. Architect or Engineer.
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-barrier 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. 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. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- E. Rigid Insulation Voids: Type VII extruded polystyrene foam insulation with a minimum compressive strength of 60 psi and meeting the requirements of ASTM C578, Type VII.
- 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 to the plane of exposed concrete surface.
  - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch 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: 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 25 percent.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- C. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed bars, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.
- D. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60, deformed bars, assembled with clips.



- E. Plain-Steel Wire: ASTM A 82, as drawn.
- F. 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/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.
- B. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, ASTM A 775/A 775M epoxy coated.
- C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.
- D. Provide Aztec "spacer wheels" to maintain clearances for vertical reinforcement.
- E. 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.

### 2.4 MECHANICAL TENSION BUTT SPLICES

- A. Mechanical tension butt splices shall conform to ACI 318-11.
- B. Provide Cadweld butt splices or position threaded couplers for hooked bars that must be butt spliced.
- C. Standards:
  - 1. Lenton Rebar Splicing, Erico Products, Inc.
  - 2. Grip Twist System, Dayton Barsplice, Inc.
  - 3. MRC 150 Mechanical Reinforcement Connector System, Dayton-Superior.
  - 4. Cadweld, C-Series, Erico Products, Inc.

2.5 END-BEARING SPLICES (COMPRESSION BUTT SPLICES)

- A. Dowel bar replacement system shall conform to ACI 318-11, Section 12.16.4.
- B. Standards:
  - 1. G-Loc, Gateway Erectors, Inc.
  - 2. Speed Sleeve, Erico Products, Inc.

2.6 DOWEL BAR REPLACEMENT SYSTEM

- A. Dowel bar replacement system shall conform to ACI 318-11.
- B. Standards:
  - 1. DB-SAE Dowel Bar Splicer, Richmond Screw Anchor Company.
  - 2. Dowel Bar Replacement System, Dayton-Superior.
  - 3. Lenton Form Saver, Erico Products, Inc.
  - 4. Systems, Intersect, Dayton-Superior.

2.7 REBAR ANCHORAGE SYSTEM

- A. Rebar anchorage system shall conform to ACI 318-11.
- B. Standards:
  - 1. Lenton Terminator, Erico Products, Inc.
  - 2. MRC D-156 Structural Rebar End, Dayton-Superior.

2.8 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 III, gray. Supplement with the following:
    - a. Fly Ash: ASTM C 618, Class C or F. Maximum loss of ignition to be 3.0 percent.

- B. Normal-Weight Aggregates: ASTM C 33, Class 3S 3M coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
  - 1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
  - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94/C 94M and potable.

## 2.9 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/C 494M, Type A.
  - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
  - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
  - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
  - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

## 2.10 FIBER REINFORCEMENT

- A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.
  - 1. Products:
    - a. Monofilament Fibers:
      - 1) Euclid Chemical Company (The); Fiberstrand 100.
      - 2) FORTA Corporation; Forta Mono.
      - 3) Grace Construction Products, W. R. Grace & Co.; Grace MicroFiber.
      - 4) Propex Concrete Systems Corp; Fibermesh 650..

## 2.11 WATERSTOPS

- A. Flexible Rubber Waterstops: CE CRD-C 513, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
1. Manufacturers:
    - a. Greenstreak.
    - b. Progress Unlimited, Inc.
    - c. Williams Products, Inc.
  2. Profile: Ribbed with center bulb.
- 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:
    - a. Colloid Environmental Technologies Company; Volclay Waterstop-RX.
    - b. Concrete Sealants Inc.; Conseal CS-231.
    - c. Greenstreak; Swellstop.
    - d. Henry Company, Sealants Division; Hydro-Flex.
    - e. JP Specialties, Inc.; Earthshield Type 20.
    - f. Carlisle Coatings & Waterproofing, Inc.; MiraSTOP.

## 2.12 VAPOR BARRIERS

- A. Plastic Vapor Barrier: ASTM E 1745, Class A with a permeance of 0.01 as tested before and after mandatory conditioning (ASTM E 1745 Section 7.1 and subparagraph 7.1.1-7.1.5) less than 0.01 perms (grains/(ft<sup>2</sup> hr in Hg)). Include manufacturer's recommended adhesive or pressure-sensitive tape.
1. Products:
    - a. Fortifiber Corporation; Moistop Ultra 20.
    - b. Reef Industries; Griffolyn G 20.
    - c. Stego Industries, Stego Wrap 20.

## 2.13 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
1. Products:
- a. Axim Concrete Technologies; Cimfilm.
  - b. Burke by Edoco; BurkeFilm.
  - c. ChemMasters; Spray-Film.
  - d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.
  - e. Dayton Superior Corporation; Sure Film.
  - f. Euclid Chemical Company (The); Eucobar.
  - g. Kaufman Products, Inc.; Vapor Aid.
  - h. Lambert Corporation; Lambco Skin.
  - i. L&M Construction Chemicals, Inc.; E-Con.
  - j. MBT Protection and Repair, Div. of ChemRex; Confilm.
  - k. Meadows, W. R., Inc.; Sealtight Evapre.
  - l. Metalcrete Industries; Waterhold.
  - m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
  - n. Sika Corporation, Inc.; SikaFilm.
  - o. Symons Corporation, a Dayton Superior Company; Finishing Aid.
  - p. Unitex; Pro-Film.
  - q. USMix Products Company; US Spec Monofilm ER.
  - r. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.
- 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, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
1. Products:
- a. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; W.B. Resin Cure.
  - b. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
  - c. Euclid Chemical Company (The); Kurez DR VOX.

- d. L&M Construction Chemicals, Inc.; L&M Cure R.
- e. Meadows, W. R., Inc.; 1100 Clear.
- f. Symons Corporation, a Dayton Superior Company; Resi-Chem Clear Cure.

#### 2.14 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips:
  - 1. ASTM D 1752, cork or self-expanding cork, Type III for exterior applications. .
  - 2. Closed-Cell polyethylene for interior applications.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. 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 IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- D. Reglets: Fabricate reglets of not less than 0.0217-inch- thick, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- E. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

#### 2.15 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.
  - 5. Products: Subject to compliance with requirements, provide one of the following:
    - a. Ardex; K-15 Self-Leveling Underlayment Concrete.

- b. BASF Construction Chemicals, Inc.; Chemrex Self-Leveling Underlayment.
  - c. Euclid Chemical Company (The); Level Magic.
  - d. L&M Construction Chemicals, Inc.; Levellex.
  - e. Specialty Construction Brands, Inc., an H.B. Fuller company; TEC EZ Level.
- B. Repair Overlayment: 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 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.
  5. Products: Subject to compliance with requirements, provide one of the following:
    - a. Ardex; K-15 Self-Leveling Underlayment Concrete.
    - b. BASF Construction Chemicals, Inc.; Chemrex Self-Leveling Underlayment.
    - c. Euclid Chemical Company (The); Level Magic.
    - d. L&M Construction Chemicals, Inc.; Levellex.
    - e. Specialty Construction Brands, Inc., an H.B. Fuller company; TEC EZ Level.

## 2.16 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: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash: 20 percent with the exception of slabs scheduled to receive adhered flooring, which shall be limited to 15 percent. .
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing high-range water-reducing 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.

2.17 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Refer to sheet S-001 for specifics.

2.18 FABRICATING REINFORCEMENT

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

2.19 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116, and furnish batch ticket information.
  1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

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 347R 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 for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
  - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 75 percent of its 28-day design compressive strength.
  - 2. 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 BARRIERS

- A. Plastic Vapor Barriers: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.
  - 1. Lap joints minimum 6 inches or as required by manufacturer, and seal with manufacturer's recommended tape.

## 3.6 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
  - 1. Do not cut or puncture vapor barrier. Repair damage and reseal vapor barrier 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, 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.

## 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 joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
  - 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
  6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  7. 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 Division 07 Section "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.
  - 1. Verify that vapor barrier is in place and not damaged and that lapped seams are taped properly in compliance with manufacturer's instructions. Do not proceed with concrete placement until damaged vapor barrier has been patched, sealed, and repaired.
- 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, or scheduled to receive a rubbed finish.
- 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.
- 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 in 1 direction.
  1. Apply scratch finish to surfaces indicated and to receive concrete floor toppings 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 receive trowel finish and 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 exposed to view or 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, 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.
- 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, and 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 aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
1. Uniformly spread 25 lb/ 100 sq. ft. of dampened slip-resistive aggregate over surface in 1 or 2 applications. Tamp aggregate flush with surface, but do not force below surface.
  2. After broadcasting and tamping, apply float finish.

### 3.12 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. 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. 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 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
  1. Defer joint filling until concrete has aged at least one month(s). Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

#### 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 in solid concrete, but not less than 1 inch in depth. 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 special inspector qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
  1. Steel reinforcement placement.
  2. Headed bolts and studs.
  3. Verification of use of required design mixture.
  4. Concrete placement, including conveying and depositing.
  5. Curing procedures and maintenance of curing temperature.
  6. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. 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. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
  2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mixture placed each day.
    - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  3. Slump: ASTM C 143/C 143M; 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.

4. 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.
  5. Concrete Temperature: ASTM C 1064/C 1064M; 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.
  6. 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.
  7. Compression Test Specimens: ASTM C 31/C 31M.
    - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
  8. 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.
  9. 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.
  10. 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.
  11. 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.
  12. 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/C 42M or by other methods as directed by Architect.
  13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
  14. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.
- D. Measure floor and slab flatness and levelness according to ASTM E 1155 within 24 hours of finishing.

END OF SECTION 033000

SECTION 033816 - UNBONDED POST-TENSIONED CONCRETE

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. Related Sections:
  - 1. Section 033000 "Cast-in-Place Concrete".

1.3 REFERENCES

- A. ACI 318 - building Code Requirements for Reinforced Concrete.
- B. ASTM A-416 - Standard Specification for Low-Relaxation, Seven-Wire Steel Strand for Prestressed Concrete.
- C. PTI Specification for Unbonded Single Strand Tendons, July 1993.
- D. Post-Tensioning Manual.
- E. Recommendations for Concrete Members Prestressed with Unbonded tendons, ACI-ASCE Committee 423.

1.4 COORDINATION

- A. Attachments and Penetrations:
  - 1. Attach permanent construction, such as curtain-wall systems, handrails, fire-protection equipment, lights, and security devices to the post-tensioned slab using embedded anchors.
  - 2. Drilled anchors, power-driven fasteners, and core drilling for sleeves or other penetrations are not allowed unless authorized in writing by Architect.
  - 3. Form penetrations within 18 inches of an anchorage with ASTM A53/A53M, Schedule 40 steel pipe.

## 1.5 PREINSTALLATION MEETINGS

## A. Preinstallation Conference: Conduct conference at Project site.

1. Review procedures related to installation and stressing of post-tensioning tendons, including, but not limited to, the following:
  - a. Construction schedule and availability of materials, personnel, and equipment needed to make progress and avoid delays.
  - b. Storage of post-tensioning materials on-site.
  - c. Structural load limitations.
  - d. Coordination of post-tensioning installation drawings and nonprestressed reinforcing steel placing drawings.
  - e. Horizontal and vertical tolerances on tendons and nonprestressed reinforcement placement.
  - f. Marking and measuring of elongations.
  - g. Submittal of stressing records and requirements for tendon finishing.
  - h. Removal of formwork.

## 1.6 ACTION SUBMITTALS

## A. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

## B. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer registered in the State of Indiana, detailing tendon layout, installation procedures, and the following:

1. Installation drawings, including plans, elevations, sections, and details.
2. Numbers, arrangement, placing sequence, and designation of post-tensioning tendons required for each beam and slab.
3. Tendon profiles and method of tendon support, including chair heights and locations. Show tendon profiles at sufficient scale to clearly indicate all support points with their associated heights.
  - a. Each post-tensioned beam shall be individually evaluated indicating the tendon profiles with tendon height at all support points. Method of tendon support shall be indicated. Anchorage details shall be detailed separately for each condition and referenced to each beam.
4. Details for horizontal curvature around openings and at anchorages.
5. Locations of anchorages and blockouts required for stressing.
6. Anchorage details, including bundled tendon flaring.
7. Tendon clearances around slab openings and penetrations.
8. Construction joint locations and pour sequence.

9. Details for corners and other locations where tendon layouts may conflict with one another or with nonprestressed reinforcing steel.
  10. Locations of nonprestressed reinforcement required for installing post-tensioning tendons, including, but not limited to, the following:
    - a. Support bars.
    - b. Backup bars and hairpins at anchorages.
    - c. Hairpins at locations of horizontal curvature.
    - d. Supplemental reinforcement at blockouts.
  11. Stressing procedures, stressing sequence, and jacking force to result in final effective forces used in determining number of tendons required.
  12. Calculated elongations for each tendon.
- C. Calculations: Submit to Architect/Engineer under the provisions of Division 1 and including:
1. Submit calculations showing all engineering required to fully design the post-tensioning system, including friction loss calculations, bursting reinforcement calculations, number of prestressing tendons, anchorage and coupling systems, tendon supports, and tendon stressing procedures, as required to fully comply with the final force and tendon profiles as shown on the structural drawings. The design shall be in accordance with the requirements of ACI 318. Submit tendon manufacturer's data that documents the wobble and curvature friction coefficients used in the friction loss calculations. Clearly show on the shop drawings the values of wobble and curvature coefficients used in the design.
  2. Submit prior to shop drawing preparation.
  3. Post-tensioning supplier shall secure the services of a qualified professional engineer, licensed in the State of Indiana, to provide the design as specified above. Calculations shall be signed and sealed by the professional engineer and shall be submitted to the Architect/Engineer for Owner's record only.
  4. Review of calculations and shop drawings by the Architect/Engineer will not relieve the Post-Tensioning Supplier of responsibility for the final design as specified herein.
  5. By offering a proposal or entering into a contract for work for this section, Post-Tensioning Supplier accepts the general design shown on the drawings adequate for compliance with performance requirements at no additional cost to the Owner.
  6. References to be used to calculate losses shall include:
    - a. Friction loss - ACI 318.
    - b. Anchorage seating loss - PTI Manual, Appendix A.3.
    - c. long-term losses (elastic shortening, creep, shrinkage, relaxation) - Concrete International; June 1979-Estimating Prestress Losses.
- D. Stressing records: Submit to Architect/Engineer within 24 hours after stressing using stressing record form and including:
1. Jack designation.
  2. Jacking pressure.
  3. Calculated elongation for each tendon.



4. Actual measured elongation for each jacking point and totals for each tendon.
5. Date of stressing operation.
6. Designation of pour location and extents.
7. Signature of the Contractor's stressing personnel or Owner designated testing agency.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturer, and testing agency. Include resume of individual supervising installation and stressing of post-tensioning tendons.
- B. Evaluation Reports: For each type of anchorage device and coupler, from ICC-ES:
- C. Product Certificates: For each type of encapsulation system.
- D. Mill Test Reports: Certified mill test reports for prestressing strand used on Project, indicating that strand is low relaxation and including the following:
  1. Coil/heat numbers or identification.
  2. Location within structure (pour identification).
  3. Breaking load.
  4. Yield strength at 1 percent extension under load.
  5. Elongation at failure.
  6. Modulus of elasticity.
  7. Diameter and net area of strand.
  8. Type of material (stress-relieved or low relaxation).
  9. ASTM conformance.
- E. Jack Calibration Certificates: Submit to Architect/Engineer under the provisions of Division 1 and indicating:
  1. Jack designation.
  2. Test date.
  3. Calibration curver certified by a testing laboratory.
  4. Guage pressure corresponding to 80% of the ultimate strength of the strand.
- F. Post-Tensioning Component and System Compliances: Submit to Architect/Engineer under the provisions of Division 1 and the following:
  1. Minimum sheathing compliance.
  2. Coating compliance.
- G. Non-Shrink Grout Compliance: Submit to Architect/Engineer under the provisions of Division 1.
- H. Proof of plant compliance per Article 1.8.
- I. Field quality-control reports.

- J. Procedures Statement: Procedures for cutting excess strand tail and patching stressing pocket.

