B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706, deformed. For use in all welded applications.

C. Steel Bar Mats: ASTM A 184, fabricated from ASTM A 615, Grade 60, deformed bars, assembled with clips.

D. Plain-Steel Wire: ASTM A 82.

E. Deformed-Steel Wire: ASTM A 496.


2.4 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615, 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, Grade 60, plain-steel bars, ASTM A 775 epoxy coated.

C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775.

D. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.

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.

2.5 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 II V where in contact with earth, gray. Supplement with the following:

   a. Fly Ash: ASTM C 618, Class F.
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, Class 3S 3M 1N 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: 1 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Water: ASTM C 94 and potable.
E. For course and fine aggregates include testing for ASR:

   1. Representative samples of each size of fine and coarse aggregate to be used shall be tested for Alkali Reactivity in accordance with ASTM C-1260. Aggregates with expansion less than 0.10% at 16 days after casting will be considered innocuous in regards to reactivity acceptance. Submit a certification to that effect for review 45 days in advance of concrete work. As an alternative, the Contractor, if applicable, may submit a certification that shall state that representative samples have been tested by the said method within the last 5 years. The certification shall be accompanied by a current (within one (1) year) Petrographic Examination report prepared in accordance with ASTM C295.

2.6 ADMIXTURES

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

   1. Water-Reducing Admixture: ASTM C 494, Type A.
   2. Retarding Admixture: ASTM C 494, Type B.
   3. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
   4. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
   5. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.
C. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.

   1. Available Manufacturers:
      a. Bayer Corporation.
      b. ChemMasters.
      c. Conspec Marketing & Manufacturing Co., Inc.; a Dayton Superior Company.
      d. Davis Colors.
      e. Elementis Pigments, Inc.
      f. Hoover Color Corporation.
      g. Lambert Corporation.
      h. Scofield, L. M. Company.
      i. Solomon Colors.
2. Color: Match Architect's sample or as selected by Architect from manufacturer's full range.

2.7 WATERSTOPS

A. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.

1. Available Products:
   a. JP Specialties, Inc.; Earth Shield TPE-Rubber.
   b. Vinylex Corp.; PetroStop.
   c. WESTEC Barrier Technologies, Inc.; 600 Series TPE-R.

2. Profile: Ribbed with center bulb.
3. Dimensions: As required per drawings; non-tapered.

2.8 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Available Products:
   a. Fortifiber Corporation; Moistop Ultra A.
   b. Raven Industries Inc.; Vapor Block 15.
   c. Reef Industries, Inc.; Griffolyn Type-65G.

B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

C. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 3/8-inch sieve, 10 to 30 percent passing a No. 100 sieve, and at least 5 percent passing No. 200 sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

2.9 FLOOR AND SLAB TREATMENTS

A. Non-Metallic Dry-Shake Concrete Floor Hardener (CH): Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.

1. Available Products:
   a. Euclid Chemical Company (The); Surfex Light Reflective.
B. Penetrating Liquid Densifier & Sealer (SC): Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.

1. Available Products:
   a. Euclid Chemical Company (The); Euco Diamond Hard.

C. Colored Concrete with pigment cure and sealer (CC-1, CC-2, CC-3)

1. Available Products:
   a. L.M. Scofield Company

2.10 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Available 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.
   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. US Mix Products Company; US Spec Monofilm ER.
   r. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

B. Pigment Cure & Sealer: ASTM C 309

1. Available Products
   a. Scofield Company: Color cure to match colored concrete.

C. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
D. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

E. Water: Potable.

2.11 RELATED MATERIALS


B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.

C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. 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.

F. 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.

2.12 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 5000 psi at 28 days when tested according to ASTM C 109.

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.

2.13 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: 25 percent.
4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
5. Silica Fume: 10 percent.
6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
2. 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.
3. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.
2.14 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
3. Slump Limit: 5 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

B. Foundation Walls: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
3. Slump Limit: 5 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

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

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Minimum Cementitious Materials Content: 520 lb/cu. yd..
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
5. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.

D. Suspended Slabs: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 3000 psi at 28 days.
2. Minimum Cementitious Materials Content: 520 lb/cu. yd..
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
5. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.

E. Suspended Slabs: Proportion structural lightweight concrete mixture as follows:

1. Minimum Compressive Strength: 3000 psi at 28 days.
2. Calculated Equilibrium Unit Weight: 110 lb/cu. ft., plus or minus 3 lb/cu. ft. as determined by ASTM C 567.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: 6 percent, plus or minus 2 percent at point of delivery for nominal aggregate size greater than 3/8 inch.
5. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.

F. Concrete Toppings: Proportion normal-weight concrete mixture as follows:
   1. Minimum Compressive Strength: 4000 psi at 28 days.
   2. Minimum Cementitious Materials Content: 520 lb/cu. yd..
   3. Slump Limit: 4 inches, plus or minus 1 inch.
   4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
   5. Air Content: Do not allow air content of troweled finished toppings to exceed 3 percent.

G. Building Frame Members: Proportion normal-weight concrete mixture as follows:
   1. Minimum Compressive Strength: 4000 psi at 28 days.
   3. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
   4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

H. Building Walls: Proportion normal-weight concrete mixture as follows:
   1. Minimum Compressive Strength: 4000 psi at 28 days.
   3. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
   4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

2.15 FABRICATING REINFORCEMENT
A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.16 CONCRETE MIXING
A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, 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.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.
1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.

2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.

3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
   2. Class B, 1/4 inch Class C, 1/2 inch Class D, 1 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 70 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 RETARDERS

A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

B. Bituminous Vapor Retarders: Place, protect, and repair vapor retarders according to manufacturer's written instructions.

C. Granular Course: Cover vapor retarder with granular fill fine-graded granular material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.

1. Place and compact a 1/2-inch- thick layer of fine-graded granular material over granular fill.

3.6 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4, 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.

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. 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.
   3. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
   4. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
   5. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   6. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
   1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
   2. 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 7 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.

3.9 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.

2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
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 to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.
C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

3. Cork-Float Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

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

3.11 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, 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 or to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces indicated 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 indicated 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 and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-foot-long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/8 inch.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated 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-resistant 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. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistant aggregate.

H. Dry-Shake Floor Hardener Finish: As required in the contract, after initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows:

1. Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. unless greater amount is recommended by manufacturer.
2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
3. After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

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. Pigment Cure & Sealer: Apply per manufacturer's requirements as soon as concrete is finished.

D. 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.

E. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

F. 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. Reccoat 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. Reccoat 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 six 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 and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Verification of use of required design mixture.
5. Concrete placement, including conveying and depositing.
6. Curing procedures and maintenance of curing temperature.
7. Verification of concrete strength before removal of shores and forms from beams and slabs.

D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. 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; 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; ASTM C 173, volumetric method, for structural lightweight 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.

   a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
   b. Cast and field 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. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
   b. 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. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

10. 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.

11. 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.

12. 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.

13. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of
concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect.

14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

15. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

E. Measure floor and slab flatness and levelness according to ASTM E 1155 within 24 hours of finishing.

END OF SECTION 033000
SECTION 04 22 00
CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Concrete masonry units.
   2. Decorative concrete masonry units.
   3. Pre-faced concrete masonry units.
   4. Mortar and grout.
   5. Steel reinforcing bars.
   7. Embedded flashing.
   8. Miscellaneous masonry accessories.

B. Products Installed but not Furnished under This Section:

C. Related Requirements:
   1. Section 033000 "Cast-in-Place Concrete" for installing dovetail slots for masonry anchors.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s) – match existing to installed. The cmu shall match at each site.

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.
1.4 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.

1.5 BUY AMERICA COMPLIANCE
A. The contractor shall comply with the applicable Buy America requirements set forth in 49 U.S.C 5323(j) and the applicable regulations in 49 C.F.R Part 661, as amended. If the contractor procures any capital items with Federal Funds, it is the Contractor’s responsibility to obtain the Buy America certification required under such regulations.

1.6 SUBMITTALS
A. Product Data: For each type of product.

B. Shop Drawings: For the following:
   1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
   2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.
   3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection:
   1. Decorative CMUs, in the form of small-scale units.
   2. Pre-faced CMUs.
   3. Colored mortar.
   4. Weep holes/vents.

D. Samples for Verification: For each type and color of the following:
   1. Exposed Decorative CMUs.
   2. Pre-faced CMUs.
   3. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.

1.7 INFORMATIONAL SUBMITTALS
A. Qualification Data: For testing agency.

B. Material Certificates: For each type and size of the following:
   1. Masonry units.
      a. Include data on material properties, [material test reports substantiating compliance with requirements.
b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

2. Integral water repellent used in CMUs to be included in the manufacture process.
3. Cementitious materials. Include name of manufacturer, brand name, and type.
5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
6. Grout mixes. Include description of type and proportions of ingredients.
7. Reinforcing bars.
8. Joint reinforcement.
9. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91/C 91M for air content.
   2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to TMS 602/ACI 530.1/ASCE 6.