#### 1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Fabricating plant certified by PTI according to procedures set forth in PTI's "Manual for Certification of Plants Producing Unbonded Single Strand Tendons."
  - 1. Proof of plant certification is required and shall accompany each tendon shipment to the jobsite.
  - 2. The certification program shall be administered by an independent agency or firm.
  - 3. Proof of PTI plan certification or a copy of the certification program for all plants applying materials to the job shall be submitted to the Architect/Engineer.
- B. The post-tensioning materials shall be supplied by a firm which has been in the post-tensioning business for a minimum of 10 years.
- C. The post-tensioning materials shall be supplied by a firm that has successfully performed on at least 10 previous projects similar to the one involved in this contract.
- D. Installer Qualifications: A qualified installer whose full-time Project superintendent has successfully completed PTI's "Level 1 Unbonded PT - Field Installation" course or has equivalent verifiable experience and knowledge acceptable to Architect/Engineer. Personnel shall maintain this certification throughout the duration of the project.
  - 1. Superintendent shall be trained by post-tensioning supplier in the operation of stressing equipment to be used on Project.
- E. The post-tensioning supplier shall supply a minimum of 5 days of on-site technical assistance to assure that correct procedures for placement of tendons and tendon stressing are implemented.
- F. Post-tensioning system shall be unbonded mono-strand system and shall conform to all material and installation requirements of ACI 318 and of this Section.
- G. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
  - 1. Testing Agency Inspector: Personnel performing field inspections and measuring elongations shall have successfully completed PTI's Level 1 - Field Fundamentals course or shall have equivalent verifiable experience and knowledge acceptable to Architect.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle post-tensioning materials according to PTI's "Field Procedures Manual for Unbonded Single Strand Tendons."
- B. Tendons shall be coiled and securely tied for shipping and handling. Coils shall be clearly identified as to grade, coil and heat number, and type (low relaxation).

- C. Equipment used to handle the tendons shall not cause damage to the tendon sheathing.
- D. During shipping, tendons shall be covered with a waterproof sheet.
- E. Adequate precaution shall be taken during loading to prevent damage in transit.
- F. All tendons shall be stored in weatherproof enclosures at the job site to ensure that they remain dry until they are placed within the form work.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain post-tensioning materials and equipment from single source.
  - 1. Stressing jacks not provided by post-tensioning supplier must be calibrated and approved for use on Project by post-tensioning supplier.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design post-tensioned reinforcement.
- B. Average Precompression:
  - 1. Minimum Average Slab Precompression: 150 psi.
- C. Comply with ACI 318 requirements unless more stringent requirements are indicated.
  - 1. Limits on stresses at transfer of prestress and under service load.
  - 2. Minimum bonded reinforcement.
  - 3. Concrete cover over reinforcement.
- D. Fire Resistance: Design members such that thickness and concrete cover over reinforcement comply with fire-resistance requirements of authorities having jurisdiction.
- E. Deflection Limits, Including Creep and Shrinkage Effects, as Follows:
  - 1. Total Dead Load:  $L/600$ .
  - 2. Total Dead Plus Live Load:  $L/360$ .
- F. Closure Strips: Locate closure strips at midspan and adjust tendon forces and profiles accordingly. Calculate moments in spans with closure strips assuming a continuous slab. Provide only nonprestressed reinforcement within closure strips. Design reinforcement in closure strip to carry ultimate moment at midspan.

## 2.3 PRESTRESSING TENDONS

- A. ACI Publications: Comply with ACI 423.7 unless otherwise indicated.
- B. Prestressing Strand:
  - 1. ASTM A416/A416M, Grade 270, uncoated, seven-wire, low-relaxation, 0.5-inch-diameter strand.
  - 2. Minimum ultimate tensile strength of 41,300 pounds.
  - 3. Strand finish: Grade A, B, or C (PTI Specification for Unbonded Single Strand Tendons).
- C. Post-Tensioning Coating: Compound with friction-reducing, moisture-displacing, and corrosion-inhibiting properties; chemically stable and nonreactive with prestressing strand, nonprestressed reinforcement, sheathing material, and concrete.
  - 1. Minimum Coating Weight: 2.5 lb for 0.5-inch- diameter strand per 100 feet of strand.
  - 2. Completely fill annular space between strand and sheathing over entire tendon length with post-tensioning coating.
- D. Tendon Sheathing
  - 1. Material:
    - a. Formed by a continuous extrusion process which applies a seamless Polyethylene or polypropylene jacket to the prestressing tendon.
    - b. Shall be chemically stable without embrittlement or softening over the anticipated exposure temperature range.
    - c. Shall be non-reactive with concrete, steel, and the coating.
    - d. Minimum Thickness: 40.
    - e. Shall be of a light color so coating leaks at damaged sheathing locations can be easily detected. Black and dark brown sheathing is not allowed. Sheathing shall be of a uniform, opaque color.
  - 2. Sheathing shall be continuous over length of tendon between anchorages to prevent intrusion of cement paste or loss of coating for a nonencapsulated system.

## 2.4 COUPLERS

- A. Couplers shall conform to the PTI Specification of Unbonded Single Strand Tendons, section 3.4.

## 2.5 ANCHORAGES :

- A. Anchorages shall conform to the PTI Specification of Unbonded Single Strand Tendons, sections 3.1, 3.2, 3.3, and 3.6. .

- B. Anchorage shall include design features permitting a watertight connection of the sheathing to the anchorage and a watertight closing of the wedge cavity for stressing and nonstressing anchorages.
  - 1. Anchorages shall be protected by a fusion-bonded epoxy coating conforming to ASTM A775 or be plastic-encased.
  - 2. All prestressing steel shall be secured at the ends by acceptable anchoring devices which shall be of such material that wires will not kink, break down, or otherwise be damaged.
  - 3. Anchorage devices shall hold the prestressing steel without slip of more than 1/4 inch at least equal to the applied load in the strand of prestressing.
  - 4. The maximum concentrated bearing stress in the concrete shall not exceed that permitted by ACI 318.

## 2.6 GROMMETS

- A. The grommet shall provide a minimum concrete cover to the anchorage of 2 inches.

## 2.7 ACCESSORIES

- A. Tendons shall be supported by tying to reinforcing steel and to standard reinforcing steel accessories.
- B. Reinforcing bars and high chairs shall conform to Section 033000.

## 2.8 GROUT

- A. A non-shrink, non-metallic grout containing no chlorides (or other chemicals known to be deleterious to the prestressing steel) shall be used to grout the anchorage recesses.
- B. An approved product is "SonogROUT" manufactured by Sonneborn.

## 2.9 NONPRESTRESSED STEEL BARS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 60 percent.
- B. Support Bars, Reinforcing Bars, and Hairpins:
  - 1. Steel: ASTM A615/A615M, Grade 60, deformed.
- C. Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening tendons and tendon support bars in place. Manufacture bar supports, according to CRSI's "Manual of Standard Practice," from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:

1. For uncoated bars, use all-plastic bar supports.

#### 2.10 ACCESSORIES

- A. Pocket Formers: Capable of completely sealing wedge cavity; sized to provide the required cover over the anchorage and allow access for cutting strand tail.
- B. Sheathing Repair Tape: Elastic, self-adhesive, moistureproof tape with minimum width of 2 inches, in contrasting color to tendon sheathing; nonreactive with sheathing, coating, or prestressing steel.

#### 2.11 PATCHING MATERIAL

- A. One-component, polymer-modified, premixed patching material containing selected silica aggregates and portland cement, suitable for vertical and overhead applications. Do not use material containing chlorides or other chemicals known to be deleterious to prestressing steel or material that is reactive with prestressing steel, anchorage device material, or concrete.

### PART 3 - EXECUTION

#### 3.1 FABRICATION

- A. Tendons shall be manufactured in such sequence and quantity as to avoid lengthy storage at the jobsite.
- B. Tendons shall be clearly identified as called for on the placing drawing for easy placement.
- C. All prestressing steel within every group or in the same member shall be of the same heat where practical. Mill certificates for material fabricated shall be kept by the post-tensioning supplier.

#### 3.2 FORMWORK

- A. Forms shall be drilled to receive tendons at edges of slab and at construction joints.
- B. Design formwork to support load redistribution that may occur during stressing operation. Ensure that formwork does not restrain elastic shortening, camber, or deflection resulting from application of prestressing force.
- C. Do not remove forms supporting post-tensioned elements until tendons have been fully stressed and elongations have been approved by Architect/Engineer.
- D. Do not place concrete in supported floors until tendons on supporting floors have been stressed and elongations have been approved by Architect/Engineer.

## E. Construction Joints:

1. Construction joints through post-tensioned beams are not allowed.
2. Construction joints shall be located in the slabs at the quarter points of the slab span where tendons are at slab mid-depth.
3. Slab construction joints shall be located at the first quarter point of the slab span measured in the direction of uniform tendon stressing.

## 3.3 INSTALLATION OF NONPRESTRESSED STEEL REINFORCEMENT

- A. Coordinate placement of nonprestressed steel reinforcement with installation of post-tensioning tendons.

## 3.4 INSTALLATION OF TENDONS

- A. Install tendons according to installation drawings and procedures stated in PTI's "Field Procedures Manual for Unbonded Single Strand Tendons."
  1. Tolerances: Comply with tolerances in ACI 423.7 for beams and slabs.
    - a. Prestressing tendons and anchorages:
      - 1) +/- 1/8 inch - slab tendons and anchorages
      - 2) +/- 1/4 inch - beam tendons and anchorages
  2. Tendon Supports: Provide continuous slab bolsters or bars supported on individual high chairs spaced at a maximum of 42 inches o.c. to ensure tendons remain in their designated positions during construction operations and concrete placement.
  3. Support tendons as required to provide profiles shown on installation drawings. Position supports at high and low points and at intervals not exceeding 48 inches. Ensure that tendon profiles between high and low points are smooth parabolic curves.
  4. Attach tendons to supporting chairs and reinforcement without damaging tendon sheathing.
  5. Support slab tendons independent of beam reinforcement.
- B. Maintain tendon profile within maximum allowable deviations from design profile as follows:
  1. 1/8 inch for (200 mm) slab tendons.
  2. 1/4 inch for (610 mm) beam tendons.
- C. Maintain minimum radius of curvature of 480-strand diameters for lateral deviations to avoid openings, ducts, and embedded items. Maintain a minimum of 2 inches of separation between tendons at locations of curvature.
- D. Limit tendon bundles to four tendons. Do not twist or entwine tendons within a bundle. Maintain a minimum distance of 12 inches between center of adjacent bundles.

- E. If tendon locations conflict with nonprestressed reinforcement or embedded items, tendon placement governs. Obtain Architect's approval before relocating tendons or tendon anchorages that interfere with one another.
  - F. Slight deviations in horizontal spacing and location of slab tendons are permitted when required to avoid openings and inserts. The maximum horizontal sweep of a tendon shall be 1 in 6 inches.
  - G. Installation of Anchorages:
    - 1. Place anchorages at locations shown on approved installation drawings.
    - 2. Do not switch fixed- and stressing-end anchorage locations without obtaining approval from Architect/Engineer.
    - 3. Attach pocket formers, intermediate anchorages, and stressing-end anchorages securely to bulkhead forms. Install stressing-end and intermediate anchorages perpendicular to tendon axis.
    - 4. Install tendons straight, without vertical or horizontal curvature, for a minimum of 12 inches behind stressing-end and intermediate anchorages.
    - 5. Embed intermediate anchorage devices at construction joints in first concrete placed at joint.
    - 6. Minimum splice length in reinforcing bars at anchorages is 24 inches. Stagger splices a minimum of 60 inches.
    - 7. Place fixed-end anchorages in formwork at locations shown on installation drawings. Support anchorages firmly to avoid movement during concrete placement.
  - H. Maintain minimum concrete cover as follows:
    - 1. From Exterior Edge of Concrete to Wedge Cavity: 1-1/2 inches.
    - 2. From Exterior Edge of Concrete to Strand Tail: 3/4 inch.
    - 3. Top, Bottom, and Edge Cover for Anchorages: 3/4 inch.
  - I. Maintain minimum clearance of 6 inches between tendons and openings.
  - J. Prior to concrete placement, mark tendon locations on formwork with spray paint.
  - K. Do not install sleeves within 36 inches of anchorages after tendon layout has been inspected.
  - L. Do not install conduit, pipe, or embeds requiring movement of tendons after tendon layout has been inspected.
  - M. Do not use couplers unless location has been approved by Architect/Engineer.
- 3.5 SHEATHING INSPECTION AND REPAIR
- A. Inspect sheathing for damage after installing tendons. Repair damaged areas by restoring post-tensioning coating and repairing or replacing tendon sheathing.
    - 1. Ensure that sheathing is watertight and there are no air voids.



2. Follow tape repair procedures in PTI's "Field Procedures Manual for Unbonded Single Strand Tendons."
- B. Maximum length of exposed strand behind anchorages is as follows:
  1. Fixed End: 12 inches.
  2. Intermediate and Stressing End: 1 inch.
    - a. Cover exposed strand with sheathing repair tape to prevent contact with concrete.
- C. Immediately remove and replace tendons that have damaged strand.

### 3.6 CONCRETE PLACEMENT

- A. Do not place concrete until placement of tendons and nonprestressed-steel reinforcement has been inspected by testing agency.
- B. Provide Architect/Engineer and testing agency a minimum of 48 hours' notice before concrete placement.
- C. Ensure compaction of concrete around anchorages.
- D. Ensure that position of tendons and nonprestressed-steel reinforcement do not change during concrete placement. Reposition tendons and nonprestressed-steel reinforcement moved during concrete placement to original location.
- E. Ensure that method of concrete placement does not damage tendon sheathing. Do not support pump lines, chutes, or other concrete-placing equipment on tendons.

### 3.7 TENDON STRESSING

- A. Calibrate stressing jacks and gages at start of project and at least every six months thereafter. Keep copies of calibration certificates for each jack-and-gage pair on Project site that are available for inspection. Exercise care in handling stressing equipment to ensure that proper calibration is maintained. If inconsistencies between the measured elongation and the jack gauge reading occur, the jack gauges shall immediately be recalibrated.
- B. There shall be a minimum of 2 properly calibrated jacks at the job site at all times.
- C. Safety precautions shall be taken to prevent workers from standing over or behind the jacks when tendons are being tensioned.
- D. The maximum tendon jacking force shall not exceed 80 percent of the ultimate strength of the strand.
- E. Stress tendons only under supervision of a qualified post-tensioning superintendent.

- F. Do not begin stressing operations until concrete compressive strength has reached 3000 psi as indicated by tests of field-cured cylinders.
- G. Complete stressing within 72 hours of concrete placement.
- H. If concrete has not reached required compressive strength, obtain Architect/Engineer's approval to partially stress tendons and delay final stressing until concrete has reached required strength.
- I. If detensioning and restressing of tendon is required, discard wedges used in original stressing and provide new wedges.
- J. Mark and measure elongations according to PTI's "Field Procedures Manual for Unbonded Single Strand Tendons." Measure elongations to closest 1/8 inch.
- K. Submit stressing records within one day of completion of stressing. If discrepancies between measured and calculated elongations exceed plus or minus 7 percent, resolve these discrepancies to satisfaction of Architect/Engineer.
- L. Prestressing will be considered acceptable if gage pressures shown on stressing record correspond to required stressing force and calculated and measured elongations agree within 7 percent.
- M. If measured elongations deviate from calculated elongations by more than 7 percent, perform additional testing, restressing, strengthening, or replacing of affected elements unless otherwise approved by Architect/Engineer.
- N. Stressing Records: Testing agency shall record the following information during stressing operations:
  - 1. Name of Project.
  - 2. Date of approved installation drawings used for installation and stressing.
  - 3. Floor number and concrete placement area.
  - 4. Date of stressing operation.
  - 5. Weather conditions, including temperature and rainfall.
  - 6. Name and signature of inspector.
  - 7. Name of individual in charge of stressing operation.
  - 8. Serial or identification numbers of jack and gage.
  - 9. Date of jack-and-gage calibration certificates.
  - 10. Gage pressure to achieve required stressing force according to supplied calibration chart.
  - 11. Tendon identification mark.
  - 12. Calculated tendon elongation.
  - 13. Actual tendon elongation.
  - 14. Actual gage pressure.

## 3.8 TENDON FINISHING

- A. Do not cut strand tails or cover anchorages until stressing records have been reviewed and approved by Architect/Engineer.
- B. Cut strand tails as soon as possible after approval of elongations.
- C. Cut strand tail between 1/2 and 3/4 inch from wedges. Do not damage tendon or concrete during removal of strand tail. Acceptable methods of cutting strand tail include the following:
  - 1. Oxyacetylene flame.
  - 2. Abrasive wheel.
  - 3. Hydraulic shears.
  - 4. Plasma cutting.
- D. Install encapsulation caps and sleeves on intermediate anchorages within one day of stressing.
- E. Cut strand tails and install encapsulation caps on stressing-end anchorages within one day of Architect's acceptance of elongations.
- F. Patch stressing pockets within one day of cutting strand tail. Clean inside surface of stressing pocket to remove laitance or post-tensioning coating before installing patching material. Finish patching material flush with adjacent concrete.

## 3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
  - 1. Before concrete placement, testing agency will inspect the following for compliance with post-tensioning installation drawings and the Contract Documents:
    - a. Location and number of tendons.
    - b. Tendon profiles and cover.
    - c. Installation of backup bars, hairpins, and other nonprestressed reinforcement shown on post-tensioning installation drawings.
    - d. Installation of pocket formers and anchorage devices.
    - e. Repair of damaged sheathing.
    - f. Connections between sheathing and anchorage devices.
  - 2. Testing agency will record tendon elongations during stressing.
  - 3. Testing agency will immediately report deviations from the Contract Documents to Architect.
- B. Prepare test and inspection reports.

3.10 PROTECTION

- A. Do not expose tendons to electric ground currents, welding sparks, or temperatures that would degrade components.
- B. Protect exposed components within one workday of their exposure during installation.
- C. Prevent water from entering tendons during installation and stressing.
- D. Provide weather protection to stressing-end anchorages if strand tails are not cut within 10 days of stressing the tendons.

3.11 REPAIRS

- A. Submit repair procedure to Architect for evaluation and approval.
- B. Do not proceed with repairs requiring removal of concrete unless authorized in writing by Architect.

END OF SECTION 033816

## 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. This Section includes the following:

1. Structural steel.
2. Architecturally exposed structural steel.
3. Prefabricated building columns.
4. Grout.

- B. Related Sections include the following:

1. Division 01 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
2. Division 05 Section "Steel Decking" for field installation of shear connectors.
3. Division 05 Section "Metal Fabrications" for steel lintels or shelf angles not attached to structural-steel frame miscellaneous steel fabrications and other metal items not defined as structural steel.
4. Division 09 painting Sections Division 09 Section "High-Performance Coatings" for surface preparation and priming requirements.

#### 1.3 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.
- B. Architecturally Exposed Structural Steel: Structural steel designated as architecturally exposed structural steel in the Contract Documents.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand ASD-service loads indicated and comply with other information and restrictions indicated.

1. Select and complete connections using schematic details indicated AISC's "Manual of Steel Construction, Allowable Stress Design," Part 4.
2. Engineering Responsibility: Fabricator's responsibilities include using a qualified professional engineer to prepare structural analysis data for structural-steel connections.

#### 1.5 ACTION SUBMITTALS

##### A. Product Data with Shop Drawings:

1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication of structural-steel components.
  - a. Base plate and anchor rod plans showing the location, size, and identification marks of all base plate, bolts, grades of steel, and setting elevations.
  - b. Erection plans (minimum 1/8" = 1'-0" scale) showing type, size, weight, and identification marks of all structural steel members. Include temporary members required for erection, dimensions locating all members relative to column grid lines, elevations of all members, and clear cross references with all other related drawings. Also, include the necessary information and instructions regarding field welds and field bolts including type, size, and extents of field welds, types of electrodes, joint welding procedures, welding sequence and size and type of field bolts.
  - c. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
  - d. Include embedment drawings.
  - e. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
  - f. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
  - g. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer licensed in the State of Indiana responsible for their preparation.
3. Substitutions: substitutions for the member sizes, types of steel, connection details, or any other modification proposed by the contractor will be considered by the Architect/Engineer under the following conditions:
  - a. The revisions in no case result in additional cost to the Owner. In considering cost savings to the Owner, adequate compensation for the Engineer's review of the substitutions shall be considered.
  - b. The request is made in writing and accepted prior to the submission of shop drawings.
  - c. It is suitably demonstrated that there is a substantial cost or time advantage to the Owner.

- d. Sufficient sketches, engineering calculations by a Professional Engineer licensed in the State of Indiana, and other data are submitted to facilitate the review by the Architect/Engineer.
4. Welding Procedure Specifications (WPS) and Procedure Qualification Records (PQR): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint, including the following:
  - a. Power source (constant current or constant voltage).
  - b. Electrode manufacturer and trade name
- B. LEED Submittal:
  1. Product Data for Credit MR 4.1[ and Credit MR 4.2]: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
    - a. Include statement indicating costs for each product having recycled content.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, fabricator, and Connection Engineer. professional engineer.
- B. Source quality-control test reports.
- C. Welding certificates.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- E. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
  1. Structural steel including chemical and physical properties.
  2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
  3. Direct-tension indicators.
  4. Tension-control, high-strength bolt-nut-washer assemblies.
  5. Shear stud connectors.
  6. Shop primers.
  7. Nonshrink grout.
- F. 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.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- B. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category Cbd.
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
- D. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."
- E. Comply with applicable provisions of the following specifications and documents:
  1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
  2. AISC's "Seismic Provisions for Structural Steel Buildings" and "Supplement No. 2."
  3. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."
  4. AISC's "Specification for the Design of Steel Hollow Structural Sections."
  5. AISC's "Specification for Allowable Stress Design of Single-Angle Members."
  6. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

#### 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 erosion and deterioration.
  1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
  2. 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.

#### 1.9 COORDINATION

- A. Furnish 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 25 percent.
- B. W-Shapes: ASTM A 992/A 992M and ASTM A 572/A 572M, Grade 50.
- C. Channels, Angles, S-Shapes: ASTM A 36/A 36M.
- D. Plate and Bar: ASTM A 36/A 36M.
- E. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
  - 1. Finish: Black, except where indicated to be galvanized.
- F. Cold-Formed Hollow Structural Sections: ASTM A500/A 500M, Grade B minimum, structural tubing.
- G. 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 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
  - 1. Finish: Plain.
  - 2. Direct-Tension Indicators: ASTM F 959, Type 325 compressible-washer type.
    - a. Finish: Plain.
- B. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy hex head steel structural bolts with splined ends; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
  - 1. Finish: Plain.
- C. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
- D. Unheaded Anchor Rods: ASTM F 1554, Grade 36.
  - 1. Configuration: Straight.
  - 2. Nuts: ASTM A 563 heavy hex carbon steel.

3. Plate Washers: ASTM A 36/A 36M carbon steel.
4. Washers: ASTM F 436 hardened carbon steel.
5. Finish: Plain.

E. Headed Anchor Rods: ASTM F 1554, Grade 36, straight.

1. Nuts: ASTM A 563 heavy hex carbon steel.
2. Plate Washers: ASTM A 36/A 36M carbon steel.
3. Washers: ASTM F 436 hardened carbon steel.
4. Finish: Plain.

F. Threaded Rods: ASTM A 36/A 36M.

1. Nuts: ASTM A 563 heavy hex carbon steel.
2. Washers: ASTM A 36/A 36M carbon steel.
3. Finish: Plain.

G. Clevises Turnbuckles: ASTM A 108, Grade 1035, cold-finished carbon steel.

H. Eye Bolts and Nuts: ASTM A 108, Grade 1030, cold-finished carbon steel.

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

## 2.3 PRIMER

- A. Primer: SSPC-Paint 25, Type I, iron oxide, zinc oxide, raw linseed oil, and alkyd.
- B. Galvanizing Repair Paint: ASTM A 780.

## 2.4 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.

## 2.5 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's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."
  1. Camber structural-steel members where indicated.
  2. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
  3. Mark and match-mark materials for field assembly.

4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
  - B. Architecturally Exposed Structural Steel: Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel identified as architecturally exposed structural steel.
    1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, seam marks, roller marks, rolled trade names, and roughness.
    2. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
  - C. 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.
  - D. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
  - E. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
  - 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 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. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
    1. Cut, drill, or punch holes perpendicular to steel surfaces.
    2. Base-Plate 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 unless otherwise indicated.
  - B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
    1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

2. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
  - a. Grind butt welds flush.
  - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

## 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.
  5. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
  1. SSPC-SP 2, "Hand Tool Cleaning."
  2. SSPC-SP 3, "Power Tool Cleaning."
  3. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
  1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
  2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

## 2.8 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/ A 123M.
  1. Fill vent holes and grind smooth after galvanizing.
  2. Galvanize [lintels] [shelf angles] attached to structural-steel frame and located in exterior walls.

## 2.9 SOURCE QUALITY CONTROL

- A. 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 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 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.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, 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.

## 3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."
- B. Base Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base[ and bearing] plates. Clean bottom surface of base[ and bearing] plates.
  - 1. Set base plates for structural members on wedges, shims, or setting nuts as required.
  - 2. Weld plate washers to top of base plate.
  - 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 base[ or bearing] plate before packing with grout.
  - 4. Promptly pack grout solidly between bearing surfaces and base[ or bearing] 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 and architecturally exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members forming 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. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
- G. Do not use thermal cutting during erection.
- H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

- I. 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 and manufacturer's written instructions.

### 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 unless otherwise indicated.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
  1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
  2. Remove backing bars or runoff tabs, 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 of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
  4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
    - a. Grind butt welds flush.
    - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

### 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: Shop-bolted connections will be 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.
  1. In addition to visual inspection, field welds will be tested according to AWS D1.1 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 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.
- E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

### 3.6 REPAIRS AND 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 and accessories[, bearing plates,] and abutting structural steel.
1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
  2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.
- C. Touchup Painting: Cleaning and touchup painting are specified in Division 09 painting Sections.

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. This Section includes the following:
  - 1. K-series steel joists.
  - 2. KCS-type K-series steel joists.
  - 3. K-series steel joist substitutes.
  - 4. Joist accessories.
- B. Related Sections include the following:
  - 1. Division 05 Section "Structural Steel Framing" .

#### 1.3 DEFINITIONS

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

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.
- B. Design special joists to withstand design loads with live load deflections no greater than the following:
  - 1. Roof Joists: Vertical deflection of 1/360 of the span.

1.5 ACTION SUBMITTALS

A. Product Data with Shop Drawings:

1. Product Data: For each type of joist, accessory, and product indicated.
2. Shop Drawings: Show layout, designation, number, type, location, and spacings of joists. Include joining and anchorage details, bracing, bridging, joist accessories; splice and connection locations and details; and attachments to other construction.
  - a. Indicate locations and details of bearing plates to be embedded in other construction.
  - b. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.

B. LEED Submittal:

1. Product Data for Credit MR 4.1: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Manufacturer Certificates: Signed by manufacturers certifying that joists comply with requirements.

C. Mill Certificates: Signed by bolt manufacturers certifying that bolts comply with requirements.

D. Qualification Data: For manufacturer.

E. Field quality-control test and inspection reports.

F. Research/Evaluation Reports: For joists.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables of SJI "Specifications."

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

B. SJI Specifications: Comply with standard specifications in SJI's "Specifications" that are applicable to types of joists indicated.

- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

#### 1.8 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.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Steel: Comply with SJI's "Specifications" for web and steel-angle chord members.
  - 1. Recycled Content: 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 25 percent.
- B. 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.
- C. Welding Electrodes: Comply with AWS standards.
- D. Galvanizing Repair Paint: ASTM A 780.

#### 2.2 PRIMERS

- A. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.
- B. Primer: Provide shop primer that complies with Division 09 painting Sections.

#### 2.3 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 steel joists.

- 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. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.
- D. Provide holes in chord members for connecting and securing other construction to joists.
- E. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated, complying with SJI's "Specifications."
- F. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."
- G. Camber joists according to SJI's "Specifications." unless otherwise indicated.
- H. 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 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: Parallel.
- B. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.
- C. Provide holes in chord members for connecting and securing other construction to joists.
- D. Camber long-span steel joists according to SJI's "Specifications." unless otherwise indicated.
- E. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

#### 2.5 | 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. Supply 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 of finished wall surface, unless otherwise indicated.
- C. Supply miscellaneous accessories, including splice plates and bolts required by joist manufacturer to complete joist installation.

## 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 1 coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil thick.

## 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.
  - 1. 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 have been applied.
- C. Field weld joists to supporting steel 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 RCSC'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 bolted connections and to perform field tests and inspections and prepare test and inspection reports.
- B. Field welds will be visually inspected according to AWS D1.1/D1.1M.
- C. In addition to visual inspection, field welds will be tested according to AWS D1.1/D1.1M and the following procedures, as applicable:
  - 1. Radiographic Testing: ASTM E 94.
  - 2. Magnetic Particle Inspection: ASTM E 709.
  - 3. Ultrasonic Testing: ASTM E 164.
  - 4. Liquid Penetrant Inspection: ASTM E 165.
- D. Bolted connections will be visually inspected.
- E. High-strength, field-bolted connections will be tested and verified according to procedures in RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts."
- F. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.
- G. Additional testing will be performed to determine compliance of corrected Work with specified requirements.

### 3.4 REPAIRS AND 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, SSPC-SP 2, or power-tool cleaning, SSPC-SP 3.
  - 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

- C. 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. This Section includes the following:

- 1. Roof deck.
- 2. Composite floor deck.
- 3. Noncomposite form deck.

- B. Related Sections include the following:

- 1. Division 03 Section "Cast-in-Place Concrete" for concrete fill.
- 2. Division 05 Section "Structural Steel Framing" for shop- and field-welded shear connectors.
- 3. Division 05 Section "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
- 4. Division 09 painting Sections for repair painting of primed deck.

1.3 ACTION SUBMITTALS

- A. Product Data with Shop Drawings:

- 1. Product Data: For each type of deck, accessory, and product indicated.
- 2. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

- B. LEED Submittal:

- 1. Product Data for Credit MR 4.1: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
  - a. Include statement indicating costs for each product having recycled content.



## 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of steel deck, signed by product manufacturer.
- B. Welding certificates.
- C. Field quality-control test and inspection reports.
- D. 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.
- E. Research/Evaluation Reports: For steel deck.

## 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated.
- B. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."
- C. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
  - 1. Fire-Resistance Ratings: Indicated by design designations of applicable testing and inspecting agency.
  - 2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.
- D. 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."
- E. FMG Listing: Provide steel roof deck evaluated by FMG and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.
- F. 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 25 percent.

## 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.

## 1.7 COORDINATION

- A. Coordinate installation of sound-absorbing insulation strips in topside ribs of acoustical deck with roofing installation specified in Division 07 Section "<Insert title of applicable roofing Section>" to ensure protection of insulation strips against damage from effects of weather and other causes.

## PART 2 - PRODUCTS

## 2.1 ROOF DECK

- A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:
  - 1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
    - a. Color: Manufacturer's standard Gray.
  - 2. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G90 zinc coating.
  - 3. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
    - a. Color: Manufacturer's standard Gray.
  - 4. Deck Profile: Type WR, wide rib.
  - 5. Profile Depth: 1-1/2 inches.
  - 6. Design Uncoated-Steel Thickness: As indicated.
  - 7. Span Condition: Triple span or more.
  - 8. Side Laps: Overlapped.

## 2.2 COMPOSITE FLOOR DECK

- A. Composite Steel 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. 30, with the minimum section properties indicated, and with the following:
1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G30G90 zinc coating.
  2. Profile Depth: 2 inches.
  3. Design Uncoated-Steel Thickness: 0.0474 inch.
  4. Span Condition: Triple span or more.

## 2.3 NONCOMPOSITE FORM DECK

- A. Noncomposite Steel Form Deck: Fabricate ribbed-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:
1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 zinc coating.
  2. Profile Depth: 1-5/16 inches.
  3. Design Uncoated-Steel Thickness: 0.0295 inch.
  4. Span Condition: As indicated.
  5. Side Laps: Overlapped.

## 2.4 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 [indicated] [recommended by SDI Publication No. 30 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. 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.
- I. Flat Sump Plate: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.
- J. Galvanizing Repair Paint: ASTM A 780.
- K. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

### 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.

#### 3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, 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.

### 3.3 ROOF-DECK INSTALLATION

- A. 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 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 as indicated.
  - 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 1/2 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 2 inches minimum.
- 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.

## 3.4 FLOOR-DECK INSTALLATION

- A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
  - 1. Weld Diameter: 3/4 inch, nominal.
  - 2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart.
  - 3. Weld Spacing: Space and locate welds as indicated.
  - 4. 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 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 or butted at Contractor's option.
- 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 independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- 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.

3.6 REPAIRS AND 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 brush and clean rust spots, welds, and abraded areas on [both surfaces] [top surface] of prime-painted deck immediately after installation, and apply repair paint.
  - 1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
- C. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Division 09 Section "<Insert title of applicable field-painting Section>."
- D. 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

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Sleeves.
  - 2. Sleeve-seal systems.
  - 3. Grout.
  - 4. Silicone sealants.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anticorrosion coated or galvanized, with plain ends and integral welded waterstop collar.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description:
  - 1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
  - 2. Designed to form a hydrostatic seal of 20 psig minimum.
  - 3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 4. Pressure Plates: Carbon steel.
  - 5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B633 of length required to secure pressure plates to sealing elements.



## 2.3 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## 2.4 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

## PART 3 - EXECUTION

## 3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in exterior walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch minimum annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete walls as new walls are constructed.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
  - 2. Using grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

## 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and

sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

### 3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
  - 1. Exterior Concrete Walls below Grade:
    - a. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch minimum annular clear space between piping and sleeve for installing sleeve-seal system.
    - b. Piping NPS 6 and Larger: Steel pipe sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch minimum annular clear space between piping and sleeve for installing sleeve-seal system.