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

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects.
   1. Build sample panels for each type of exposed unit masonry construction typical exterior wall in sizes approximately 48 inches (1200 mm) long by 36 inches (900 mm) high by full thickness.
   2. Build sample panels facing south.
   3. Where masonry is to match existing, build panels adjacent and parallel to existing surface.
   4. Protect approved sample panels from the elements with weather-resistant membrane.
   5. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless Architect specifically approves such deviations in writing.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
   1. Build mockup of typical wall area as required.
   2. Build mockups for each type of exposed unit masonry construction in sizes approximately 48 inches (1200 mm) long by 36 inches (900 mm) high by full thickness, including face and backup wythes and accessories.
      a. Include a sealant-filled joint at least 16 inches (400 mm) long in each exterior wall mockup.
      b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches (300 mm) wide by 16 inches (400 mm) high.
      c. Include through-wall flashing installed for a 24-inch (600-mm) length in corner of exterior wall mockup approximately 16 inches (400 mm) down from top of mockup, with a 12-inch (300-mm) length of flashing left exposed to view (omit masonry above half of flashing).
   3. Protect accepted mockups from the elements with weather-resistant membrane.
   4. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
      a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
      b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in
covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.10 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls, and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.


PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality,
including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.2 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to TMS 602/ACI 530.1/ASCE 6.
2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

2.3 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work and will be within 20 feet (6 m) vertically and horizontally of a walking surface.

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.4 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide square-edged or bullnose, to match existing, units for outside corners unless otherwise indicated.

B. Integral Water Repellent: Provide units made with integral water repellent for exposed units.

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E 514/E 514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.
C. Insulated CMUs: Where indicated, units shall contain rigid, specially shaped, cellular thermal insulation units complying with ASTM C 578, Type I, designed for installing in cores of masonry units.

D. CMUs: ASTM C 90.
   1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength as shown on drawings.
   2. Density Classification: Normal weight
   3. Size (Width): Manufactured to dimensions 3/8 inch (10 mm) less-than-nominal dimensions.
   4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
   5. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

E. Decorative CMUs: ASTM C 90.
   1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of as shown on drawings
   2. Density Classification: Normal weight.
   4. Pattern and Texture, match existing CMU Wall pattern and texture
      a. Standard pattern, ground-face finish. Match existing CMU Wall pattern and texture
      b. Standard pattern, split-face finish. Match existing CMU Wall pattern and texture
      c. Standard pattern, split-ribbed finish. Match existing CMU Wall pattern and texture
      d. Scored vertically so units laid in running bond appear as square units laid in stacked bond, standard finish. Match existing CMU Wall pattern and texture
      e. Triple scored vertically so units laid in running bond appear as vertical units laid in stacked bond (soldier courses), standard finish. Match existing CMU Wall pattern and texture
   5. Colors: Match existing CMU wall.

2.5 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150/C 150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
   1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.
B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C 91/C 91M.

E. Mortar Cement: ASTM C 1329/C 1329M.

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979/C 979M. Use only pigments with a record of satisfactory performance in masonry mortar.

G. Colored Cement Products: Packaged blend made from portland cement and hydrated lime masonry cement or mortar cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

2. Colored Masonry Cement:

3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.

4. Pigments shall not exceed 10 percent of portland cement by weight.

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

H. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.

2. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.

3. White-Mortar Aggregates: Natural white sand or crushed white stone.

4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

I. Aggregate for Grout: ASTM C 404.

J. Epoxy Pointing Mortar: ASTM C 395, epoxy-resin-based material formulated for use as pointing mortar for glazed or pre-faced masonry units (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's colors.

K. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

L. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.
M. Water: Potable.

2.6 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420) Deformed

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

C. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A 951/A 951M.
   1. Exterior Walls: Hot-dip galvanized carbonsteel.
   2. Wire Size for Side Rods: [0.148-inch (3.77-mm)] diameter.
   3. Wire Size for Cross Rods: [0.148-inch (3.77-mm)] diameter.
   4. Spacing of Cross Rods: Not more than 16 inches (407 mm) o.c.
   5. Provide in lengths of not less than 10 feet (3 m) with prefabricated corner and tee units.

2.7 TIES AND ANCHORS

A. General: Ties and anchors shall extend at least 1-1/2 inches (38 mm) into masonry but with at least a 5/8-inch (16-mm) cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

   6. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 316.
   7. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane or PVC.
B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406] and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D 226/D 226M, Type I (No. 15 asphalt felt).

2.9 MASONRY-CELL FILL

A. Loose-Fill Insulation: Perlite complying with ASTM C 549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).

B. Lightweight-Aggregate Fill: ASTM C 331/C 331M.

2.10 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement mortar unless otherwise indicated.
3. For exterior masonry, use portland cement mortar.
4. For reinforced masonry, use portland cement mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type M] [Type S].
2. For reinforced masonry, use [Type S] [Type N].

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
3. Mix to match Architect's sample.
4. Application: Use pigmented mortar for exposed mortar joints with the following units:
   a. Decorative CMUs.
   b. Pre-faced CMUs.
   c. Cast-stone trim units.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
   1. Mix to match Architect's sample.
   2. Application: Use colored-aggregate mortar for exposed mortar joints with the following units:
      a. Decorative CMUs.
      b. Pre-faced CMUs.
      c. Cast-stone trim units.

F. Grout for Unit Masonry: Comply with ASTM C 476.
   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
   2. Proportion grout in accordance with ASTM C 476, [Table 1] or [paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa)].
   3. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.

G. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.
   1. Application: Use epoxy pointing mortar for exposed mortar joints with pre-faced CMUs.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
   2. Verify that foundations are within tolerances specified.
   3. Verify that reinforcing dowels are properly placed.
   4. Verify that substrates are free of substances that would impair mortar bond.
B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.

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

3.2 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).

2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).

3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.

2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.

3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.

4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.

5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.

6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm).

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm).

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond or bond pattern indicated on Drawings or match existing CMU wall pattern do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than [2 inches (50 mm)] [4 inches (100 mm)]. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch (13-mm) clearance between end of anchor rod and end of tube. Space anchors 48 inches (1200 mm) o.c. unless otherwise indicated.
3. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Wet joint surfaces thoroughly before applying mortar.
3. Rake out mortar joints for pointing with sealant.

D. Rake out mortar joints at pre-faced CMUs to a uniform depth of 1/4 inch (6 mm) and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.

E. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

F. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

G. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.
3.6 MASONRY-CELL FILL

A. Pour loose-fill insulation into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than 20 feet (6 m).

B. Install molded-polystyrene insulation units into masonry unit cells before laying units.

3.7 MASONRY-JOINT REINFORCEMENT

A. General: See drawings for reinforcing size and spacing.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

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

3.8 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:

1. Provide an open space not less than 1/2 inch (13 mm) wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.

2. Anchor masonry with anchors embedded in masonry joints and attached to structure.

3. See drawings for anchor size and spacing

3.9 CONTROL AND EXPANSION JOINTS

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

B. Form control joints in concrete masonry as follows using one of the following method:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.

2. Install preformed control-joint gaskets designed to fit standard sash block.

3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

3.10 REINFORCED UNIT MASONRY INSTALLATION

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

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

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

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

1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

3.11 FIELD QUALITY CONTROL

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

B. Inspections: Special inspections according to Level B C in TMS 402/ACI 530/ASCE 5.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.

3. Place grout only after inspectors have verified proportions of site-prepared grout.
C. Testing Prior to Construction: One set of tests.

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

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

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

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

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

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

3.12 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch (19 mm). Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot (3 mm per 300 mm). Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.13 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.14 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches (100 mm) in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
3. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.

C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042200
SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Structural steel. Structural steel framing and support members, complete with required braces, connection plates, welds, washers, bolts, nuts, shims, anchor bolts, templates and shop finishes.
2. Erecting, connecting, field welding and adjusting for plumb and level.
3. Field-installed shear connectors.
5. All other work normally related to the above, as shown on drawings, or specified under this section.

B. Related Requirements:

1. Section 053100 "Steel Decking" for field installation of shear connectors through deck.
2. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame miscellaneous steel fabrications and other steel items not defined as structural steel.
3. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for surface-preparation and priming requirements.
4. Section 133419 "Metal Building Systems" for structural steel.

1.3 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:

1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches (38 mm).
2. Welded built-up members with plates thicker than 2 inches (50 mm).
3. Column base plates thicker than 2 inches (50 mm).

D. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

E. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

F. Architecturally Exposed Structural Steel: Structural steel designated as architecturally exposed structural steel in the Contract Documents.

1.4 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of 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.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project sites.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication of structural-steel components.
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Include embedment Drawings.
   3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
   4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
   5. Identify members and connections of the Seismic-Load-Resisting System.
   6. Indicate locations and dimensions of protected zones.
   7. Identify demand critical welds.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:
1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand critical welds.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, fabricator, shop-painting applicators, testing agency.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural steel, including chemical and physical properties.

E. Product Test Reports: For the following:
   1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
   2. Direct-tension indicators.
   3. Tension-control, high-strength, bolt-nut-washer assemblies.
   4. Shear stud connectors.
   5. Shop primers.

F. Survey of existing conditions.

G. Source quality-control reports.

H. Field quality-control and special inspection reports.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint to SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

E. Comply with applicable provisions of the following specifications and documents:
1. AISC 303.
2. AISC 341 and AISC 341s1.
3. AISC 360.
4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

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

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992/A 992M, ASTM A 572/A 572M, Grade 50

B. Channels, Angles, M, S-Shapes: ASTM A 36/A 36M

C. Plate and Bar: ASTM A 36/A 36M

D. Corrosion-Resisting Structural-Steel Shapes, Plates, and Bars: ASTM A 588/A 588M, Grade 50.

E. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade B, structural tubing.

F. Corrosion-Resisting, Cold-Formed Hollow Structural Sections: ASTM A 847/A 847M, structural tubing.

G. Steel Pipe: ASTM A 53/A 53M, Type E or Type S, Grade B.

1. Weight Class: As shown on drawings.
2. Finish: Black except where indicated to be galvanized.
H. Steel Castings: ASTM A 216/A 216M, Grade WCB with supplementary requirement S11.

I. Steel Forgings: ASTM A 668/A 668M.

J. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.

B. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy-hex steel structural bolts hardened carbon-steel washers with plain finish.

1. Direct-Tension Indicators: ASTM F 959, Type 490 (ASTM F 959M, Type 10.9), compressible-washer type with plain finish.

C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Plain.

D. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

E. Headed Anchor Rods: ASTM F 1554, Grade 36, ASTM F 1554, Grade 55, or ASTM F 1554 Grade 105 weldable straight.

3. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
4. Finish: Plain

F. Threaded Rods: ASTM A 193/A 193M, Grade B7

2. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
3. Finish: Plain

2.3 PRIMER

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Public Health’s (formerly, the California Department of Health Services’) “Standard Method for the Testing and Evaluation of
Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers”.

B. Primer: Comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting." Section 099600 "High-Performance Coatings."

C. Primer: SSPC-Paint 25, [Type I] [Type II], zinc oxide, alkyd, linseed oil primer.

D. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

E. Galvanizing Repair Paint: ASTM A 780/A 780M.

2.4 GROUT

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

2.5 FABRICATION


1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
4. Mark and match-mark materials for field assembly.
5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, "Power Tool Cleaning."

F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.

H. Welded Door Frames: Build up welded door frames attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches (250 mm) o.c. unless otherwise indicated.

I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened and Slip critical, as shown on drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
2. Surfaces to be field welded.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
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 3, "Power Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). 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 surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

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 and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
2. Galvanize lintels, shelf angles, and welded door frames attached to structural-steel frame and located in exterior walls.

2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency, at no additional cost to the Owner, to perform shop tests and inspections.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Bolted Connections: Inspect and test shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
4. Radiographic Inspection: ASTM E 94.

D. In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

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

1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

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

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

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


1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are 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/D1.1M 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 and Slip critical.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
   2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

3.5 PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

3.6 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high-strength bolted connections.
4. See drawings for additional special inspection requirements.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Bolted Connections: Inspect and test bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.

1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

   a. Liquid Penetrant Inspection: ASTM E 165.
   b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
   c. Ultrasonic Inspection: ASTM E 164.
   d. Radiographic Inspection: ASTM E 94.

E. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.
3.7 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780/A 780M.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

   1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

C. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

D. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

END OF SECTION 051200
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Roof deck.
   2. Acoustical roof deck.
   3. All accessories including fillers, etc.
   4. Touch-up painting of galvanized deck

B. Related Requirements:
   1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
   2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
   3. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
   5. Section 099123 "Interior Painting" for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS

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

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

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.
B. Product Certificates: For each type of steel deck.

C. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
   1. Power-actuated mechanical fasteners.
   2. Acoustical roof deck.

D. Evaluation Reports: For steel deck, from ICC-ES.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.


C. Electrical Raceway Units: Provide UL-labeled cellular floor-deck units complying with UL 209 and listed in UL's "Electrical Construction Equipment Directory" for use with standard header ducts and outlets for electrical distribution systems.


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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

C. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 ROOF DECK

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Verco Manufacturing Co or Approved Equal
   2. Nucor Corp
   3. Vulcraft Group

B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
   1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), [Grade 50] Zinc coating.
   2. Deck Profile: As indicated on drawings
   3. Profile Depth: As indicated on drawings
   4. Design Uncoated-Steel Thickness: As indicated on drawings
   5. Span Condition: As indicated on drawings

2.3 ACOUSTICAL ROOF DECK

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Verco Manufacturing Co or Approved Equal
   2. Nucor Corp
   3. Vulcraft Group

B. Acoustical Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
   1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), [Grade 50]
   2. Deck Profile: As indicated on drawings
   3. Profile Depth: As indicated on drawings
   4. Design Uncoated-Steel Thickness: As indicated on drawings
   5. Span Condition: As indicated on drawings
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 (4.8-mm) 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 (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

G. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.

H. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch (1.52 mm), 0.0747 inch (1.90 mm) thick, with factory-punched hole of 3/8-inch (9.5-mm) minimum diameter.

I. Galvanizing Repair Paint: ASTM A 780/A 780M

J. 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 of the Work.

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

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.
C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

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 (38 mm) long, and as indicated on drawings:

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span as indicated on drawings.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:

1. End Joints: Lapped 2 inches minimum

D. 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.

E. 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 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Field welds will be subject to inspection.

C. Prepare test and inspection reports.

3.5 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces 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.
   2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

C. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

END OF SECTION 053100
055000 - METAL FABRICATIONS

1 - GENERAL

1.1 SECTION INCLUDES

A. Summary System Scope Description. This specification section includes requirements for Metal Fabrications equipment and materials for the expansion of two existing compressed natural gas (CNG) vehicle-fueling systems owned by the Regional Transportation Commission of Southern Nevada (RTC or Owner). The facilities are identified as Integrated Bus Maintenance Facility (IBMF) and Sunset Bus Maintenance Facility (SMF).

B. Shop fabricated steel, aluminum and miscellaneous metal items.

1.2 RELATED REQUIREMENTS

A. Section 042200 – Concrete Unit Masonry: Placement of metal fabrications in masonry.

B. Section 099113 – Exterior Painting: Paint type & finish.

1.3 PRICE AND PAYMENT PROCEDURES

A. Components:
   1. Basis of Measurement: By the pound (kg).
   2. Basis of Payment: Includes fabrication, finishing, and installation.

B. Components:
   1. Basis of Measurement: By the unit.

1.4 REFERENCE STANDARDS


F. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped,
Zinc-Coated, Welded and Seamless; current edition.


M. ASTM A 500/A 500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; current edition.


W. ASTM B 210 - Standard Specification for Aluminum and Aluminum-Alloy Drawn
Seamless Tubes; current edition.


AC. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; current edition.


AF. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings; current edition.


AH. SSPC-SP 2 - Hand Tool Cleaning; Society for Protective Coatings; current edition.

1.5 SUBMITTALS

A. See Section 01 31 00 – Project Management & Coordination: 1.5 Submittals

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, stamped engineered calcs, elevations, and details where applicable.

1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

C. Welders’ Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.

1.6 QUALITY ASSURANCE
A. Design all brackets and connections under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State of Nevada / which the Project is located.

2 - PRODUCTS

2.1 MATERIALS - STEEL

A. Steel Angles, Bars and Plates: ASTM A 36.

B. Steel Tubing – HSS: ASTM A 500, Grade B cold-formed structural tubing.

C. Steel W Shapes: ASTM A 992.

D. Pipe: ASTM A 53, Grade B Schedule 40, black finish.

E. Slotted Channel Framing: ASTM A 653, Grade 33.

F. Slotted Channel Fittings: ASTM A 1011.

G. Fasteners.

H. Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, galvanized to ASTM A 153/A 153M where connecting galvanized components.

I. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

J. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

K. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.2 FABRICATION

A. Fit and shop assemble items in largest practical sections, for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Continuously seal joined members by intermittent welds and plastic filler.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with component design, except where specifically noted otherwise.

F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
2.3 FABRICATED ITEMS

A. Ledge Angles, Shelf Angles, Channels, Tubes and Plates Not Attached to Structural Framing: For support of metal gate accessories; prime paint finish.

B. Lintels: As detailed; prime paint finish.

C. Bent Plate, gate profiles with support attachments for adjustment as indicated on drawings.

2.4 FINISHES - ALUMINUM

2.5 FABRICATION TOLERANCES

A. Squareness: 1/8 inch (3 mm) maximum difference in diagonal measurements.

B. Maximum Offset Between Faces: 1/16 inch (1.5 mm).

C. Maximum Misalignment of Adjacent Members: 1/16 inch (1.5 mm).

D. Maximum Bow: 1/8 inch (3 mm) in 48 inches (1.2 m).

E. Maximum Deviation From Plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

3 - EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

3.2 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

B. Supply setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry. Template working sections of gates as required prior to installation.