END OF SECTION 220517

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Copper tube and fittings.
  - 2. PEX tube and fittings.
  - 3. Piping joining materials.
  - 4. Transition fittings.

1.2 ACTION SUBMITTALS

- A. Product Data: For transition fittings.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type K water tube, drawn temper.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Copper Unions:
  - 1. MSS SP-123.

2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

### 2.3 PEX TUBE AND FITTINGS

- A. Tube Material: PEX plastic according to ASTM F 876 **and** ASTM F 877.
- B. Fittings: ASTM F 1807, metal insert and copper crimp rings and ASTM F 1960, cold expansion fittings and reinforcing rings.
- C. Fittings: ASSE 1061, push-fit fittings.
- D. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 876; with plastic or corrosion-resistant-metal valve for each outlet.

### 2.4 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
  1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
  2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.
- E. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

### 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.

## PART 3 - EXECUTION

## 3.1 EARTHWORK

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

## 3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance.
- D. Install domestic water piping level without pitch and plumb.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping to permit valve servicing.
- G. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install PEX tubing with loop at each change of direction of more than 90 degrees.
- K. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- L. Install sleeves for piping penetrations of walls and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- M. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

## 3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- F. Joints for PEX Tubing: Join according to ASTM F 1807 for metal insert and copper crimp ring fittings and ASTM F 1960 for cold expansion fittings and reinforcing rings.
- G. Joints for PEX Tubing: Join according to ASSE 1061 for push-fit fittings.

### 3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
  - 1. Fittings for **NPS 2** and Larger: Sleeve-type coupling.

### 3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

### 3.6 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

### 3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Piping Inspections:
  - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
  - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
    - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
    - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
  - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
  - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:
  - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
  - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
  - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
  - d. Cap and subject piping to static water pressure of **50 psig** above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
  - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
  - f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

### 3.8 CLEANING

A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

### 3.9 PIPING SCHEDULE

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

- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger shall be one of the following:
  - 1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
- E. Under-building-slab, domestic water piping, NPS 2 and smaller shall be one of the following:
  - 1. Hard or soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings.
  - 2. PEX tube, NPS 1 and smaller.
    - a. Fittings for PEX tube:
      - 1) ASTM F 1807, metal insert and copper crimp rings.
      - 2) ASTM F 1960, cold expansion fittings and reinforcing rings.
      - 3) ASSE 1061, push-fit fittings.
- F. Aboveground domestic water piping, NPS 2 and smaller shall be one of the following:
  - 1. Hard copper tube, ASTM B 88, Type K; cast- or wrought-copper, solder-joint fittings; and soldered joints.
  - 2. PEX tube, NPS 1 and smaller.
    - a. Fittings for PEX tube:
      - 1) ASTM F 1807, metal insert and copper crimp rings.
      - 2) ASTM F 1960, cold expansion fittings and reinforcing rings.
      - 3) ASSE 1061, push-fit fittings.
- G. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 shall be the following:
  - 1. Hard copper tube, ASTM B 88, Type K; cast- or wrought-copper, solder-joint fittings; and soldered joints.
- H. Aboveground domestic water piping, NPS 5 to NPS 8 shall be the following:
  - 1. Hard copper tube, ASTM B 88, Type K; cast- or wrought-copper, solder-joint fittings; and soldered joints.

END OF SECTION 221116



SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. PVC pipe and fittings.
  - 2. Specialty pipe fittings.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 WARRANTY

- A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

2.2 PIPING MATERIALS

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

## 2.3 PVC PIPE AND FITTINGS

- A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F 656.
- E. Solvent Cement: ASTM D 2564.

## 2.4 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
  - 1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
  - 2. Shielded, Nonpressure Transition Couplings:
    - a. Standard: ASTM C 1460.
    - b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
    - c. End Connections: Same size as and compatible with pipes to be joined.

## PART 3 - EXECUTION

## 3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

## 3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
  - 1. Indicated locations and arrangements were used to size pipe and and other design considerations.
  - 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Diagonal runs are prohibited unless specifically indicated otherwise.

- C. Install piping at indicated slopes.
- D. Install piping free of sags and bends.
- E. Install fittings for changes in direction and branch connections.
- F. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
  - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
  - 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
    - a. Straight tees, elbows, and crosses may be used on vent lines.
  - 3. Do not change direction of flow more than 90 degrees.
  - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
    - a. Reducing size of waste piping in direction of flow is prohibited.
- G. Lay buried building waste piping beginning at low point of each system.
  - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
  - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
  - 3. Maintain swab in piping and pull past each joint as completed.
- H. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
  - 1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
- I. Install underground PVC piping according to ASTM D 2321.
- J. Plumbing Specialties:
  - 1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
    - a. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
  - 2. Install drains in sanitary waste gravity-flow piping.
    - a. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

- K. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- L. Install sleeves for piping penetrations of walls and floors.
  - 1. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- M. Install sleeve seals for piping penetrations of concrete walls and slabs.
  - 1. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

### 3.3 JOINT CONSTRUCTION

- A. Plastic, Non pressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

### 3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
  - 1. Install transition couplings at joints of piping with small differences in ODs.
  - 2. In Waste Drainage Piping: Shielded, non pressure transition couplings.

### 3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
  - 1. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
  - 2. Comply with requirements for cleanouts and drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

## 3.6 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
- B. Re inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re inspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
  - 1. Test for leaks and defects in new piping.
    - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 2. Leave uncovered and unconcealed new until it has been tested and approved.
    - a. Expose work that was covered or concealed before it was tested.
  - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
    - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
    - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    - c. Inspect joints for leaks.
  - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  - 5. Prepare reports for tests and required corrective action.

## 3.7 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Repair damage to adjacent materials caused by waste and vent piping installation.

3.8 PIPING SCHEDULE

- A. Underground, soil, waste, and vent piping NPS 4 and smaller shall be the following:
  - 1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  - 2. Dissimilar Pipe-Material Couplings: Shielded, non pressure transition couplings.
  
- B. Underground, soil and waste piping NPS 5 and larger shall be the following:
  - 1. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints.
  - 2. Dissimilar Pipe-Material Couplings: Shielded, non pressure transition couplings.

END OF SECTION 221316

SECTION 221319.13 - SANITARY DRAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor drains.

1.2 DEFINITIONS

- A. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Standard: ASME A112.6.3.
2. Pattern: Floor drain.
3. Body Material: Gray iron.
4. Seepage Flange: Not required.
5. Anchor Flange: Required.
6. Clamping Device: Not required.
7. Outlet: Bottom.
8. Backwater Valve: Not required.
9. Coating on Interior and Exposed Exterior Surfaces: Not required.
10. Sediment Bucket: See drawings
11. Top or Strainer Material: See drawings.
12. Top of Body and Strainer Finish: See drawings
13. Top Shape: Round.
14. Dimensions of Top or Strainer: Manufacturer's standard.

15. Top Loading Classification: Light duty in Finished Areas and Heavy Duty in Mechanical Rooms.
16. Funnel: See drawings.
17. Trap Material: Cast iron.
18. Trap Pattern: Standard P-trap in Finished Areas, Deep seal in Mechanical Rooms.
19. Trap Features: Cleanout.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
  1. Position floor drains for easy access and maintenance.
  2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
  3. Set with grates depressed according to the following drainage area radii:
    - a. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
  4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
    - a. Maintain integrity of waterproof membranes where penetrated.
  5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

#### 3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for miscellaneous sanitary drainage piping specialties.
- C. Install piping adjacent to equipment to allow service and maintenance.

#### 3.3 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319.13



SECTION 221413 - FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. PVC pipe and fittings.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
  - 1. Storm Drainage Piping: 10-foot head of water.

2.2 PVC PIPE AND FITTINGS

- A. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D 2665; drain, waste, and vent.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F 656.

- E. Solvent Cement: ASTM D 2564.

### PART 3 - EXECUTION

#### 3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

#### 3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
  - 1. Indicated locations and arrangements were used to size pipe and other design considerations.
  - 2. Install piping as indicated unless deviations from layout are approved on coordination drawings.
- B. Install piping at indicated slopes.
- C. Install piping free of sags and bends.
- D. Install fittings for changes in direction and branch connections.
- E. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
  - 1. Do not change direction of flow more than 90 degrees.
  - 2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
    - a. Reducing size of drainage piping in direction of flow is prohibited.
- F. Lay buried building piping beginning at low point of each system.
  - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
  - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
  - 3. Maintain swab in piping and pull past each joint as completed.
- G. Install piping at the following minimum slopes unless otherwise indicated:
  - 1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
- H. Install underground PVC piping according to ASTM D 2321.
- I. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping.
  - a. Comply with requirements for cleanouts specified in Section 22 14 23 "Storm Drainage Piping Specialties."
- J. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- K. Install sleeves for piping penetrations of walls and floors.
  1. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- L. Install sleeve seals for piping penetrations of concrete walls and slabs.
  1. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

### 3.3 JOINT CONSTRUCTION

- A. **PVC, Nonpressure-Piping, Solvent-Cemented Joints:** Clean and dry joining surfaces. Join pipe and fittings according to the following:
  1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendices.

### 3.4 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping.
- C. Connect storm drainage piping to storm drainage specialties.
  1. Comply with requirements for cleanouts specified in Section 22 14 23 "Storm Drainage Piping Specialties."

### 3.5 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
  2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

- B. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
  - 1. Test for leaks and defects in new piping.
    - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 2. Leave uncovered and unconcealed new storm drainage piping until it has been tested and approved.
    - a. Expose work that was covered or concealed before it was tested.
  - 3. Test Procedure:
    - a. Test storm drainage piping on completion of roughing-in.
    - b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
  - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  - 5. Prepare reports for tests and required corrective action.
- C. Piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.6 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

### 3.7 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Underground storm drainage piping NPS 6 and smaller shall be the following:
  - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- C. Underground, storm drainage piping NPS 8 and larger shall be the following:
  - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION 221413

## SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Miscellaneous storm drainage piping specialties.
  - 2. Cleanouts.

## 1.2 ACTION SUBMITTALS

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

## 1.3 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

## PART 2 - PRODUCTS

## 2.1 CLEANOUTS

- A. Cast-Iron Exposed Floor Cleanouts:
  - 1. Standard: ASME A112.36.2M.
  - 2. Size: Same as connected branch.
  - 3. Type: **Adjustable housing.**
  - 4. Body or Ferrule: Cast iron.
  - 5. Clamping Device: **Not required.**
  - 6. Outlet Connection: **No hub.**
  - 7. Closure: **Brass plug with tapered threads.**
  - 8. Adjustable Housing Material: **Cast iron.**
  - 9. Frame and Cover Material and Finish: **Nickel-bronze, copper alloy in Finished Areas and Cast Iron in Mechanical Rooms and Exterior.**
  - 10. Frame and Cover Shape: **Round.**
  - 11. Top Loading Classification: **Heavy in Mechanical Rooms and Exterior and Medium Duty in Finished Areas.**

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
  - 1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
  - 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
  - 3. Locate cleanouts at minimum intervals in accordance with the State of Indiana Plumbing Code.
- B. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

## 3.2 FLASHING INSTALLATION

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
- C. Set flashing on floors roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.

## 3.3 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221423

## SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

### 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. Electrical equipment coordination and installation.
  - 2. Codes and standards.
  - 3. Work and workmanship.
  - 4. Drawings and minor deviations.
  - 5. Common electrical installation requirements.
  - 6. Miscellaneous work.
  - 7. Protection and treatment of property.

#### 1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.

#### 1.4 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
  - 1. To allow maximum possible headroom, unless specific mounting heights that reduce headroom are indicated.
  - 2. To provide for ease of disconnecting equipment with minimum interference to other installations.
  - 3. To allow right of way for piping and conduit installed at required slope.
  - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

- C. Rough-in: Verify exact location of rough-in prior to installation, checking mounting heights with equipment manufacturers or casework suppliers.
- D. Each Contractor and subcontractor shall study all Drawings applicable to this work so complete coordination between trades will be effected. Special attention shall be given to points where ducts cross and where pipes, ducts, and conduit pass through walls.
- E. It is responsibility of each Contractor and Subcontractor to leave necessary room for other trades. No extra compensation will be allowed to cover cost of removing piping, conduit, ducts or equipment found encroaching on space required by others.

1.5 CODES AND STANDARDS

- A. All materials and workmanship shall comply with all applicable Codes, Specifications, local ordinances, industry standards, and utility company regulations.
- B. In case of difference between building codes, specifications, state laws, local ordinances, industry standards, utility company regulations, and Contract Documents, most stringent shall govern. Contractor shall promptly notify Architect/Engineer in writing of such difference.
- C. Non-Compliance: Should Contractor perform Work that does not comply with requirements of applicable building codes, state laws, local ordinances, industry standards, and utility company regulations, Contractor shall bear all costs related to correcting deficiencies.
- D. Applicable codes and standards shall include all state laws, local ordinances, utility company regulations and applicable requirements of following nationally accepted codes and standards.
- E. Building codes (with all state and local amendments) shall include, but not be limited to following:
  - 1. National Electrical Code.
  - 2. International Building Code.
  - 3. Indiana Accessibility Code.
  - 4. International Fire Code.
  - 5. International Mechanical Code.
  - 6. International Plumbing Code.
  - 7. Indiana Accessibility Code.
- F. These requirements shall be considered minimum and shall be exceeded when so indicated on Drawings or herein specified.
- G. Permits: Contractor shall pay for all building permits required by the Work, permits for opening streets, and for connection to various utilities, including fees for electric meter installation and other requirements necessary to carry out the Work.



- H. Where streets or sidewalks are cut, they shall be repaired to at least as good a condition as they were before, all at expense of this Contractor. Permits shall be posted in a prominent place at building Site properly protected from weather and physical damage.
- I. Industry Standards, Codes and Specifications
  - 1. IEEE: Institute of Electrical and Electronic Engineers.
  - 2. ASA: American Standards Association.
  - 3. ASTM: American Society of Testing Materials.
  - 4. IPCEA: Insulated Power Cable Engineers Association.
  - 5. NBS: National Bureau of Standards.
  - 6. NEMA: National Electric Manufacturers Association.
  - 7. NFPA: National Fire Protection Association.
  - 8. UL: Underwriters Laboratories.
  - 9. NECA: National Electrical Contractors Association.
  - 10. OSHA: Occupational Safety and Health Act.
- J. Occupancy Safety and Health Standards
  - 1. All Work shall comply with current requirements of U.S. Department of Labor Occupational Safety and Health Administration, entitles Occupational Safety and Health Standards; National Consensus Standards and Established Federal Standards.
- K. Work and Workmanship
  - 1. Provide all required labor, materials, equipment and Contractor's services necessary for complete installation of systems required in full conformity with requirements of authorities having jurisdiction; all as indicated on Drawings and herein specified.
  - 2. Finished job shall be functional and complete in every detail including all such items required for complete system, whether or not these items are specified or shown on Drawings.
  - 3. Special attention shall be given to accessibility of working and controlling parts. Adjustable parts shall be within easy reach. Removable parts shall have space for removal.
  - 4. Each Contractor shall become fully acquainted with details of all Work to be performed by other trades and take necessary steps to integrate and coordinate its work with other trades.
  - 5. Wherever tables or schedules show quantities of materials, they shall not be used as a final count. These figures are provided only as a guide to Contractor. Each Contractor shall be responsible for furnishing all materials on Drawings or as specified.
  - 6. Owner and Architect/Engineer have full power to reject Work, materials, or equipment not in accordance with these Specifications and Drawings or are not in compliance with manufacturer's specifications or drawings which are approved by Owner or Architect/Engineer.

7. Work or equipment that is rejected shall be removed and replaced to satisfaction of Owner, at Contractor's expense. Work or equipment that is rejected shall be so stated in writing by Owner or Architect/Engineer.
8. Decisions that Owner or Architect/Engineer may make with respect to questions concerning quality, fitness of materials, equipment, and workmanship shall be binding upon parties and entities involved in that Work.