3.3 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects. Rolling assemblies shall operate smoothly and true.

B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Field weld components indicated and as approved by vendor’s drawings.
D. Perform field welding in accordance with AWS D1.1/D1.1M.

E. Obtain approval prior to site cutting or making adjustments not scheduled.

F. Provide splice connection to accommodate expansion movement.

G. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.4 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch (6 mm) in 12'-0" length, non-cumulative.

B. Maximum Offset From True Alignment: 1/8 inch (6 mm).

C. Maximum Out-of-Position: 1/8 inch (6 mm).

END OF SECTION
SECTION 055313

GRATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Metal bar gratings.
   2. Metal frames and supports for gratings.

B. Related Sections include the following:
   1. Division 5 Section "Structural Steel" for structural-steel framing system components.
   2. Division 5 Section "Metal Stairs" for grating treads and landings of steel-framed stairs.
   3. Division 5 Section "Pipe Railings" for metal pipe and tube handrails and railings.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance of Gratings: Provide gratings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   1. Floors: Uniform load of 125 lbf/sq. ft. or concentrated load of 2000 lbf, whichever produces the greater stress.
   2. Floors: Uniform load of 250 lbf/sq. ft. or concentrated load of 3000 lbf, whichever produces the greater stress.
   3. Walkways and Elevated Platforms Other Than Exits: Uniform load of 60 lbf/sq. ft.
   4. Walkways and Elevated Platforms Used as Exits: Uniform load of 100 lbf/sq. ft.
   5. Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of 250 lbf/sq. ft. or concentrated load of 8000 lbf, whichever produces the greater stress.
   6. Limit deflection to L/240 dead load and live load L/360 live load or 1/4 inch, whichever is less.

B. Seismic Performance: Provide gratings capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."
1.4 SUBMITTALS

A. Product Data: For the following:

1. Formed-metal plank gratings.
2. Clips and anchorage devices for gratings.
3. Paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Provide templates for anchors and bolts specified for installation under other Sections.
2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.

D. Welding certificates.

E. Qualification Data: For professional engineer.

1.5 QUALITY ASSURANCE

A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual" and NAAMM MBG 532, "Heavy-Duty Metal Bar Grating Manual."

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating gratings without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
2. Provide allowance for trimming and fitting at site.
1.7  COORDINATION

A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1  MANUFACTURERS

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

1. Metal Bar Gratings:
   a. Alabama Metal Industries Corporation.
   b. All American Grating, Inc.
   c. Barnett/Bates Corp.
   d. Borden Metal Products (Canada) Limited.
   e. Fisher & Ludlow.
   f. Grupo Metelmex, S.A. de C.V.
   g. IKG Industries; a Harsco Company.
   h. Marwas Steel Co.; Laurel Steel Products Division.
   i. Ohio Gratings, Inc.
   j. Seidelhuber Metal Products, Inc.
   k. Tru-Weld.

2.2  FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Wire Rod for Grating Crossbars: ASTM A 510.

C. Uncoated Steel Sheet: ASTM A 1011, structural steel, Grade 30.

D. Galvanized Steel Sheet: ASTM A 653, structural quality, Grade 33, with G90 coating.

E. Expanded Metal, Carbon Steel: ASTM F 1267, Class 1.

2.3  FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.
B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 2.


F. Anchors: Provide cast-in-place chemical or torque-controlled expansion anchors with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.


2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy that is welded.

B. Shop Primers: Provide primers that comply with Division 9 painting Sections.

C. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.

1. Use primer with a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Zinc-Rich Primer: Zinc-rich primer, complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.

1. Use primer with a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
3. Products: Subject to compliance with requirements, provide one of the following:

b. Carboline Company; Carbozinc 621.
c. ICI Devoe Coatings; Catha-Coat 313.
f. Sherwin-Williams Company (The); Corothane I GalvaPac Zinc Primer.


F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

D. Fit exposed connections accurately together to form hairline joints.

E. Welding: Comply with AWS recommendations and the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.

F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.
   1. Fabricate toeplates to fit grating units and weld to units in shop, unless otherwise indicated.
   2. Fabricate toeplates for attaching in the field.
   3. Toeplate Height: 4 inches, unless otherwise indicated.

2.6 METAL BAR GRATINGS

A. Welded Steel Grating:
   1. Bearing Bar Spacing: As indicated.
   2. Bearing Bar Depth: As indicated.
   3. Bearing Bar Thickness: As indicated.
   4. Crossbar Spacing: As indicated.
   5. Grating Mark W-11-4 (1 x 3/16) STEEL: As indicated.
   6. Traffic Surface: As indicated.
7. **Steel Finish**: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. of coated surface.

### 2.7 GRATING FRAMES AND SUPPORTS

**A. Frames and Supports for Metal Gratings**: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.

**B. Frames and Supports for Glass-Fiber-Reinforced Plastic Gratings**: Fabricate from glass-fiber-reinforced plastic shapes of sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, use shapes made from same resin as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integral anchors.

**C. Galvanize steel frames and supports in the following locations:**

1. Exterior.
2. Interior, where indicated.

### 2.8 STEEL FINISHES

**A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.**

**B. Finish gratings, frames, and supports after assembly.**

**C. Galvanizing**: For those items indicated for galvanizing, apply zinc coating by the hot-dip process complying with ASTM A 123/A 123M.

**D. Preparation for Shop Priming**: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:

1. **Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich Primer**: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. **Interiors (SSPC Zone 1A)**: SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

**E. Apply shop primer to uncoated surfaces of gratings, frames, and supports, except those with galvanized finishes and those to be embedded in concrete or masonry,**

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.
   1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Attach toeplates to gratings by welding at locations indicated.

F. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.

G. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 INSTALLING METAL BAR GRATINGS

A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.
C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 painting Sections.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055313
071900 – WATER REPELLENTS

1 – GENERAL  *(This Section is Optional for use at RTC’s discretion)*

1.1 SECTION INCLUDES

   A. Summary System Scope Description. This specification section includes requirements for Water Repellents, equipment and materials for the expansion of two existing compressed natural gas (CNG) vehicle-fueling systems owned by the Regional Transportation Commission of Southern Nevada (RTC or Owner). The facilities are identified as Integrated Bus Maintenance Facility (IBMF) and Sunset Bus Maintenance Facility (SMF).

   B. Water Repellents for the Following Applications:
      1. Above-grade, vertical masonry and concrete surfaces.
      2. Slab-on-grade, horizontal concrete surfaces.

1.2 RELATED REQUIREMENTS

   A. Section 033000 – Cast-in-Place Concrete.

   B. Section 042200 – Concrete Unit Masonry.

1.3 SUBMITTALS

   A. See Section 01 31 00 – Project Management & Coordination:  1.5 Submittals

   B. Product Data: Manufacturer’s data sheets on each product to be used, including:
      1. Preparation instructions and recommendations.
      2. Storage and handling requirements and recommendations.
      3. Installation methods.

   C. Installer Qualifications:  Submit qualifications of applicator.
      1. Certification stating applicator is experienced in the application of the specified products for the past 5 years.
      2. List of recently completed water repellent projects of similar scope, including project name and location, names of owner and architect, and description of products used, substrates, applicable local environmental regulations, and application procedures.

   D. Environmental Regulations:  Submit applicable local environmental regulations.

   E. VOC Certification:  Submit certification that water repellents furnished comply with regulations controlling the use of VOC solvents.

1.4 QUALITY ASSURANCE

   A. Manufacturer Qualifications:  Minimum 5 year experience manufacturing similar products.
B. Installer Qualifications: Minimum 5 year experience installing similar products.

1.5 TEST PANELS

A. Before full-scale application, review manufacturer’s product data sheets to determine the suitability of each product for the specific surfaces. Apply each water repellent to test panels to determine number of applications, coverage rates, compatibility, effectiveness, surface preparation, application procedures, and desired results.

B. Apply water repellents to test panels in accordance with manufacturer’s written instructions. Allow sufficient time before evaluating final appearance and results. Some products require up to 10 days curing time to develop full, long-term repellency. Do not begin full-scale application until test panels are inspected and approved by the RTC Representative.

C. Test Panel Requirements:
   1. Size: Minimum 100 square feet (9 sq. meters) each.
   2. Locations: As determined by the RTC Representative / QC Inspector.
   3. Number: As required to completely test each water repellent with each type of substrate to be protected.

D. Retain and protect test panels approved by the QC Inspector in undisturbed condition during the work of this section, to be used as a standard for judging the water repellent work.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to starting work of this section.

1.7 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers.

B. Storage and Handling: Store containers upright in a cool, dry, well-ventilated place, out of the sun. Store away from all other chemicals and potential sources of contamination. Keep containers tightly closed when not in use. Store and handle materials in accordance with manufacturer’s written instructions.

C. Containers shall be clearly labeled and identified with product and manufacturer name.

1.8 PROJECT CONDITIONS

A. Temperature Limitations:
   1. 80 degrees F for a minimum of 8 hours after application, unless otherwise indicated by manufacturer’s written instructions.
   2. Do not apply at surface and air temperatures below 50 degrees F or above 95 degrees F, unless otherwise indicated by manufacturer’s written instructions.
   Do not apply when surface and air temperatures are not expected to remain above 50 degrees F.
   B. Do not apply under windy conditions which may result in uncontrolled and excessive water repellent drift.
C. Do not apply to frozen substrate. Allow adequate time for substrate to thaw, if freezing conditions exist before application.

D. Do not apply earlier than 24 hours after rain or if rain is predicted for a period of 8 hours after application, unless otherwise indicated by manufacturer’s written instructions.

1.9 SEQUENCING

A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

L&M Construction Chemicals; A product brand of LATICRETE International, Inc. which is located at 1 Laticrete Park N.; Bethany, CT 06524-3423; Toll free tel: 800-362-3331; Tel: 402-453-6600; Email: request info (info@lmcc.com); web: www.lmcc.com

SURFKOAT, Surface Koatings, Inc. 134 Davis Street, Portland, TN 37148 Tel: 615-323-9461: Fax; 615-323-9816 Masonry & Concrete water repellents.

Pecora Water Repellents for Masonry & Concrete; Construction Sealants & Supply; 4450 West Diablo Drive, Las Vegas, NV 89118 Tel; 702-873-0203; Fax; 702-8730096 Email: www.pecora.com

B. Substitutions: Permitted

C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 – Product Requirements – Substitution Request 1.4 B.

2.2 WATER REPELLENTS

A. Vertical work: Silan-Siloxane Water Repellent: “HYDROPEL WB” (or equal). Clear, penetrating water repellent for use on concrete, brick, and clay tile surfaces. Protects against moisture intrusion and resists efflorescence, leaching, mildew staining, atmospheric staining, and freeze-thaw spalling. Treated masonry and concrete resists alkalis and acid rain.
   1. Total Solids: 8 percent.
   2. Color: White liquid, dries clear.
   3. Odorless, water-based and VOC compliant.
   4. VOC: less than 200 grams per liter.

B. Horizontal work: Silan-Siloxane Micro Emulsion Water Repellent, Horizontal
Concrete: “AQUAPEL” (or equal) clear, penetrating VOC compliant, silane/siloxane blend designed to repel water and protect concrete from moisture and chloride-ion (salt) ingress.
1. Active Substance Silane-siloxane.
2. Total Solids: 10 percent.
3. Color: sprays white, dries clear.
4. VOC: less than 200 grams per liter.

3 - EXECUTION

3.1 EXAMINATION

A. Verify by examination that masonry and concrete surfaces are acceptable to receive the specified water repellents. Notify the RTC representative if surfaces are not acceptable to receive the specified products.

3.2 PROTECTION

A. Protect surrounding areas, equipment, machinery, vehicles, and non-masonry surfaces during the work from contact with water repellents, masonry or concrete cleaners if used, residues, rinse water, fumes, wastes, and effluents in accordance with manufacturer’s written instructions. Control any corrosive residues from contact with surrounding equipment.

3.3 SURFACE PREPARATION

A. Clean all dirt, dust, oil, grease, curing compounds and other contaminants from surfaces that interfere with penetration or performance of water repellents. Use appropriate masonry or concrete cleaners approved by the water repellent manufacturer where necessary. Rinse thoroughly using pressure water spray to remove cleaner residues. Allow surfaces to dry completely before application of water repellents.

B. Repair, patch, and fill all cracks, voids defects, and damaged areas in surface as approved by Engineer and RTC’s representative. Allow repair materials to cure completely before application of water repellents.

C. Apply specified sealants and caulking and allow to cure completely before application of water repellents.

D. Seal all open joints.

E. Allow new masonry and concrete construction and re-pointed surfaces to cure for minimum of 14 days before application of water repellents.

3.4 APPLICATION

A. Apply water repellents to substrates in accordance with manufacturer’s written
instructions, environmental regulations, and application procedures determined from test panel results approved by the Architect.

B. Apply to clean, dry, cured, and properly prepared surfaces approved by the Architect.

C. Do not dilute or alter water repellents. Apply directly from container.

3.5 FIELD QUALITY CONTROL

A. Inspection: Inspect the water repellent work with the Contractor, Architect, applicator, and representative and compare with test panel results approved by the Architect. Determine if the substrates are suitably protected by the water repellents.

B. Manufacturer’s Field Services: Provide the services of a manufacturer’s authorized field representative to verify specified products are used, and protection, surface preparation, and application of water repellents are in accordance with the manufacturer’s written instructions and the test panel results approved by the Architect.

END OF SECTION
079200 – JOINT SEALANTS

1 - GENERAL

1.1 SECTION INCLUDES

A. Summary System Scope Description. This specification section includes requirements for Joint Sealant materials for the expansion of two existing compressed natural gas (CNG) vehicle-fueling systems owned by the Regional Transportation Commission of Southern Nevada (RTC or Owner). The facilities are identified as Integrated Bus Maintenance Facility (IBMF) and Sunset Bus Maintenance Facility (SMF).

   A. Sealants and joint backing.
   B. Pre-compressed foam sealers.
   C. Hollow gaskets.

1.2 RELATED REQUIREMENTS

A. Section 01 60 00 – Product Requirements.

1.3 REFERENCE STANDARDS


1.4 ADMINISTRATIVE REQUIREMENTS

1.5 SUBMITTALS

A. See Section 01 31 00 – Project Management & Coordination: 1.5 Submittals.

B. Product Data: Provide data indicating appropriate use for location and sealant chemical characteristics.

C. Samples: Submit 4 samples, 4" in size illustrating sealant colors for selection. Mock up on site may serve for sample review and approval.
1.6 QUALITY ASSURANCE

A. Maintain one copy of each referenced document covering installation requirements on site.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

C. Applicator Qualifications: Company specializing in performing the work of this section with minimum 5 years experience.

1.7 MOCK-UP

A. Provide mock-up of sealant joints in conjunction location and placement at elements to receive sealant.

B. Construct mock-up with specified sealant types and with other components necessary for a complete installation.

C. Locate where directed by RTC representative

D. Mock-up may remain as part of the Work.

1.8 FIELD CONDITIONS

A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.9 WARRANTY

A. Correct defective work within a five year period after Date of Substantial Completion.

B. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, exhibit loss of adhesion, separation or cohesion, or do not cure.

2 - PRODUCTS

2.1 MANUFACTURERS (Or Approved Equal)

A. Silicone Sealants:
   5. Red Devil; 100% Silicone Industrial Grade RTV Sealant: www.reddevil.com.

B. Acrylic Sealants:
2.2 SEALANTS

A. Sealants and Primers - General: Provide products having volatile organic compound (VOC) content as specified in Section 01 60 00.

B. Silicone Sealant: ASTM C 920, Grade NS, Class 25, Uses NT, A, G, M, O; single component, solvent curing, non-sagging, non-staining, fungus resistant, non-bleeding.
   1. Color: Match adjacent finished surfaces.

2.3 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to percent larger than joint width.

D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

3 - EXECUTION

3.1 EXAMINATION

A. Verify that substrate surfaces are clean and ready to receive work.

B. Verify that joint backing and release tapes are compatible with sealant.

3.2 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.

B. Clean and prime joints in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C 1193.

D. Protect elements surrounding the work of this section from damage or disfigurement.

E. Selected sealants shall be appropriate for location of application.

3.3 INSTALLATION

A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Perform installation in accordance with ASTM C 1193.

C. Perform acoustical sealant application work in accordance with ASTM C 919.
D. Install bond breaker where joint backing is not used.

E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges. Do not apply in full sun or extreme temperatures.

G. Tool joints concave.

3.4 CLEANING

A. Clean adjacent soiled surfaces.

3.5 PROTECTION

A. Protect sealants until cured.

3.6 SCHEDULE

A. Exterior Joints for Which No Other Sealant Type is Indicated: Type silicone, color to match adjacent finish color. Paintable where required to match adjacent finish.

END OF SECTION
099113 - EXTERIOR PAINTING

1 – GENERAL

A. Summary System Scope Description. This specification section includes requirements for Exterior Painting, equipment and materials for the expansion of two existing compressed natural gas (CNG) vehicle-fueling systems owned by the Regional Transportation Commission of Southern Nevada (RTC or Owner). The facilities are identified as Integrated Bus Maintenance Facility (IBMF) and Sunset Bus Maintenance Facility (SMF).

1.1 SECTION INCLUDES

A. Exterior paint and coatings systems including surface preparation.

1.2 RELATED SECTIONS

A. Section 03 30 00 - Cast-in-Place Concrete.
B. Section 05 12 00 - Steel Framing.
C. Section 05 50 00 – Metal Fabrications

1.3 REFERENCES

A. Steel Structures Painting Council (SSPC):
   1. SSPC-SP 1 - Solvent Cleaning.
   2. SSPC-SP 2 - Hand Tool Cleaning.
   3. SSPC-SP6/NACE No. 3, Commercial Blast Cleaning.
   4. SSPC-SP7/NACE No. 4, Brush-Off Blast Cleaning.
   5. SSPC-SP11, Power Tool Cleaning to Bare Metal.
   6. SSPC-SP 13 / NACE No. 6 Surface Preparation for Concrete.