L. Drawings and Minor Deviations

1. Electrical Drawings show general arrangement of all raceways, equipment, and appurtenances. They shall be followed as closely as actual building construction and Work of other trades will permit. Electrical Work shall conform to requirements shown on all Drawings. Because of small scale of Electrical Drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Contractor shall investigate structural and finish conditions affecting Work and shall arrange its Work accordingly, providing such fittings and accessories as may be required to meet such conditions.
2. In event of conflict of requirements detailed in Drawings, General Conditions, these General Provisions and subsequent sections of these Specifications, Bidder shall inform Architect/Engineer of such conflict in writing not later than 5 days before bids are due. If such notification is not provided, Contractor shall accept Architect/Engineer's decision to resolve such conflict without further compensation.
3. For purpose of clarity and legibility, Drawings are essentially diagrammatic, although size and location of equipment and piping are drawn to scale wherever possible. Verify Contract Documents information at Site.
4. Drawings indicate required sizes and points of termination of conduits and ducts and suggest routes. It is not intention of Drawings to indicate all necessary offsets. Install work in manner to conform to structure, avoid obstructions, preserve headroom, and keep openings and passageways clear. Do not scale from Drawings.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

### 3.2 MISCELLANEOUS WORK

- A. Floor and Wall Openings
  - 1. Floor and wall openings for electrical Work shall be provided by Electrical Contractor.
  - 2. Final sizes and exact locations of electrical penetrations in floor and wall openings are responsibility of Electrical Contractor.
- B. Cutting and Patching
  - 1. Electrical Contractor shall provide all cutting and patching required for installation of new conduit. Cutting and patching shall comply with requirements of Division 1 Section "Cutting and Patching."
- C. Excavation and Backfilling
  - 1. Electrical Contractor shall provide all excavation and backfilling required for installation of new electrical equipment. Excavation and backfilling shall comply with requirements of Division 31.

### 3.3 PROTECTION AND TREATMENT OF PROPERTY

- A. Protect existing utilities. Cap existing utilities that are abandoned.

END OF SECTION 260500

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Metal conduits and fittings, including GRC.
  - 2. Rigid nonmetallic duct.
  - 3. Flexible nonmetallic duct.
  - 4. Duct accessories.

1.3 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
  - 1. Two or more ducts installed in parallel, with or without additional casing materials.
  - 2. Multiple duct banks.

1.4 FIELD CONDITIONS

- A. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Allied Tube & Conduit; a part of Atkore International.
  - 2. Republic Conduit.
  - 3. Western Tube and Conduit Corporation.
  - 4. Wheatland Tube Company.
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

- A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CANTEX INC.
  - 2. National Pipe & Plastics.
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
- D. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 DUCT ACCESSORIES

- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CANTEX INC.

- B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

#### 3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Electrical Cables More Than 600 V: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.
- B. Duct for Electrical Feeders 600 V and Less: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.
- C. Duct for Electrical Feeders 600 V and Less: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.
- D. Duct for Electrical Branch Circuits: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.
- E. Stub-ups: GRC.

#### 3.3 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct according to NEMA TCB 2.

- C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.
- E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.
- F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- G. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- H. Pulling Cord: Install 200-lbf- test nylon cord in empty ducts.
- I. Concrete-Encased Ducts and Duct Bank:
  - 1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
  - 2. Width: Excavate trench 3 inches wider than duct on each side.
  - 3. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
  - 4. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
  - 5. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
  - 6. Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
  - 7. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances.

- a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
  - b. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.
    - 1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab
8. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
  9. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
  10. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
  11. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
    - a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions, or use other specific measures to prevent expansion-contraction damage.
    - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.
  12. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.
- J. Direct-Buried Duct and Duct Bank:
1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
  2. Width: Excavate trench 12 inches wider than duct on each side.
  3. Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.
  4. Set elevation of bottom of duct bank below frost line.
  5. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.



6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
  7. Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.
  8. Install manufactured GRC elbows for stub-ups, at building entrances.
    - a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    - b. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.
      - 1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab
  9. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
    - a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
    - b. Place minimum 6 inches of engineered fill above concrete encasement of duct.
- K. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.

2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch- long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
- B. Correct deficiencies and retest as specified above to demonstrate compliance.
- C. Prepare test and inspection reports.

### 3.5 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION 260543

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

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. Tapes.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.

2.2 TAPES

- A. Underground-Line Warning Tape:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Ideal Industries, Inc.
    - c. LEM Products Inc.
    - d. Marking Services, Inc.
    - e. Reef Industries, Inc.
    - f. Seton Identification Products.
  - 2. Tape:
    - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.
    - b. Printing on tape shall be permanent and shall not be damaged by burial operations.

- c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- 3. Color and Printing:
  - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
  - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE" .

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Verify identity of each item before installing identification products.
- C. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- D. Underground Line Warning Tape:
  - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
  - 2. Install underground-line warning tape for direct-buried cables and cables in raceways.

END OF SECTION 260553

SECTION 270500 – COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. This section of the project specifications pertains to and addresses scope and performance requirements for all division 26, 27, 28 specifications sections.
  
- B. For each element of the Information Transport System listed below, the contractor shall provide all services, labor, equipment, supplies, materials and appurtenances for the complete installation and commissioning of a fully operational system per the drawings and the project manual. The Information Transport System includes but is not limited to:
  - 1. Grounding and Bonding
  - 2. Pathways
  - 3. Hangers and Supports
  - 4. Cable Trays
  - 5. Underground Pathways and Structures
  - 6. Sleeves and Sleeve Seals
  - 7. Identification Systems
  - 8. Equipment Room Fittings
  - 9. Racks Frames and Enclosures
  - 10. Backbone Cabling
  - 11. Horizontal Cabling
  
- C. Purpose and Scope
  - 1. All systems specified herein are associated with the Information Transport System.
  - 2. Whether expressed or implied all work is included. Any item not specifically indicated, but necessary for a complete, fully functional and operational system shall be provided.
  - 3. Indications or reasonable implications of articles, materials, means or methods related to execution of the work that are prescribed, means execution of each such item of work shall be included.
  - 4. Omission of a device, component or assembly from the specifications does not indicate that it is not to be provided if it is necessary for a complete operational system based on the entirety of the specifications and industry standard or convention.
  - 5. Language that denotes singularity or plurality shall not be used to limit the provision of scope as is necessary for a fully functional and operational system.
  - 6. Refer to dimensioned architectural/structural drawings for locations of equipment, building elements and devices.
  - 7. Field verification of measurements takes priority over dimensioned drawings.

8. The contractor shall accommodate movement of a device up to 10 feet from the location indicated on the drawings without additional cost up to and until rough in is complete.

## 1.2 SCOPE AND RESPONSIBILITY

- A. Provide full time on site field representation for Division 27 scope of work once site work has commenced.
- B. Include detailed scheduling information for Information Transport System installation and testing in the construction schedule. Provide detailed construction schedule information including but not limited to:
  1. Notice to Proceed
  2. Design
  3. Shop drawings
  4. Electrical Work
  5. Fabrication
  6. Equipment installation
  7. Testing, commissioning, and training.
- C. Submit schedule information as soon as possible but no later than 2 calendar weeks after NTP. The schedule durations shall be such that the overall project milestones in the project manual are maintained.
- D. Equipment rooms and closets associated with Information Transport System shall be finished, cleaned and temperature controlled as soon as possible to facilitate completion of wiring and terminations. Space shall be free of dust and dirt prior to installation of any Equipment. The Architect shall determine that the condition of these rooms is acceptable prior to the installation of any equipment in the space.
- E. Attend contractor coordination meetings and make other trades and contractors aware of critical path elements of construction. Coordinate work of this trade with other trades and contractors including but not limited to electrical and mechanical.
- F. Provide a complete pathway system including back boxes, junction boxes, mortar boxes, conduit and cable tray for the Information Transport System.
- G. Conduit from telecommunications outlets shall extend to the equipment room or closet uninterrupted.
- H. Provide Telecommunications Grounding System as shown on the drawings and specified herein.
- I. Furnish and install all devices, equipment, and appurtenances resulting in complete, functional, and fully operational systems as specified herein, indicated on the drawings and listed below:
  1. Section 27 05 26 – Grounding and Bonding for Communications Systems
  2. Section 27 05 28 – Pathways for Communications Systems
  3. Section 27 05 28.29 – Hangers and Supports for Communications Systems
  4. Section 27 05 36 – Cable Trays for Communications Systems
  5. Section 27 05 43 – Underground Pathways and Structures for Communication Systems

6. Section 27 05 44 – Sleeves and Sleeve Seals for Communication Systems
7. Section 27 05 53 – Identification for Communications Systems
8. Section 27 11 00 – Communications Equipment Room Fittings
9. Section 27 11 16 – Communications Racks, Frames and Enclosures
10. Section 27 13 23 – Communications Optical Fiber Backbone Cabling
11. Section 27 15 13 – Communications Copper Horizontal Cabling

- J. Contractor shall provide commissioning of the Information Transport System. Contractor shall submit test data from all copper and fiber testing. Contractor shall provide the owner/user with the manufacturer’s certificate of warranty for the commissioned system.

### 1.3 RELATED DOCUMENTS

#### A. General

1. Information relative to this scope of work is included elsewhere in the drawings and specifications. The contractor and all subcontractors and suppliers are responsible for the content of the entire project documents package.

#### B. Reference Specifications, Standards, and/or Codes

1. Permitting and fees are the responsibility of the contractor.
2. NFPA, NEC and IBC shall govern all work.
3. All work shall conform to all Federal, State and local ordinances.
4. Where applicable, all fixtures, equipment and materials shall be as approved or listed by the following:
  - a. Factory Mutual Laboratories (FM).
  - b. Underwriters Laboratories, Inc. (UL).
  - c. National Electrical Manufacturers Association (NEMA).
5. Where design drawings and specifications are above the minimum code requirements, the drawings and specifications shall govern.

#### C. All work shall meet or exceed the standards and procedures of the following:

1. American National Standards Institute (ANSI/EIA/TIA)
  - a. 568-C.0 Generic Telecommunications Cabling for Customer Premise
  - b. 568-C.1 Commercial Building Telecommunications Cabling Standard
  - c. 568-C.2 Balanced Twisted Pair Telecommunications Cabling and

Component Standard

- d. 568-C.3 Optical Fiber Cabling Components Standard.
- e. 569-B Commercial Building Standard for Telecommunications Pathways and Spaces
- f. 598-B Commercial Building Standard for Telecommunications Optical Fiber Cable Color Coding.
- g. 606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
- h. 607 Commercial Buildings Grounding (Earthing) and Bonding Requirements for Telecommunications
- i. 758-A Customer Owned Outside Plant Telecommunications Cabling Standard.
- j. TSB-67 Performance Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems.

2. All work shall meet or exceed the standards set forth in the following:

- a. National Electrical Manufacturers Association (NEMA)
- b. American Society of Testing Materials (ASTM)
- c. Institute of Electronic & Electrical Engineers (IEEE)
- d. Americans With Disabilities Act (ADA)

- D. Include all items of labor and material required to comply with such standards and codes. Where quantity, sizes or other requirements indicated on the drawings or herein specified are in excess of the standard or code requirements, the specifications or drawings, respectively, shall govern.
- E. Installation shall be performed in accordance with the applicable standards, requirements and recommendations of the current local codes and any additional authorities having jurisdiction.

1.4 QUALITY ASSURANCE

A. General

- 1. All equipment and components will be new product unused, without defect.
- 2. All similar equipment shall be a product of a single manufacturer.

A. Qualifications

- 1. The contractor shall have been in business under the same name for a minimum of 5 years.
- 2. The contractor shall specialize in the installation of low voltage and Information Transport System and shall be experienced in provisioning systems of equal scope, quality, type, and complexity to that required herein.



3. The contractor will own, at time of bid, all required testing equipment called for in the specifications. Technicians responsible for operating testing equipment will have successfully completed all manufacture approved training courses for the successful operation of the testing equipment.
4. The contractor shall be an authorized dealer for the cabling solution intended to be provided for at least one year prior to bid time.
5. The principal members and key personnel to be assigned to the project shall each have a minimum of 5 years' experience in completing projects of equal scope, quality, type, and complexity to that required herein.
6. The contractor shall have completed a minimum of 5 Information Transport System projects of similar size and scope, installed and operational for a minimum of one year.
7. Contractor shall employ one BICSI Registered Communications Distribution Designer (RCDD).
8. Contractors on site installation technicians shall be BICSI certified level 1 or level 2 technicians.

## 1.5 SUBMITTALS

### A. Bill of Materials

1. Provide a bill of materials for all major components, accessories, and hardware to be provided in order to assemble a complete functioning system.
2. Bill of materials shall include
  - a. Manufacture Name
  - b. Model
  - c. Version
  - d. Quantity

B. RCDD shall seal all shop drawings.

C. Provide shop drawings electronically or in accordance with Division 1.

D. Submittals are due within 30 calendar days of NTP.

E. Product Submittal

1. Submittal must consist of a complete package; the submittal shall include the following:
  - a. A Title Page complete with the following required information:
  - b. Project name.

- c. Date.
  - d. Name of Architect.
  - e. Name of Construction Manager
  - f. Name Electrical Contractor
  - g. Name General Contractor
  - h. Name Subcontractors.
2. An Index Page complete with the following required information:
- a. Name of the Supplier.
  - b. Name of the Manufacturer.
  - c. Title, section and paragraph of the Specification Sections. (Example section 271500, paragraph 2.4)
  - d. Products in order as specified in PART II of the related specification.
3. Each Data Sheet shall have the specific reference to the Specification it is to be used for, noting the section and paragraph.
4. Product Data showing multiple products, models or options shall be clearly marked identifying the specific product, model and options, which are submitted for review. Unmarked submittals or facsimile copies shall not be acceptable.
5. Submit product data for all equipment showing:
- a. Product performance, mechanical and electrical specifications.
  - b. Manufacturer's installation instructions.
  - c. Certification from the submitted manufacturers that the Contractor's designated personnel are trained on the installation of the system. Include Contractor installer's name, experience and responsibility.
  - d. Product test compliance certificates if required.

F. Shop Drawings

1. Submittals consisting of reproduced copies of the original bidding documents will be rejected. The contractor is required to develop a complete set of drawings specific to the final configuration of the system based on the manufacturer and models of all components included. Shop drawings are to include all changes noted in addenda, as well as any changes included in architect's special instructions or change orders issued prior to the submittal of the shop drawings.
2. Shop drawings shall be submitted with product data.
3. All drawings shall be created using an industry recognized computer aided design program. Recognized programs include AutoDesk Revit or AutoCAD. All drawings are to be made using one of the last 3 software releases available.
4. Submit shop drawings for all equipment showing:
  - a. Location and type of all field equipment on floor plans.

- i. Telecommunications Outlets Of All Types
  - ii. Telecommunication Rooms
  - iii. Equipment Rooms
- b. Large scale (minimum 1/4"=1') floor plan and elevation view drawings of all telecommunications closets depicting all racks, consoles, cabinets, equipment, outlets, etc.
  - c. Size and spacing of all anchors, wall penetrations, joinery construction, etc., required for complete system installation.
  - d. Electrical riser diagrams identifying all signal, power, and ground circuitry.
  - e. Elevations of all equipment racks showing equipment mounting locations (front and rear if any equipment is rear mounted).
  - f. Wall elevations showing mounting of cabinets, and wall mount hardware and electronics.
  - g. Wire management details for the installation of cable harnesses inside racks, equipment cabinets and other areas of exposed cable.
  - h. Block diagrams depicting wire connectivity to all data closets.
  - i. Wiring diagrams for all equipment and devices (active and passive).
    - i. Wiring diagrams are required to show point to point connection of all terminations for all devices.
    - ii. Indicate wire type used for connection.
    - iii. Indicated type of termination to be made.
  - j. Equipment room layout, relay rack elevations and fiber management panel layout drawings
  - k. Equipment room layout and fiber management panel layout drawings
  - l. Information Transport System grounding and bonding system

#### G. Samples

- 1. Provide samples as requested for review and approval of substitutions or as specified in Division 27 specifications.

#### H. Training Plan

- 1. Submit a training plan for all systems for approval.
- 2. As a minimum, the plan submitted must include individualized training paths for the following personnel on all aspects of the Information Transport System.
  - a. Administrators
  - b. Supervisors
  - c. Operators
  - d. Maintenance Personnel

3. As a minimum, the plan submitted must include the following:
  - a. Proposed classes or sessions.
  - b. Recommended attendees for each class or session.
  - c. Proposed class or session objectives.
  - d. Proposed class or session agenda and duration.
  - e. Proposed supporting materials for each class or session.
  - f. Proposed testing procedure for evaluation purposes.
  - g. Proposed documentation of testing and evaluation.

I. Operating and Maintenance Data

1. Provide operating and maintenance manual for all Division 27 systems and equipment.
2. The O & M manuals shall be cross-referenced to the Record Documents and contain the following information for all systems:
  - a. Product catalog cut sheets and specifications of all equipment.
  - b. Operational description of all equipment and performance features in each system using clear and understandable terminology.
  - c. Detailed programming instructions for all systems and all software programs.
  - d. Troubleshooting procedures to diagnose malfunctions in each system.
  - e. Repair procedures for all equipment.
  - f. Preventative maintenance procedures for all equipment.
  - g. Table listing the model numbers for all equipment in each system including the names and phone numbers of the manufacturer and their representative directly responsible for this project.

J. Record Documents

1. Submit an electronic copy of the "As-built" condition of all systems including:
  - a. A set of updated shop drawings showing all Contract changes.
  - b. A set of updated product data showing all Contract changes.
  - c. Floor plan showing conduit raceway routing including all equipment rack, cabinet and pull box locations, and conduit sizes.
  - d. Complete point-to-point wiring diagrams showing equipment, devices, wire and cable (Signal, power and ground). This document shall also include all terminal block designations, abbreviations and color-coding.
2. Provide report showing results of all tests required and outlined in individual 27 05

- 00 series specifications.
- 3. Two (2) copies of training session DVD.
- 4. Transmittal letter listing delivery of complete spare parts inventory.
- 5. Copy of warranty certificate.
- 6. Procedures for addressing warranty/repair issues.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. Products that have been in manufacture for at least one year, unless otherwise specified by performance requirements.

### 2.2 SUBSTITUTIONS

#### A. Deviations from specifications

- 1. Changes to the scope of work in the bid proposal are not acceptable.
- 2. Any proposed equipment substitution must be submitted 10 calendar days prior to the bid date. Accompany the request, the Contractor must provide manufacture product specifications for the exact model be substituted. This literature must clearly state all specifications called for in the bidding documents, as well as performance characteristics not specified but inherent to the product listed in the specifications. Any items approved as a substitute will be listed by addendum prior to the bid opening. Substitutions after the award of bid will only be allowed in case of discontinued equipment, or if an item of equal or better quality is available and will not affect the contract cost of the system.
- 3. Changes to the general provisions are not acceptable. Any proposed change is to be submitted to the Architect for review. Any approved changes will be listed by addendum prior to the bid opening.
- 4. When a specified item is found to be discontinued or obsolete by the manufacturer, the contractor is required to substitute the manufacture recommended equivalent for that product. If an equivalent is not available, the contractor is instructed to notify the Architect in writing prior to bid time.
- 5. Any manufacturer that is not listed in the specifications must be qualified and owner approved prior to use.

- B. Where specific products are sole source specified, no substitutions will be allowed.

### 2.3 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are readily available.
- B. All factory wiring shall be identified on or provided with the equipment being furnished

and on all wiring diagrams and included with O & M manuals.

C. When factory testing is specified

1. The Architect shall have the option of witnessing factory tests. The Contractor shall notify the Architect a minimum of 21 calendar days prior to the manufacturers making the factory tests.
2. When equipment fails to meet factory test and reinspection is required, the Contractor shall be liable for all additional expenses.

2.4 EQUIPMENT IDENTIFICATION

- A. In addition to the requirements of the National Electrical Code, install an identification sign which will clearly indicate information required for use and maintenance of items such as cabinets, control devices and other significant equipment.
- B. Nameplates shall be laminated black phenolic resin with a white core and engraved lettering, a minimum of 1/4-inch high. Nameplates that are furnished by manufacturer, as a standard catalog item, or where other methods of identification are herein specified, are exceptions.
- C. All inputs and outputs are to be clearly labeled. Inputs to include the source location and signal type. Outputs should indicate location signal is sent to.
- D. All custom input plates labeling shall be engraved and paint filled or laser etched with a contrasting color.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Before installing equipment, carefully inspect the installed Work of all other Trades. Verify that all such Work is complete to the point where the installation of electronic equipment may properly commence. Verify that the telecommunications closets are free of airborne contaminants prior to the installation of electronic equipment.
- B. Verify that all equipment is installed in accordance with all pertinent codes and regulations, the original design, and the referenced standards.
- C. In the event of discrepancy, immediately notify the Architect.
- D. Do not proceed with installation in areas of discrepancy until such discrepancies have been fully resolved.
- E. Return to original new condition any work disturbed during system installation.

3.2 INSTALLATION

- A. Install all equipment in strict accordance with the manufacturer's recommendations, reviewed shop drawings, BICSI TDMM latest edition, and EIA/TIA Standards for UTP and fiber optic cable.
- B. Secure equipment with fasteners suitable for the use, materials, and loads encountered. If requested, submit evidence proving suitability. Do not attach electrical materials to roof

decking, removable or knockout panels, or temporary walls and partitions.

- C. Working spaces shall be not less than specified in the National Electrical Code for all voltages specified.
- D. Where the Architect determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled as directed at no additional cost to the Owner/User. "Conveniently accessible" is defined as having the capability of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, and duct work.

### 3.3 WORK PERFORMANCE

- A. Coordinate location of equipment with other trades to minimize interferences.
- B. Holes through concrete and masonry in new and existing structures shall be cut with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by the Architect as required by limited working space.
- C. Holes shall not affect structural sections such as ribs or beams.
- D. Holes shall be laid out in advance. The Architect shall be advised prior to drilling through structural sections for determination of proper layout.
- E. Any holes created in walls, floors, or ceilings by the Contractor are to be sealed with a fire rated caulking according to all national, state, and local codes and this project manual.
- F. Hangers and other supports shall support only equipment and materials. Provide not less than a safety factor of 5, which shall conform to any specific requirements in the Construction Documents.
- G. The Contractor is responsible for repairing and or replacing any damage caused by their workforce at no additional cost to the Owner/User, or the Owner/User's representatives.

### 3.4 PROTECTION AND CLEANING OF SYSTEMS AND EQUIPMENT

- A. Protect all materials and equipment from damage during storage at the Site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain.
- B. Prevent damage from rain, dirt, sun and ground water by storing equipment on elevated supports and covering all sides with securely fastened protective rigid or flexible waterproof coverings.
- C. Protect piping by storing it on elevated supports and capping the ends with suitable closure material to prevent dirt accumulation in the piping.
- D. During construction, cap the top of all conduits and raceway installed vertically.
- E. During installation, protect equipment against entry of foreign matter on the inside, and vacuum clean both inside and outside before testing and operating.
- F. Damaged equipment, as determined by the Architect, shall be replaced.
- G. Protect painted surfaces with removable heavy kraft paper, sheet vinyl or equal, installed

at the factory and removed prior to final inspection.

- H. Repaint damaged "FINISH" paint on equipment and materials with painting equipment and finished with same quality of paint and workmanship as used by the original manufacturer so repaired areas are not obvious.
- I. Conduit back boxes, floor boxes, and poke thru's shall be vacuumed clean prior to the installation of cable.

### 3.5 IDENTIFICATION

- A. Nameplates shall be laminated black phenolic resin with white core and engraved lettering, a minimum of ¼ inch high. Nameplates that are furnished by manufacturer, as a standard catalog item, or where other methods of identification are herein specified, are exceptions.
- B. Uppercase letters of uniform height; centered on device, cover plate, or enclosure; engraved letters filled with a contrasting color; and all characters made clearly and distinctly.
- C. Use abbreviations defined in the contract documents whenever possible. Use plan designations for labeling unless indicated otherwise.

### 3.6 LABELING

- A. All cables shall be properly identified using a thermal transfer labeling device such as the Kroy.
- B. Cable
  - 1. Provide typewritten labels on both ends of all system cabling. Locate label within 6" of cable termination. Cover label with clear heat shrink tubing.
  - 2. Hand written labels are prohibited.
- C. Power Outlets
  - 1. Power outlet labels are to be mechanically generated.
  - 2. All power outlets designated for equipment shall be labeled on top.
  - 3. Provide a second label on the bottom of the outlet cover plate indicating service panel number and circuit breaker number.
  - 4. Text lettering to be 1/8" high.
- D. Rack Mounted Electronic Components
  - 1. Electronic component labels are to be mechanically generated.
  - 2. All inputs are to be labeled identifying source location of signal.
  - 3. All outputs are to be labeled identifying signal destination.
  - 4. Provide ¼" diameter indicator dot showing level setting for all rotary knobs, sliders, and pushbutton switches.
  - 5. Power switches shall be clearly labeled indicating switch is to be left in the on position at all times.



### 3.7 CABLE TERMINATIONS AND DRESS

A. Installation of communication conductors shall adhere to the following:

1. Furnish and install cable supports as specified.
2. All cables and/or conductors shall be terminated with approved cable termination connectors compatible with the specific termination.
3. Label all cables on both ends and on all patch panel/termination points.
4. Cables shall be neatly bundled using latch and hook type straps.

### 3.8 CLEANING

- A. Daily during construction and prior to Owner acceptance of the building, remove from the premises and dispose of all packing material and debris caused by work performed under Division 27 specifications.
- B. Remove all dust and debris from interiors and exteriors of electrical equipment. Clean accessible current carrying elements prior to being energized.
- C. Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and the like and leave the premises clean, neat and orderly.

### 3.9 TESTING EQUIPMENT

A. Copper Certification Tester

1. Cable Types
  - a. Shielded and unshielded twisted pair LAN cabling
    - i. TIA Category 6, and 6A: 100 ohm
    - ii. ISO/IEC Class C and D: 100 ohm and 120 ohm
    - iii. ISO/IEC Class E, 100 ohm ISO/IEC Class F, 100 ohm
    - iv. Cat 6A/Class Ez permanent link adapters Plug type and lift: shielded and unshielded cable, TIA Cat 3, 4, 5, 5E, 6, and 6A and ISO/IEC Class C,D, E, and Ea permanent link
    - v. Cat 6A/Class Ea channel adapters Plug type and life: shielded and unshielded cable, TIA Cat 3, 4, 5, 5E, 6, and 6A and ISO/IEC Class C,D, E, and Ea channels.
2. Test Standards
  - a. TIA Category 6 and 6A per ANSI/TIA-568-C.
  - b. 2.TIA Category 6 per TIA/EIA-568B.2-1
  - c. TIA Category 6A per ANSI/TIA-568-C.2 (6A DTX-1800 only)
  - d. TIA TSB-155 (DTX-1800 only)

- e. TR24750 (DTX-1800only)
- f. EN 50173 Class C, D, E
- g. EN 50173 Class Ea, F (DTX-1800 only)
- h. ANSI TP-PMD
- i. IEEE 802.3 10 BASE-T, 100 BASE-T, 1000 BASE-T
- j. IEEE 802.3an 10GBASE-T

3. Supported Test Parameters

- a. Wire Map
- b. Length
- c. Propagation  
Delay
- d. Delay Skew
- e. DC Loop  
resistance
- f. Insertion Loss  
(Attenuation)
- g. Return  
Loss
- h. NEXT
- i. Attenuation to cross  
talk Ratio
- j. ACR-F
- k. Power Sum ACR-  
F
- l. Power Sum NEXT
- m. Power Sum ACR-  
N
- n. Power Sum Alien Near End Xtalk
- o. Power Sum Alien Attenuation XTalk Ratio for End

B. Fiber Certification Tester

- 1. Wavelengths
  - a. Multimode: 850 nm, 1300 nm
  - b. Single Mode: 1310 nm, 1550 nm
- 2. Compatible Fiber Types:
  - a. Multimode: 50/125 um, 62.5/125 um
  - b. Single Mode: 9/125-micrometer
- 3. Event Dead Zone:

- a. Multi Mode: 850 nm: .5 m, 1300 nm: .7 m
  - b. Single Mode: 1310: 3.6 m, 1550: 3.7 m
4. Attenuation Dead Zone:
- a. Multi Mode: 850 nm: 2.2 m, 1300 nm: 4.5 m
  - b. Single Mode: 1310: 3.6 m, 1550: 3.7 m
5. Dynamic Range:
- a. Multi Mode: 850 nm: 28 dB, 1300 nm: 30 dB
  - b. Single Mode: 1310: 32 dB, 1550: 30 dB
6. Max Distance Range Setting:
- a. Multi Mode: 40 km
  - b. Single Mode: 130 km
7. Distance Measurement Range:
- a. Multi Mode: 850 nm: 9 km, 1300 nm: 35 km
  - b. Single Mode: 1310: 80 km, 1550: 130 km

### 3.10 COMPLETION

#### A. Results Expected

1. All equipment and materials shall be in place and all systems shall be demonstrated to be operationally complete.
2. All testing, start-up and cleaning work shall be complete.
3. All documented testing results are submitted and approved by the Architect.
4. All O & M Manuals and Record Documents are reviewed and accepted.
5. Substantial Completion inspection is performed and granted. The Substantial
6. Completion inspection punch list is completed by the Contractor.
7. All facility training shall be complete and DVD of the training sessions are reviewed.
8. All “minimum” twenty (20) year structured cable plant certifications and warranties are received.
9. Transmittal letter listing delivery of complete spare parts inventory

### 3.11 MAINTENANCE MATERIALS

- A. Provide spare materials as indicated in Contract Documents and as required for

proper maintenance of systems.

### 3.12 WARRANTY, WARRANTY SERVICE AND MAINTENANCE

#### A. Warranty

1. The Information Transport System shall have a factory warranty for twenty (20) years beginning on the date of Owner acceptance.
2. The Division 27 Components not covered under the Structured Cabling System “minimum” twenty (20) year warranty shall be fully guaranteed by the Contractor for a period of two (2) years beginning on the date of Owner acceptance.
3. The guarantee shall include the entire Division 27 Information Transport System scope of work including all equipment, devices, materials, cable/wire and installation.
4. Work shall be guaranteed to be free from defects. Any defective materials or workmanship, as well as damage to the Work of all other Trades resulting from same, shall be replaced or repaired as directed by the Owner for a period of two (2) years from the date of Owner/User final acceptance. The Contractor shall provide written warranties for all systems and all buildings to the Owner.
5. The guarantee shall exclude acts of God, vandalism, physical abuse or operator misuse.
6. Acceptance by a manufacturer of an order for equipment for this contract signifies acceptance of this warranty. During the warranty period there shall be no charge to the Owner for equipment, material, etc. for guarantee work.
7. During the warranty period, there shall be no charges to the Owner/User for service calls (mileage, labor, travel, expenses, etc.) for guarantee work.

#### B. Warranty Service

1. Warranty service shall be provided as part of this Contract by the Contractor during the warranty period.

END OF SECTION 270500

SECTION 270543 - UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATION  
SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal conduit and fittings, including GRC and PVC-coated GRC.
2. Rigid nonmetallic duct.
3. Duct accessories, including rigid innerduct and textile innerduct.
4. Precast concrete handholes.
5. Polymer concrete handholes and boxes with polymer concrete cover.
6. Fiberglass handholes and boxes with polymer concrete cover.
7. Fiberglass handholes and boxes.
8. High density plastic boxes.
9. Precast manholes.
10. Cast-in-place manholes.
11. Utility structure accessories.

1.3 DEFINITIONS

- A. Direct-Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials, such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
  1. Two or more ducts installed in parallel, with or without additional casing materials.
  2. Multiple duct banks.
- D. GRC: Galvanized rigid conduit.
- E. IMC: Intermediate metal conduit.
- F. RNC: Rigid nonmetallic conduit.

G. Traffic Ways: Locations where vehicular or pedestrian traffic is a normal course of events.

#### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include duct-bank materials, including spacers and miscellaneous components.
2. Include duct and conduits and their accessories, including elbows, end bells, bends, fittings, duct spacers and solvent cement.
3. Include accessories for manholes, handholes, and boxes, and other utility structures.
4. Include underground-line warning tape.

B. Shop Drawings:

1. Precast or Factory-Fabricated Underground Utility Structures:
  - a. Include plans, elevations, sections, details, attachments to other work, and accessories.
  - b. Include duct entry provisions, including location and duct size.
  - c. Include reinforcement details.
  - d. Include frame and cover design and manhole chimneys.
  - e. Include ladder details.
  - f. Include grounding details.
  - g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
  - h. Include joint details.

C. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

1. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
2. Include duct entry provisions, including location and duct size.
3. Include cover design.
4. Include grounding details.
5. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

#### 1.5 INFORMATIONAL SUBMITTALS

A. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
  2. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
- C. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.
- D. Source quality-control reports.
- E. Field quality-control reports.
- 1.6 MAINTENANCE MATERIALS SUBMITTALS
- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Furnish cable-support stanchions, arms, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.
- 1.7 QUALITY ASSURANCE
- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- 1.8 FIELD CONDITIONS
- A. Interruption of Existing Communications Service: Do not interrupt communications service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary communications service according to requirements indicated:
1. Notify Owner no fewer than two days in advance of proposed interruption of communications service.
  2. Do not proceed with interruption of communications service without Owner's written permission.
- B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.
- C. Ground Water: Assume ground-water level is 36 inches below ground surface unless a higher water table is noted on Drawings.

## PART 2 - PRODUCTS

### 2.1 METAL CONDUITS AND FITTINGS

- A. Manufacturers:
  - a. Allied Steel
  - b. Republic Conduit
  - c. Thomas & Betts
  - d. Or other qualified Owner approved manufacturer
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. PVC-Coated Steel Conduit: PVC-coated GRC.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch minimum.
- D. General Requirements for Metal Conduits and Fittings:
  - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
  - 2. Comply with TIA-569-C and TIA-758-C.