B. Material Safety Data Sheets / Environmental Data Sheets: Per manufacturer's MSDS/EDS for specific VOCs (calculated per 40 CFR 59.406). VOCs may vary by base and sheen.

C. South Coast Air Quality Management District (SCAQMD): Rule 1113 - Architectural Coatings.

D. Green Seal, Inc.:
   2. GC-03 - Environmental Criteria for Anti-Corrosive Paints.

1.4 SUBMITTALS

A. See Section 01 31 00 – Project Management & Coordination: 1.5 Submittals.

B. Product Data: For each paint system indicated, including.
   1. Product characteristics.
   2. Surface preparation instructions and recommendations.
   3. Primer requirements and finish specification.
   4. Storage and handling requirements and recommendations.
5. Application methods.
6. Cautions for storage, handling and installation.

C. Verification Samples: For each finish product specified, submit samples that represent actual product, color, and sheen.

D. Only submit complying products based on project requirements. One must also comply with the regulations regarding VOCs. To ensure compliance with district regulations and other rules, businesses that perform coating activities should contact the local district in each area where the coating will be used.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Paint / Coat exposed surfaces. If a color of finish, or a surface is not specifically mentioned, match adjacent surface unless noted otherwise by Architect.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels unless indicated.

D. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
1. Finish surfaces for verification of products, colors and sheens.
2. Finish area designated by Architect.
3. Provide samples that designate primer and finish coats.
4. Do not proceed with remaining work until the RTC Representative or Architect approves the mock-up.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver manufacturer's unopened containers to the work site. Packaging shall bear the manufacturer's name, label, and the following list of information.
1. Product name, and type (description).
3. VOC content.
4. Environmental handling.
5. Batch date.
6. Color number.

B. Storage: Store and dispose of solvent-based materials, and items with solvent materials, in accordance with requirements of local authorities having jurisdiction.

C. Store materials in an area that is within the acceptable temperature range, per manufacturer's instructions. Protect from freezing.

D. Handling: Maintain a clean, dry storage area, to prevent contamination or damage to the coatings.
1.7 PROJECT CONDITIONS
   A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.8 EXTRA MATERIALS
   A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.
   B. Furnish Owner with an additional one percent of each material and color, but not less than 1 gal (3.8 l) or 1 case, as appropriate.

2 - PRODUCTS

2.1 MANUFACTURERS
   A. Acceptable Manufacturer: (or equal)
      1. Pratt & Lambert Paints
      2. Sherwin-Williams
      3. ICI Paints
   B. Substitutions: Permitted.
   C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 – Product Requirements – 1.4 B. Substitution Request.

2.2 APPLICATIONS
   A. Exterior Paints and Sealer Coatings:
      1. Concrete: Paints / Sealers
      2. Masonry: Concrete masonry units, cinder or concrete block sealer.
      3. Concrete: Concrete floor sealer
      5. Metal: Miscellaneous iron, ornamental iron, ferrous metal. (painted surfaces).

2.3 PAINT MATERIALS - GENERAL
   A. Paints and Coatings.
      1. Unless otherwise indicated, provide factory-mixed coatings. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
   B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.
   C. Coating Application Accessories: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required, per
manufacturer’s specifications. Prep substrate as required.

D. Color: Refer to Finish Schedule for paint colors, locations and sealers.

E. Scope: Use products specified in this section to finish exterior surfaces exposed to view, unless otherwise indicated; DO NOT PAINT THE FOLLOWING:
   1. Items specified or provided with factory finish; materials and products having factory-applied primers are not considered factory finished.
   2. Items indicated to receive other finishes.
   3. Items indicated to remain unfinished.
   5. Concrete masonry in utility, mechanical, and electrical spaces.
   7. Equipment nameplates, fire rating labels, and operating parts of equipment.
   9. Concealed pipes, ducts, and conduits.

F. Exterior Surfaces To Be Painted:
   1. Concrete masonry walls -- water repellent (see Section 07 19 00).
   2. Bare metal, primed metal, metal fascia panel and galvanized metal - corrosion-resistant finish. Paint shall be appropriate for exterior location and application and shall perform in climate of Southern Nevada.
   3. Pipes, ducts, conduits, hangers and supports, equipment, and equipment enclosures exposed to weather or view - corrosion-resistant finish.

G. Colors: Match facility standard color theme or as directed by RTC representative.
   1. Finish pipes, ducts, and conduit (white), unless directed otherwise.
   2. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.

2.4 EXTERIOR PAINT SYSTEMS

A. All Exterior Surfaces Indicated to be Painted with High Performance Coatings, Palgard Polyamide Epoxy. Unless Otherwise Specified:
   Preparation as specified by manufacturer.
   1 coat of primer as recommended by manufacturer.

B. Paints and Coatings - General:
   1. Unless otherwise indicated, provide factory-mixed coatings. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
   2. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
   3. Supply each coating material in quantity required to complete entire project's work from a single production run.
C. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.

D. Coating Application Accessories: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required.

3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared; notify Architect of unsatisfactory conditions before proceeding. If substrate preparation is the responsibility of another installer, notify Architect / RTC representative of unsatisfactory preparation before proceeding.

B. Proceed with work only after conditions have been corrected and approved by all parties, otherwise application of coatings will be considered as an acceptance of surface conditions.

C. Previously Painted Surfaces: Verify that existing painted surfaces do not contain lead based paints, notify Architect immediately if lead based paints are encountered.

3.2 SURFACE PREPARATION

A. General: Surfaces shall be dry and in sound condition. Remove oil, dust, dirt, loose rust, peeling paint or other contamination to ensure good adhesion.

1. Remove mildew before painting by washing with a solution of 1 part liquid household bleach and 3 parts of warm water. Apply the solution and scrub the mildewed area. Allow the solution to remain on the surface for 10 minutes. Rinse thoroughly with clean water and allow the surface to dry a minimum of 48 hours before painting. Wear protective glasses or goggles, waterproof gloves, and protective clothing. Quickly wash off any of the mixture that comes in contact with your skin. Do not add detergents or ammonia to the bleach/water solution.

2. Remove items including but not limited to equipment controls, electrical devices, outlets, switch covers and similar items prior to painting. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

3. No exterior painting should be done immediately after a rain, during foggy weather, when rain is predicted, high winds or when the temperature is below 50 degrees F (10 degrees C), unless products are designed specifically for these conditions. On large expanses of metal siding, the air, surface and material temperatures must be 50 degrees F (10 degrees F) or higher to use low temperature products. Products used must be appropriate for application and climate of Southern Nevada.

B. Aluminum: Remove all oil, grease, dirt, oxide and other foreign material by cleaning per SSPC-SP1, Solvent Cleaning.

C. Block (Cinder and Concrete): Remove all loose mortar and foreign material.
must be free of laitance, concrete dust, dirt, form release agents, moisture curing membranes, loose cement, and hardeners. Concrete and mortar must be cured at least 30 days at 75 degrees F (24 degrees C). The pH of the surface should be between 6 and 9, unless the products are designed to be used in high pH environments.

Concrete, SSPC-SP13 or NACE 6: This standard gives requirements for surface preparation of concrete by mechanical, chemical, or thermal methods prior to the application of bonded protective coating or lining systems. The requirements of this standard are applicable to all types of cementitious surfaces including cast-in-place concrete floors and walls, precast slabs, masonry walls, and shotcrete surfaces. An acceptable prepared concrete surface should be free of contaminants, laitance, loosely adhering concrete, and dust, and should provide a sound, uniform substrate suitable for the application of protective coating or lining systems.

D. Galvanized Metal: Clean per SSPC-SP1 using detergent and water or a degreasing cleaner to remove greases and oils. Apply a test area, priming as required. Allow the coating to dry at least one week before testing. If adhesion is poor, Brush Blast per SSPC-SP7 is necessary to remove these treatments.

E. Steel: Structural, Plate, And Similar Items: Should be cleaned by one or more of the surface preparations described below. These methods are used throughout the world for describing methods for cleaning structural steel. Visual standards are available through the Society of Protective Coatings. A brief description of these standards together with numbers by which they can be specified follow.
1. Solvent Cleaning, SSPC-SP1: Solvent cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants. Solvent cleaning does not remove rust or mill scale. Change rags and cleaning solution frequently so that deposits of oil and grease are not spread over additional areas in the cleaning process. Be sure to allow adequate ventilation.
2. Hand Tool Cleaning, SSPC-SP2: Hand Tool Cleaning removes all loose mill scale, loose rust, and other detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Before hand tool cleaning, remove visible oil, grease, soluble welding residues, and salts by the methods outlined in SSPC-SP1.
3. Power Tool Cleaning, SSPC-SP3: Power Tool Cleaning removes all loose mill scale, loose rust, and other detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Before power tool cleaning, remove visible oil, grease, soluble welding residues, and salts by the methods outlined in SSPC-SP1.
4. Power Tool Cleaning to Bare Metal, SSPC-SP11: Metallic surfaces that are prepared according to this specification, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxide corrosion products, and other foreign matter. Slight residues of rust and paint may be left in the lower portions of pits if the original surface is pitted. Prior to power tool surface preparation, remove visible deposits of oil or grease by any of the methods specified in SSPC-SP1, Solvent Cleaning, or other agreed upon methods.
3.3 INSTALLATION

A. Apply all coatings and materials with the manufacturer's specifications in mind. Mix and thin coatings according to manufacturer's recommendations.