## 2.2 RIGID NONMETALLIC DUCTS

- A. Manufacturers:
  - a. Carlon
  - b. Cantex
  - c. JM Eagle
  - d. Or other qualified Owner approved manufacturer
- B. Underground Plastic Utilities Duct: Type EPC-80-PVC and Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- C. Underground Plastic Utilities Duct: Type DB-60-PVC and Type DB-120-PVC RNC, complying with NEMA TC 6 & 8 and with ASTM F-512 for direct burial, with matching fittings complying with NEMA TC 9 by same manufacturer as duct.
- D. Underground Plastic Utilities Duct: Type EB-20 PVC RNC, complying with NEMA TC 6 & 8, ASTM F-512, and UL 651, with matching fittings complying with NEMA TC 9 by same manufacturer as duct.
- E. General Requirements for Nonmetallic Ducts and Fittings:
  - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
  - 2. Comply with TIA-569-C and TIA-758-C.
- F. Solvents and Adhesives: As recommended by duct manufacturer.

## 2.3 FLEXIBLE NONMETALLIC DUCTS

- A. Manufacturers:



- a. Anamet Anaconda
  - b. Carflex
  - c. Galco
  - d. Or other qualified Owner approved manufacturer
- B. HDPE Duct: Type EPEC 40-HDPE complying with NEMA TC 7 and UL 651A.
1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
  2. Comply with TIA-569-C and TIA-758-C.

#### 2.4 DUCT ACCESSORIES

- A. Rigid Innerduct: Corrugated HDPE duct, orange in color, designed for installation within a duct or pathway.
1. Carlon
  2. Thomas & Betts
  3. Or other qualified Owner approved manufacturer
- B. Fabric Innerduct: Continuous, polyester, multi -pocket fabric innerduct, with internal pull tape and tracer wire.
1. Maxcell
  2. Or other qualified Owner approved manufacturer
- C. Duct Spacers: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
1. Carlon
  2. Allied Tube & Conduit
  3. Or other qualified Owner approved manufacturer
- D. Underground-Line Warning Tape: Underground-line warning tape specified in Section 270553 "Identification for Communications Systems."

#### 2.5 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Description: Monolithically poured, factory-fabricated, reinforced-concrete walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
1. Oldcastle Precast, Inc.

2. Riverton Concrete Products
  3. Tindall Precast
  4. Or other qualified Owner approved manufacturer
- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- D. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- E. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
1. Cover Hinges: Concealed, with hold-open ratchet assembly.
  2. Cover Handle: Recessed.
- F. Frame and Cover: Weatherproof aluminum frame, with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
1. Cover Hinges: Concealed, with hold-open ratchet assembly.
  2. Cover Handle: Recessed.
- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, "COMMUNICATIONS."
- I. Configuration: Units shall be designed for flush burial and have closed bottom unless otherwise indicated.
- J. Extensions and Slabs: Designed to mate with bottom of enclosure and made of same material as enclosure.
1. Extension shall provide increased depth of 12 inches.
  2. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.
- K. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- L. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct and duct banks, plus an additional 6 inches vertically and horizontally to accommodate alignment variations.
1. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
  2. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
  3. Knockout panel openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening. Knockout panels shall be 1-1/2 to

2 inches thick.

- M. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
  - 1. Type and size shall match fittings to duct or conduit to be terminated.
  - 2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.
- N. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

## 2.6 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

- A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
  - 1. Quazite
  - 2. Oldcastle
  - 3. Or other qualified Owner approved manufacturer
- B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- C. Color: Gray.
- D. Configuration: Units shall be designed for flush burial and have closed bottom unless otherwise indicated.
- E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- G. Cover Legend: Molded lettering, "COMMUNICATIONS"
- H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- J. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

## 2.7 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER

- A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

1. Quazite
  2. Oldcastle
  3. Or other qualified Owner approved manufacturer
- B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- C. Color: Gray.
- D. Configuration: Units shall be designed for flush burial and have closed bottom unless otherwise indicated.
- E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- G. Cover Legend: Molded lettering, "COMMUNICATIONS."
- H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end- bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- J. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

## 2.8 FIBERGLASS HANDHOLES AND BOXES

- A. Description: Molded of fiberglass-reinforced polyester resin, with covers made of castiron.
1. Quazite
  2. Oldcastle
  3. Or other qualified Owner approved manufacturer
- B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- C. Color: Gray.
- D. Configuration: Units shall be designed for flush burial and have closed bottom unless otherwise indicated.
- E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- G. Cover Legend: Molded lettering, "COMMUNICATIONS."
- H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end- bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- J. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts

for cable racks and pulling-in irons.

## 2.9 UTILITY STRUCTURE ACCESSORIES

- A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.
1. Neenah Foundry Company
  2. Quazite
  3. Oldcastle
  4. Or other qualified Owner approved manufacturer
- B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B, with milled cover-to-frame bearing surfaces; 26-inch diameter.
    - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
    - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
  2. Cover Legend: Cast in. Selected to suit system.
  3. Manhole Chimney Components: Precast concrete rings, with dimensions matched to those of roof opening.
    - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities of less than 2.0 cu. ft., where packaged mix complying with ASTM C 387, Type M, may be used.
    - b. Seal joints watertight using preformed plastic or rubber conforming to ASTM C 990. Install sealing material according to the sealant manufacturers' printed instructions.
- C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch diameter eye, and 1-by-4-inch bolt.
1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch diameter eye, rated 2500-lbf minimum tension.
- F. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2- inch ID by 2-3/4 inches deep, flared to a minimum of 1-1/4 inches at base.
1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
- H. Ground Rod Sleeve: 3-inch, PVC duct sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct entering the structure.
- I. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip, with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- J. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass- reinforced polymer.
1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of nine holes for arm attachment.
  2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.
- K. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic duct, metallic duct, duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- L. Fixed Manhole Ladders: Arranged for attachment to roof or wall of manhole. Ladder, mounting brackets, and braces shall be fabricated from hot-dip galvanized steel.
- M. Portable Manhole Ladders: UL-listed, heavy-duty fiberglass specifically designed for portable use for access to electrical manholes. Minimum length equal to distance from deepest manhole floor to grade plus 36 inches. One required.
- N. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater required.

## 2.10 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by an independent testing agency.
  2. Strength tests of complete boxes and covers shall be by either an independent

testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.
- C. Clear and grub vegetation to be removed and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

### 3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Communications: Type EPC-80-PVC, in concrete-encased duct bank unless otherwise indicated.
- B. Duct for Communications: Type EPC-80-PVC, in direct-buried duct bank unless otherwise indicated.
- C. Duct for Communications: Type EPEC-80-HDPE duct in direct-bored duct bank unless otherwise indicated.
- D. Stub-Ups for Communications: Concrete-encased GRC.

### 3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for Communications:
  1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
  2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-5 or Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
5. Cover design load shall not exceed the design load of the handhole or box.

B. Manholes: Precast or cast-in-place concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

### 3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area immediately after backfilling is completed or after construction in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work.
- E. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- F. Cut and patch existing pavement in the path of underground duct, duct bank, and utility structures according to the "Cutting and Patching" Article in Section 017300 "Execution."

### 3.5 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct and duct bank according to NEMA TCB 2 and TIA-758-C.
- C. Slope: Pitch duct and duct bank a minimum slope of 1:100 down toward manholes and handholes and away from buildings and equipment. Slope duct and duct bank from a high point in runs between two manholes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use



manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.

1. Duct and duct banks shall have maximum of two 90-degree bends, or the total of all bends shall be no more 180 degrees between pull points.
- E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings, so those of adjacent ducts do not lie in same plane.
- F. Installation Adjacent to High-Temperature Steam Lines: Where duct or duct banks are installed parallel to underground steam lines, perform calculations showing the duct or duct bank will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct or duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- G. End-Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct slope and without forming a trap in the line.
  2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight-line direct-buried duct and duct banks, with calculated expansion of more than 3/4 inch.
  3. Grout end bells into structure walls from both sides to provide watertight entrances.
- H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
1. Begin change from regular spacing to terminator spacing 10 feet from the terminator without reducing duct slope and without forming a trap in the line.
  2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight-line duct or duct bank, with calculated expansion of more than 3/4 inch.
- I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct slope away from the building or forming a trap in the duct. Use fittings manufactured for RNC duct-to-GRC conduit transition. Install GRC penetrations of building walls as specified in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."
- J. Sealing: Provide temporary closure at terminations of duct that has cables pulled. Seal

spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-  
psig hydrostatic pressure.

K. Innerduct: Install immediately after mandreling duct. Size and type as indicated on Drawings.

L. Pulling Cord: Install 200-lbf test nylon cord in empty duct and innerduct.

M. Concrete-Encased Duct and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct or duct bank. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct or duct bank on each side.
3. Width: Excavate trench 3 inches wider than duct or duct bank on each side.
4. Depth: Install top of duct and duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
5. Support duct and duct bank on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
6. Minimum Space Between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around duct or duct bank.
8. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct run unless otherwise indicated. Extend concrete encasement throughout length of elbow.
9. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
  - a. Couple GRC to duct with adapters designed for this purpose and encase coupling with 3 inches of concrete.
  - b. Stub-Ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
    - i. Stub-ups shall be flush with minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.
  - c. Stub-Ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.
    - i. Stub-ups shall be flush with minimum 4 inches above finished floor and no

less than 3 inches from conduit side to edge of wall.

10. Reinforcement: Reinforce concrete-encased duct and duct bank where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
11. Forms: Use trench walls to form side walls of duct and duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
12. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between ducts, and 4 inches between power and communications duct.
13. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
  - a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.
  - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.
14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between ducts and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto duct. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

N. Direct-Buried Duct and Duct Banks:

1. Excavate trench bottom to provide firm and uniform support for duct and duct bank.
2. Comply with requirements in Section 312300 "Excavating, Backfilling and Compacting for
3. Utilities" for preparation of trench bottoms for duct less than 6 inches in nominal diameter.
4. Install duct with a minimum of 3 inches between duct for like services and 6 inches between power and signal duct.
5. Width: Excavate trench 12 inches wider than duct or duct bank on each side.
6. Width: Excavate trench 3 inches wider than duct or duct bank on each side.
7. Depth: Install top of duct or duct bank at least 36 inches below finished grade unless otherwise indicated.
8. Set elevation of bottom of duct or duct bank below frost line.

9. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
10. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around duct or duct bank.
11. Elbows: Install manufactured duct elbows for stub-ups, at building entrances through floor, and at changes of direction in duct unless otherwise indicated. Encase elbows for stub-ups throughout length of elbow. Extend encasement minimum of 36 inches beyond elbow joints.
12. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.
  - a. Couple GRC to duct with adapters designed for this purpose and encase coupling with 3 inches of concrete.
  - b. For equipment mounted on outdoor bases, extend GRC horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
13. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving duct at end of run free to move with expansion and contraction, as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around duct to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312300 "Excavating, Backfilling and Compacting for Utilities" for installation of backfill materials.
  - a. Place minimum of 3 inches of sand as a bed for duct and duct bank. Place sand to a minimum of 6 inches above top level of duct and duct bank.
  - b. Place minimum of 6 inches of engineered fill above concrete encasement of duct bank.
- O. Underground-Line Warning Tape: Bury nonconducting underground-line warning tape specified in Section 270553 "Identification for Communication Systems" no less than 12 inches above all concrete-encased duct and duct bank and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

### 3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Cast-in-Place Manhole Installation:
1. Finish interior surfaces with a smooth-troweled finish.
  2. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
  3. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.
- B. Precast Concrete Handhole and Manhole Installation:
1. Comply with ASTM C 891 unless otherwise indicated.
  2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
  3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevations:
1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
  2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
  3. Install handholes with bottom below frost line, below grade.
  4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade.
    - a. Set covers of other handholes 1 inch above finished grade.
  5. Where indicated, cast handhole cover frame integrally with handhole structure.
- D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- E. Manhole Access: Circular opening in manhole roof; sized to match cover size.
1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
  2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.
- F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Section 071300 "Sheet Waterproofing." After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at

least three days.

- G. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After duct has been connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for field-installed anchor bolts installed. Use a minimum of two anchors for each cable stanchion.

### 3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct and duct bank, and seal joint between box and extension as recommended by manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install handholes and boxes with bottom below frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy- vehicle loading, form and pour a concrete ring, encircling, and in contact with, enclosure, and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
  - 1. Concrete: 3000 psi, 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
  - 2. Concrete," with a troweled finish.
  - 3. Dimensions: 10 inches wide by 12 inches deep.

3.8 GROUNDING

- A. Ground underground duct, duct bank, and utility structures according to Section 270526 "Grounding and Bonding for Communications Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
  - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
  - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
  - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 270526 "Grounding and Bonding for Communications Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.10 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris.
- B. Clean internal surfaces of manholes, including sump.
  - 1. Sweep floor, removing dirt and debris.
  - 2. Remove foreign material.

END OF SECTION 270543

SECTION 334600.99 – VAPOR MITIGATION SYSTEM

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. Products Supplied Under This Section:

1. Non-woven GeoTextile Fabric
2. Crushed Stone/Gravel Venting Layer
3. Vapor-Vent Low Profile Vent System (as described in following sections)
4. Schedule 40 PVC Piping for Header Exhaust Runs
5. Stego Wrap 20-mil Vapor Barrier (as described in following sections)
6. Vapor Barrier Sealant Materials
7. Collection Plenum Boxes
8. Retro-Coat™ System (as described in following sections)
9. Sub-Slab Monitoring Points

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM)
  1. ANSI/ASTM C 136 – Method for Sieve Analysis of Fine and Coarse Aggregates
  2. ASTM E 1745 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs
  3. ASTM E 154 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs



4. ASTM E 96 Standard Test Methods for Water Vapor Transmission of Materials
5. ASTM E 1643 Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
6. ASTM D 1434 Standard Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheeting
7. ASTM D 5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles
8. ASTM D 4751 Standard Test Methods for Determining Apparent Opening Size of a Geotextile

B. American Concrete Institute (ACI)

1. ACI 302.1R-6 & 7 - Section 3.2.3 Vapor Retarder

1.4 SUBMITTALS

A. Non-woven Geotextile

1. Geotextile Manufacturer's specifications and literature.

B. Crushed Stone/Gravel Venting Layer

1. Material profile from quarry including sieve analysis.

C. Vapor-Vent Low Profile Venting System

1. Submit Product Data for each type of gas venting system specified, including manufacturer's specifications.
2. Vapor-Vent Manufacturer's installation instructions.

D. Vapor Barrier

1. Laboratory test results showing compliance with ASTM & ACI Standards.
2. Vapor barrier Manufacturer's samples, literature.
3. Vapor barrier Manufacturer's installation instructions for placement, seaming and penetration repair instructions.