B. Do not apply to wet or damp surfaces. Wait at least 30 days before applying to new concrete or masonry. Or follow manufacturer's procedures to apply appropriate coatings prior to 30 days. Test new concrete for moisture content. Wait until wood is fully dry after rain or morning fog or dew.

C. Apply coatings using methods recommended by manufacturer.

D. Uniformly apply coatings without runs, drips, or sags, without brush marks, and with consistent sheen.

E. Apply coatings at spreading rate required to achieve the manufacturers recommended dry film thickness.

F. Regardless of number of coats specified, apply as many coats as necessary for complete hide, and uniform appearance.

G. Inspection: The coated surface must be inspected and approved by the Architect or RTC representative just prior to the application of each coat.

3.4 PROTECTION

A. Protect finished coatings from damage until completion of project.

B. Touch-up damaged coatings after substantial completion, following manufacturer's recommendation for touch up or repair of damaged coatings. Repair any defects that will hinder the performance of the coatings.

END OF SECTION
SECTON 26 05 11 - REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION
A. This section applies to all sections of Division 26.
B. Furnish and install electrical systems, materials, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, conductors and cable, switchboards, switchgear, panelboards, motor control centers, generators, automatic transfer switches, and other items and arrangements for the specified items are shown on the drawings.
C. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system and obtain electric utility company approval for sizes and settings of these devices.
D. Conductor ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways sized per NEC. Aluminum conductors are not acceptable.

1.2 MINIMUM REQUIREMENTS
A. The International Building Code (IBC), National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL), and National Fire Protection Association (NFPA) codes and standards are the minimum requirements for materials and installation. Applicable Editions shall be as adopted by the local jurisdiction at the time the permit for the project is issued.
B. The drawings and specifications shall govern in those instances where requirements are greater than those stated in the above codes and standards.

1.3 TEST STANDARDS
A. All materials and equipment shall be listed, labeled, or certified by a Nationally Recognized Testing Laboratory (NRTL) to meet applicable Underwriters Laboratories, Inc. (UL), standards.
B. Definitions:
   1. Listed: Materials and equipment included in a list published by an organization that is acceptable to the Authority Having Jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production or listed materials and equipment or periodic evaluation of services, and whose listing states that the materials and equipment either meets appropriate designated standards or has been tested and found suitable for a specified purpose.
   2. Labeled: Materials and equipment to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the Authority Having Jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled materials and equipment, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
   3. Certified: Materials and equipment which:
a. Have been tested and found by a NRTL to meet nationally recognized standards or to be safe for use in a specified manner.

b. Are periodically inspected by a NRTL.

c. Bear a label, tag, or other record of certification.

4. Nationally Recognized Testing Laboratory: Testing laboratory which is recognized and approved by the Secretary of Labor in accordance with OSHA regulations.

1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)

A. Manufacturer’s Qualifications: The manufacturer shall regularly and currently produce, as one of the manufacturer’s principal products, the materials and equipment specified for this project, and shall have manufactured the materials and equipment for at least five years.

B. Product Qualification:

1. Manufacturer’s materials and equipment shall have been in satisfactory operation, on three installations of similar size and type as this project, for at least five years.

2. The Owner’s Representative reserves the right to require the Contractor to submit a list of installations where the materials and equipment have been in operation before approval.

C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.5 APPLICABLE PUBLICATIONS

A. Applicable publications listed in all Sections of Division 26 are the issue adopted by the Authority Having Jurisdiction at the time the permit for the project is issued, unless otherwise noted. If no issue of a publication has been explicitly adopted by the Authority Having Jurisdiction, the latest publication date of the publication, at the time the Contractor’s bid is submitted, shall be used.

B. Products specified in all sections of Division 26 shall comply with the applicable publications listed in each section.

1.6 MANUFACTURED PRODUCTS

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, and for which replacement parts shall be available. Materials and equipment furnished shall be new, and shall have superior quality and freshness.

B. When more than one unit of the same class or type of materials and equipment is required, such units shall be the product of a single manufacturer.

C. Equipment Assemblies and Components:

1. Components of an assembled unit need not be products of the same manufacturer.

2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.

3. Components shall be compatible with each other and with the total assembly for the intended service.
4. Constituent parts which are similar shall be the product of a single manufacturer.

D. Factory wiring and terminals shall be identified on the equipment being furnished and on all wiring diagrams.

E. When Factory Tests are specified, Factory Tests shall be performed in the factory by the equipment manufacturer, and witnessed by the contractor. In addition, the following requirements shall be complied with:

1. The Project Manager shall have the option of witnessing factory tests. The Contractor shall notify the Project Manager a minimum of thirty (30) days prior to the manufacturer’s performing of the factory tests and allow witnessing of the tests by the Project Manager if desired.

2. When factory tests are successful, contractor shall furnish PDFs of the equipment manufacturer’s certified test reports to the Project Manager fourteen (14) days prior to shipment of the equipment, and not more than ninety (90) days after completion of the factory tests.

3. When factory tests are not successful, factory tests shall be repeated in the factory by the equipment manufacturer, and witnessed by the Contractor. The Contractor shall be liable for all additional expenses for re-testing.

1.7 VARIATIONS FROM CONTRACT REQUIREMENTS

A. Where the Project Manager or the Contractor requests variations from the contract requirements, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods. If modifications to the Construction Documents are required due to a change initiated by the Contractor, the contractor shall reimburse the Engineer for the costs of such modifications.

1.8 MATERIALS AND EQUIPMENT PROTECTION

A. Materials and equipment shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.

1. Store materials and equipment in a clean dry space, with uniform temperature to prevent condensation, acceptable to the Owner’s Representative.

2. During installation, equipment shall be protected against entry of foreign matter, and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.

3. Damaged equipment shall be repaired or replaced, as determined by the Owner’s Representative.

4. Painted surfaces shall be protected with factory installed removable heavy Kraft paper, sheet vinyl or equal.

5. Damaged paint on equipment shall be repaired with the same quality of paint and workmanship as used by the equipment manufacturer, applied to the satisfaction of the Owner’s Representative.

1.9 WORK PERFORMANCE

A. All electrical work shall comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 sub part J – General Environmental Controls, OSHA Part
1910 sub part K – Medical and First Aid, and OSHA Part 1910 sub part S – Electrical, in addition to other references required by contract.

B. Job site safety and worker safety is the responsibility of the Contractor.

C. Electrical work shall be accomplished with all affected circuits or equipment de-energized.

D. For work that affects existing electrical systems, schedule work to assure minimal interference with normal functioning of the facility. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.

E. New work shall be installed and connected to existing work in a workman-like manner. Disturbed or damaged work shall be replaced or repaired to its prior condition, as required by Section 01 00 00, GENERAL REQUIREMENTS.

F. Coordinate location of equipment and conduit with other trades to minimize interference.

1.10 EQUIPMENT INSTALLATION AND REQUIREMENTS

A. Equipment location shall be as close as practical to locations shown on the drawings.

B. Working clearances shall not be less than specified in the NEC.

C. Inaccessible Equipment:

1. Where the Owner's Representative determines that the Contractor has installed equipment not readily accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Owner.

2. "Readily accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, duct work, conduit and raceways.

1.11 EQUIPMENT IDENTIFICATION

A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance of items such as switchboards and switchgear, panelboards, cabinets, motor controllers, fused and non-fused safety switches, generators, automatic transfer switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.

B. Identification signs for equipment shall be laminated white phenolic resin with a black core with engraved lettering. Lettering shall be a minimum of 12 mm (1/2 inch) high. Identification signs shall indicate equipment designation, rated bus amperage, voltage, number of phases, and number of wires. Secure nameplates with stainless steel screws.

C. Install adhesive arc flash warning labels on all equipment as required by NFPA 70E. Label shall show specific and correct information for specific equipment based on its arc flash calculations. Obtain Arc Flash calculations for the existing Service Switchboards (SESs) and for downstream switchboards from the SES equipment manufacturer. Labels shall show the following:

1. Nominal system voltage.

2. Arc flash boundary (inches).
3. Available arc flash incident energy at the corresponding working distance (calories/cm²).
4. Required PPE category and description.
5. Limited approach distance (inches), restricted approach distance (inches).
6. Equipment/bus name, date prepared, and manufacturer name and address.