PART 2 – PRODUCTS

## 2.1 MATERIALS

## A. Non-woven Geotextile Fabric conforming to following specifications:

1. Weight (ASTM D 5261): 6 oz/yd<sup>2</sup> (minimum)
2. Apparent Opening Size (ASTM D 4751): 70 U.S. Sieve (maximum)

## B. AASHTO #57 Stone (Washed) (or equivalent)

1. Coarse stone, crushed gravel, pit run, angular, washed, natural stone, free of shale, clay, friable material, sand, debris; graded in accordance with ANSI/ASTM C136 within the following limits:

<u>Sieve Size</u>	<u>Percent Passing</u>
1 ½-inch	100
1-inch	95 to 100
½-inch	25 to 60
No. 4	0 to 10
No. 8	0 to 5

## C. Vapor Barrier

1. Vapor barrier must have all of the following qualities:

- a. Maintain permeance of less than 0.01 Perms [grains/(ft<sup>2</sup> · hr · inHg)] as tested in accordance with mandatory conditioning tests per ASTM E1745 Section 7.1 (7.1.1-7.1.5).
- b. Other performance criteria:
  - Strength: ASTM E 1745 Class A.
  - Thickness: 20 mils minimum
- c. Provide third party documentation that all testing was performed on a single production roll per ASTM E1745 Section 8.1

2. Vapor barrier products:

- a. Basis of Design: Stego Wrap 20-Mil Vapor Barrier by Stego Industries LLC., (877) 464-7834 [www.stegoindustries.com](http://www.stegoindustries.com).
- b. No Substitutions

## D. Vent Pipe Materials – Sub-Slab/Horizontal Locations

2. Vapor-Vent - Vapor-Vent is a low profile, trenchless, flexible, sub slab vapor collection system used in lieu or in conjunction with perforated piping. Manufactured by Land Science Technologies
  3. 4-inch diameter solid Schedule 40 piping and fittings at sub-slab horizontal locations for Vent System runs to Vapor-Vent, at tees, couplings, elbows, and adapters to connect to Vapor-Vent.
  4. 6-inch diameter solid Schedule 40 piping and fittings at sub-slab horizontal locations for Vent System exhaust runs, at tees, couplings, elbows, and adapters to connect to 6-inch diameter solid Schedule 40 PVC piping at vertical vent riser locations (Note SDR pipe is not an option for the vertical riser)
  5. Collection plenum boxes constructed of concrete blocks at vent termination locations per plan drawings
- E. Retro-Coat™ System - Manufactured by Land Science Technologies (Specification enclosed)

## 2.2 ACCESSORIES

- A. Seams:
1. Stego Tape by Stego Industries LLC, (877) 464-7834 [www.stegoindustries.com](http://www.stegoindustries.com).
- B. Sealing Penetrations of Vapor barrier:
1. Stego Mastic by Stego Industries LLC, (877) 464-7834 [www.stegoindustries.com](http://www.stegoindustries.com).
  2. Stego Tape by Stego Industries LLC, (877) 464-7834 [www.stegoindustries.com](http://www.stegoindustries.com).
- C. Perimeter/edge seal:
1. Stego Crete Claw by Stego Industries LLC, (877) 464-7834 [www.stegoindustries.com](http://www.stegoindustries.com).
  2. Stego Term Bar by Stego Industries LLC, (877) 464-7834 [www.stegoindustries.com](http://www.stegoindustries.com).
  3. StegoTack Tape (double-sided sealant tape) by Stego Industries LLC, (877) 464-7834 [www.stegoindustries.com](http://www.stegoindustries.com).
- D. Sealants, Cleaners
1. PVC cleaner and cement
  2. Polyurethane elastometric sealant (caulk)
- E. Vapor-Vent End Out

## PART 3 – EXECUTION

### 3.1 PREPARATION

- A. Ensure that base material preparation is approved by Architect or Geotechnical Engineer.
1. Level and compact base material.
  2. Install non-woven geotextile fabric on top of base material, prior to venting layer placement.
  3. Non-woven geotextile fabric to be overlain by a minimum of 6 inches and open areas around penetrations minimized.
  4. All concrete slabs that come in contact with the ground shall be laid over a gas permeable material made up of a minimum 4-inch thick uniform layer of clean AASHTO #57 gravel aggregate.
  5. The gravel placement shall be phased so that that the Vapor-Vent has a minimum of 2” of gravel underneath.
  6. Once the Vapor-Vent is placed, remaining gravel can be added (if desired) so as to completely cover the Vapor-Vent layout with approximately one inch of gas permeable material above the Vapor-Vent.
  7. Seal all joints or penetrations in slab or other floor systems and below- grade walls, which will not be accessible at time of final inspection.
  8. Sealing of all pathways between the sub-slab soil and the building interior after the slab is poured is critical to the VIMS effectiveness and building energy/cost efficiency. This step is particularly important to:
    - a. avoid leakage of conditioned air within the building into the VIMS beneath the slab (e.g., energy loss), and conversely,
    - b. avoid conditions in bathrooms and commercial spaces where exhaust fans can effect negative pressurization indoors (e.g., overcoming sub-slab depressurization that allows sub-surface contaminants to enter the building).
  9. Stub-outs to be provided where indicated on drawings, so as to connect with vent system above and below slab.
  10. All opening, gaps, and joints in floor and wall assemblies in contact soil or gaps around pipes, toilets, or drains penetrating these assemblies shall be filled or closed with materials that provide a permanent air-tight seal.
  11. Seal large openings with non-shrink mortar, grouts, or expanding foam materials and smaller gaps with an elastomeric joint sealant.

### 3.2 SUB-SLAB PERFORATED VENT PIPE INSTALLATION

- A. Vapor-Vent utilized under the slab and vapor barrier to provide an active mitigation vent system and shall be installed as per the following:
1. Vapor-Vent™

2. Shall underlain by a minimum of 2 inches of AASHTO #57 gravel aggregate (for 4-inch minimum permeable vent layer).
3. Vapor-Vent shall be solidly connected and sealed to 4-inch and 6-inch solid PVC pipe where indicated via Vapor-Vent End Outs and diameter adapters/reducers (Schedule 40 PVC).
4. Any through-slab riser stub-outs shall be solid 6-inch diameter Schedule 40 PVC.
5. Through-slab riser stub-outs to be labeled "SOIL VENT PIPE" or the like, and temporarily capped to keep out soil, concrete, etc.
6. Vapor-Vent™ shall pass through interior footings, grade-beams, or other barriers via solid, non-perforated 4-inch diameter Schedule 40 PVC.
7. All pipe joints and connections to be permanently sealed with adhesives as specified by the manufacturer of the pipe material so as to be gas tight.

### 3.3 COLLECTION PLENUM BOX CONSTRUCTION

- A. At locations specified in plans, construct soil gas collection plenum boxes for the horizontal vent pipe terminations and connections as follows:
  1. Plenum boxes shall be fabricated by placing 8x8x16-inch concrete blocks (or equivalent) on their sides so that the hollow core sections are parallel to the slab and a square shape layout of 3 blocks by 2 blocks is formed.
  2. The perforated 4-inch diameter vent pipe, solid 4-inch diameter pipe, and solid 6-inch diameter pipe shall be cut to terminate inside the plenum box approximately 3 inches inside of the inner block edge (i.e., the pipe is not to be run continuous through the plenum box). The face shell of the concrete block may be cut as needed to accommodate the vent pipe connections.
  3. The top of each plenum box shall be covered with a 4-foot square section of 1-inch plywood or metal siding as approved by the project design team/structural engineer.

### 3.4 SUB-SLAB SOLID PVC PIPE INSTALLATION

- A. Solid pipe utilized under the slab and vapor barrier to provide exhaust runs to risers and runs to perforated pipe lengths and shall be installed as per the following:
  1. Solid 4-inch diameter Schedule 40 PVC and solid 6-inch diameter Schedule 40 PVC (in locations as indicated on design drawings).
  2. Shall have a minimum of 2 inches of clean AASHTO #57 aggregate above and below solid piping to ensure venting communication around pipe and this thickness is to extend at least 3 feet on either side, then tapering to 4-inch thick aggregate venting layer.
  3. Vapor-Vent shall be solidly connected and sealed to 4-inch and 6-inch solid PVC pipe where indicated via Vapor-Vent End Outs and diameter adapters/reducers (Schedule 40 PVC).

4. Any through-slab riser stub-outs shall be solid 6-inch diameter Schedule 40 PVC.
5. Through-slab riser stub-outs to be labeled "SOIL VENT PIPE" or the like, and temporarily capped to keep out soil, concrete, etc.
6. All pipe joints and connections to be permanently sealed with adhesives as specified by the manufacturer of the pipe material so as to be gas tight.
7. 3/8-inch diameter holes shall be drilled through the bottom of the pipe at (at least) 10-foot intervals and at low spots to drain moisture from the piping.

### 3.5 VAPOR BARRIER INSTALLATION

- A. Install vapor barrier in accordance ASTM E1643.
  1. Unroll vapor barrier with the longest dimension parallel with the direction of the concrete placement and face laps away from the expected direction of the placement whenever possible.
  2. Extend vapor barrier to the perimeter of the slab. If practicable, terminate it at the top of the slab, otherwise (a) at a point acceptable to the structural engineer or (b) where obstructed by impediments, such as dowels, waterstops, or any other site condition requiring early termination of the vapor barrier. At the point of termination, seal vapor barrier to the foundation wall, grade beam or slab itself.  
[Specifier note: The perimeter seal can be handled several ways. When sealing to the slab, Crete Claw is the best option. When sealing to a stem wall or wall, the best option is to use StegoTack Tape or both StegoTack Tape and Stego Term Bar.]
    - a. Seal vapor barrier to the entire slab perimeter using Stego Crete Claw, per manufacturer's instructions.
    - OR
    - b. Seal vapor barrier to the entire perimeter wall or footing/grade beam with double sided StegoTack Tape, or both Stego Term Bar and StegoTack Tape, per manufacturer's instructions. Ensure the concrete is clean and dry prior to adhering tape.
  3. Overlap joints 6 inches and seal with manufacturer's seam tape.
  4. Apply seam tape/Crete Claw to a clean and dry vapor barrier.
  5. Seal all penetrations (including pipes) per manufacturer's instructions.
  6. For interior forming applications, avoid the use of non-permanent stakes driven through vapor barrier. Use blunt-end and/or threaded nail stakes (screed pad posts) and insert them into Beast Foot. Ensure Beast Foot's peel-and-stick adhesive base is fully adhered to the vapor barrier
  7. If non-permanent stakes must be driven through vapor retarder, repair as recommended by vapor retarder manufacturer.
  8. Use reinforcing bar supports with base sections that eliminate or minimize the potential for puncture of the vapor barrier.

9. Repair damaged areas with vapor barrier material of similar (or better) permeance, puncture and tensile.
10. For vapor barrier-safe concrete screeding applications, install Beast Scream (vapor barrier-safe screed system) per manufacturer's instructions prior to placing concrete.

### 3.5 SUB-SLAB MONITORING POINTS INSTALLATION

- A. Install sub-slab monitoring points in accordance with design detail and structural engineer/concrete contractor coordination.
  1. Prior to vapor barrier installation open a 1.5 to 2-inch hole extending to approximately 1 inch from the geotextile.
  2. Insert 3-inch long, ¼-inch steel mesh screen attached to 4-inch long, ¼-inch steel pipe in open hole. Ensure steel mesh screen ends no closer than 1-inch below the proposed bottom of concrete slab. Seal metal pipe with threaded cap or tape
  3. Insert 1" Schedule 40 PVC at a length that extends from the top of the steel mesh screen to 1 to 2 feet above the proposed top of concrete slab.
  4. Through 1-inch PVC stub-out labeled "SUB-SLAB MONITORING POINTS" or the like, and temporarily capped to keep out soil, concrete, etc.
  5. After slab is poured and cured cut down PVC to desired height (at grade or below grade) to retrofit for plug or cap.
  6. Mix and place approximately 2-inch thick layer of hydraulic cement inside 1-inch PVC, around steel pipe. Ensure hydraulic cement extends at least 1" above bottom of slab.

### 3.6 RETRO-COAT APPLICATION

- A. Apply Land Science Technologies Retro-Coat™ System on below grade foundation walls and elevator pits in accordance with manufacturer's instructions and specifications enclosed.

END OF SECTION 334600.99

# Land Science Technologies Specifications for Retro-Coat™ Version 1.0

## Part 1 – Scope

### 1.1 Product and Application

This specification describes the application of the Retro-Coat™ System. The minimum thickness of the system is between 25-30 mils, including a 20 mil minimum application of Retro-Coat.

### 1.2 Acceptable Manufacturers

- A. Retro-Coat as manufactured by Land Science Technologies San Clemente, CA.

### 1.3 Performance Criteria

- A. Retro-Coat as manufactured by Land Science Technologies San Clemente, CA.
  - 1. Diffusion Coefficient (Columbia Labs)  
PCE:  $7.6 \times 10^{-14} \text{ m}^2/\text{s}$   
TCE:  $8.2 \times 10^{-14} \text{ m}^2/\text{s}$
  - 2. Tensile Elongation (ASTM D-638)  
Minimum: 6000 psi
  - 3. Tensile Elongation (ASTM D-638)  
Minimum: 6 %
  - 4. Flexural Strength (ASTM D-790)  
Minimum: 7000 psi
  - 5. Hardness, Shore D (ASTM D-2240)  
Maximum: 85
  - 6. Gardner Impact (ASTM D-2794)  
Minimum: 80 inch-pounds
  - 7. Bond Strength to Quarry Tile  
Minimum: 1000 psi
  - 8. Vapor Transmission Rate (ASTM E-96)  
Maximum: .07 perms
  - 9. Water Absorption (ASTM D-570)  
Maximum: .02% in 24 hours
  - 10. 60° Gloss  
Minimum: 100.

### 1.4 Materials

- A. Retro-Coat "A" shall be a modified epoxy containing special flexibilizers and specially formulated resins for superior chemical resistance and enhanced resilience. No solvents are allowed.
- B. Retro-Coat "B" shall be customized blend of hardeners specifically formulated to maximize chemical resistance. No solvents are allowed.

### 1.5 Applicator

- A. Applicator must be a certified contractor of Land Science Technologies.



## Part 2 – Application

### 2.1 Surface Preparation

- A. All existing surfaces that will be covered with the systems specified herein should be mechanically ground, shot blasted or sand blasted to yield a minimum 60 grit surface texture. All loosely adhered coatings will be removed. Any grease and other contaminants found on the concrete must also be removed.
- B. All open cracks 1/2" and greater should be v-notched to a 3/4" width by 1/2" depth and cleaned of any debris. Such cracks should be filled with Retro-Coat Gel and struck off flush with the surrounding surface.
- C. Cut back and/or remove any expansion joint backing or filler strips to a minimum of 1 1/2" deep. Insert disposable filler in the joints to prevent filling with the overlayment materials and to allow for accurate location of final saw cuts in the overlayment.

### 2.2 Material Application

- A. Retro-Coat CAULK
  1. Apply Retro-Coat CAULK around the base of all pipe penetrations making sure to fill any gap between the penetration and concrete slab
  2. Apply Retro-Coat CAULK to the joint created between horizontal and vertical transitions. The caulking material should be applied and pressed into the joint filling any gaps that might be present.
- B. Retro-Coat PRIMER
  1. Apply Retro-Coat PRIMER to all areas at a thickness of 6 mil and allow to dry tack free. In areas where the concrete surface is in need of slight repair or needs to be leveled, a slurry form of Retro-Coat PRIMER called Retro-Coat PRIMER-S can be applied with a flat squeegee. Retro-Coat PRIMER-S is self priming and does not need to be primed again.
- C. Retro-Coat
  1. Mix Retro-Coat, Part A with a low-speed (<750 rpm) jiffy-style mixer for about 30 seconds, or until uniform in color, then mix in Retro-Coat Coating, Part B for another 30-60 seconds.
  2. Dump contents onto floor in a ribbon pattern, squeegee, and then back roll at a coverage rate of 160 SF/gallon to achieve a film thickness of 10 mils.
  3. Apply second coat 10 mil coat to achieve a total thickness of 20 mils. Repeat as necessary to achieve specified thickness.
  4. If a flooring material will be placed over Retro-Coat after it is applied, or appearance is not a priority, (1) 20 mil coat can be applied.

### 2.3 Protection of Finished Work

- A. Prohibit foot traffic on floor for 24 hours after laying (at 70°F). At 50°F, this time should be extended to 48 hours.
- B. Rinse off any chemicals that may come in contact within 7 days of installation with the freshly laid floor immediately.

### 2.4 Cleanup

- A. Properly dispose of all unused and waste materials.
- B. Tools can be washed in warm, soapy water when wet, but after drying, can only be cleaned by grinding or with a paint stripper.
- C. Unused resin can be set off with proper amount of hardener and disposed of in regular trash bins.

## **Part 3 – Quality Control**

### **3.1 Warranty**

- A. Installer shall provide a one year warranty against delamination, chemical attack and normal wear and tear.
- B. Manufacturer will provide a one year material warranty.

### **3.2 Quality Control**

- A. Installer shall use a notched squeegee to apply Retro-Coat to the specified mil thickness and calculations shall be done to determine if the correct amount of material has been applied. Retro-Coat contains 100% solids at the time of application; therefore no material shrinkage will occur during the curing process. One gallon will cover 80 square feet.
- B. A wet mil film gauge can be used to spot check the Retro-Coat thickness to make certain the minimum 20 mil thickness has been applied, though some discretion should be used because high points or low points on the underlying surface can adversely affect the thickness measurements.

### **3.3 Floor Care**

- A. The standard smooth surface of Retro-Coat should be cleaned on a regular basis by damp mopping the floor with conventional commercial cleaners. It is important to first remove any grease or oils by a suitable cleaner, preferably a citrus based cleaner. Rinse with clear water to help eliminate film buildup and then allow to dry. Never use abrasive powder cleaners like Ajax or Comet as they tend to scratch the floor.
- B. Additional steps can also be taken to prolong the look and life of a seamless floor:
  - 1. Protect the floor during transference of heavy equipment
  - 2. Educate the drivers inside the building the importance of avoiding "jack-rabbit" starts and stops, as well as keeping the metal forks lifted
  - 3. Regular cleaning should take place as to not allow the buildup of abrasive material, such as sand or dirt, on the coating
  - 4. Eliminate all metal wheels
  - 5. Change over to light-colored polyurethane wheels
  - 6. Do not slide heavy metal totes, drums or bins across the floor
  - 7. Immediately hose down chemical spills, especially on newly laid floors.