1.12 SUBMITTALS

A. Submit to the Owner's Representative, in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. The Owner's Representatives approval shall be obtained for all materials and equipment before delivery to the job site. Delivery, storage or installation of materials and equipment which has not had prior approval will not be permitted.

C. All submittals shall be in electronic format (PDFs) of adequate descriptive literature, catalog cuts, shop drawings, test reports, certifications, samples, and other data necessary for the Owner's Representative to ascertain that the proposed materials and equipment comply with drawing and specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify specific materials and equipment being submitted.

D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
   1. Mark the submittals, "SUBMITTED UNDER SECTION ________________ ".
   2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
   3. Submit each section separately.

E. The submittals shall include the following:
   1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, manuals, pictures, nameplate data, and test reports as required.
   2. Submittal information indicating, explicitly, the installation requirements necessary for the specific Seismic Zone where the equipment will be mounted. These requirements shall be part of the NRTL Listing documentation for the equipment.
   3. Elementary and interconnection wiring diagrams for communication and signal systems, control systems, and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
   4. Parts list which shall include information for replacement parts and ordering instructions, as recommended by the equipment manufacturer.

F. Maintenance and Operation (O&M) Manuals:
   1. Submit as required for systems and equipment specified in the technical sections. Furnish in hardcover binders or an approved equivalent.
   2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, material, equipment, building, name of Contractor, and contract name and number. Include in the manual
the names, addresses, and telephone numbers of each subcontractor installing the system or equipment. The format of the O&M Manual cover for each system shall be consistent across all systems and be approved by the Owner's Representative.

3. Provide a table of contents and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.

4. The manuals shall include:
   a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
   b. A control sequence describing start-up, operation, and shutdown.
   c. Description of the function of each principal item of equipment.
   d. Installation instructions.
   e. Safety precautions for operation and maintenance.
   f. Diagrams and illustrations.
   g. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers.
   h. Performance data.
   i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare and replacement parts, and name of servicing organization.
   j. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.

G. Approvals will be based on complete submission of shop drawings, manuals, test reports, certifications, and samples as applicable.

H. After approval and prior to installation, furnish the Owner's Representative with one sample of each of the following:
   1. A minimum 300 mm (12 inches) length of each type and size of wire and cable along with the tag from the coils or reels from which the sample was taken. The length of the sample shall be sufficient to show all markings provided by the manufacturer.

1.13 SINGULAR NUMBER
   A. Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.14 ACCEPTANCE CHECKS AND TESTS
   A. The Contractor shall furnish the instruments, materials, and labor for tests.
   B. Where systems are comprised of components specified in more than one section of Division 26, the Contractor shall coordinate the installation, testing, and adjustment of all components between various manufacturer's representatives and technicians so that a complete, functional, and operational system is delivered to the Project Manager.
C. When test results indicate any defects, the Contractor shall repair or replace the defective materials or equipment, and repeat the tests. Repair, replacement, and retesting shall be accomplished at no additional cost to the Owner.

1.15 WARRANTY

A. All work performed and all equipment and material furnished under this Division shall be free from defects and shall remain so for a period of one year from the date of acceptance of the entire installation by the Owners Representative.

1.16 INSTRUCTION

A. Instruction to designated Government personnel shall be provided for the particular equipment or system as required in each associated technical specification section.

B. Furnish the services of competent and factory-trained instructors to give full instruction in the adjustment, operation, and maintenance of the specified equipment and system, including pertinent safety requirements. Instructors shall be thoroughly familiar with all aspects of the installation, and shall be factory-trained in operating theory as well as practical operation and maintenance procedures.

C. A training schedule shall be developed and submitted by the Contractor and approved by the Owners Representative at least 30 days prior to the planned training.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

---END---
SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION
A. This section specifies the furnishing, installation, connection, and testing of the electrical conductors and cables for use in electrical systems rated 600 V and below, indicated as cable(s), conductor(s), wire, or wiring in this section.

1.2 RELATED WORK
A. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire-resistant rated construction.
B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for conductors and cables.
E. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Installation of conductors and cables in manholes and ducts.

1.3 QUALITY ASSURANCE
A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS
A. Conductors and cables shall be thoroughly tested at the factory per applicable NEMA standards to ensure that there are no electrical defects. Factory tests shall be certified.

1.5 SUBMITTALS
A. Submit the following, in PDF format, in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
   1. Shop Drawings:
      a. Submit sufficient information to demonstrate compliance with drawings and specifications.
      b. Submit the following data for approval:
         1) Electrical ratings and insulation type for each conductor and cable.
         2) Splicing materials and pulling lubricant.
   2. Certifications: Two weeks prior to final inspection, submit the following.
      a. Certification by the manufacturer that the conductors and cables conform to the requirements of the drawings and specifications.
      b. Certification by the Contractor that the conductors and cables have been properly installed, adjusted, and tested.
1.6 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by designation only.

B. American Society of Testing Material (ASTM):
   - D2301-10 Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
   - D2304-10 Test Method for Thermal Endurance of Rigid Electrical Insulating Materials
   - D3005-10 Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

C. National Electrical Manufacturers Association (NEMA):
   - WC 70-09 Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy

D. National Fire Protection Association (NFPA):
   - 70-11 National Electrical Code (NEC)

E. Underwriters Laboratories, Inc. (UL):
   - 44-10 Thermoset-Insulated Wires and Cables
   - 83-08 Thermoplastic-Insulated Wires and Cables
   - 467-07 Grounding and Bonding Equipment
   - 486A-486B-03 Wire Connectors
   - 486C-04 Splicing Wire Connectors
   - 486D-05 Sealed Wire Connector Systems
   - 486E-09 Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
   - 514B-04 Conduit, Tubing, and Cable Fittings

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Conductors and cables shall be in accordance with NEMA, UL, as specified herein, and as shown on the drawings.

B. All circuit conductors shall be copper.

C. Single Conductor and Cable:
   1. No. 12 AWG: Minimum size, except where smaller sizes are specified herein or shown on the drawings.
   2. No. 8 AWG and larger: Stranded.
   3. No. 10 AWG and smaller: Solid; except shall be stranded for final connection to motors, transformers, and vibrating equipment.
4. Insulation: THHN/THWN.

D. Color Code:
1. No. 10 AWG and smaller: Solid color insulation or solid color coating.
2. No. 8 AWG and larger: Color-coded using one of the following methods:
   a. Solid color insulation or solid color coating.
3. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
4. Conductors shall be color-coded as follows:

<table>
<thead>
<tr>
<th>208/120 V</th>
<th>Phase</th>
<th>480/277 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>A</td>
<td>Brown</td>
</tr>
<tr>
<td>Red</td>
<td>B</td>
<td>Orange</td>
</tr>
<tr>
<td>Blue</td>
<td>C</td>
<td>Yellow</td>
</tr>
<tr>
<td>White</td>
<td>Neutral</td>
<td>Gray *</td>
</tr>
</tbody>
</table>
|           |       | * or white with colored (other than green) tracer.

5. Lighting circuit “switch legs”, and 3-way and 4-way switch “traveling wires,” shall have color coding that is unique and distinct (e.g., pink and purple) from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC. Coordinate color coding in the field with the Owners Representative.

2.2 SPLICES

A. Splices shall be in accordance with NEC and UL.

B. Above Ground Splices for No. 10 AWG and Smaller:
1. Solder-less, screw-on, reusable pressure cable type, with integral insulation, approved for copper and aluminum conductors.
2. The integral insulator shall have a skirt to completely cover the stripped conductors.
3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.

C. Above Ground Splices for No. 8 AWG to No. 4/0 AWG:
1. Compression, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.
2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
3. Splice and insulation shall be product of the same manufacturer.
4. All bolts, nuts, and washers used with splices shall be zinc-plated steel.

D. Above Ground Splices for 250 kcmil and Larger:
1. Long barrel “butt-splice” or “sleeve” type compression connectors, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.

2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.

3. Splice and insulation shall be product of the same manufacturer.

E. Underground Splices for No. 10 AWG and Smaller:
   1. Solder less, screw-on, reusable pressure cable type, with integral insulation. Listed for wet locations, and approved for copper and aluminum conductors.
   2. The integral insulator shall have a skirt to completely cover the stripped conductors.
   3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.

F. Underground Splices for No. 8 AWG and Larger:
   1. Mechanical type, of high conductivity and corrosion-resistant material. Listed for wet locations, and approved for copper and aluminum conductors.
   2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
   3. Splice and insulation shall be product of the same manufacturer.

G. Plastic electrical insulating tape: Per ASTM D2304, flame-retardant, cold and weather resistant.

2.3 CONNECTORS AND TERMINATIONS

A. Mechanical type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.

B. Long barrel compression type of high conductivity and corrosion-resistant material, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.

C. All bolts, nuts, and washers used to connect connections and terminations to bus bars or other termination points shall be zinc-plated steel.

2.4 CONTROL WIRING

A. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified herein, except that the minimum size shall be not less than No. 14 AWG, except where explicitly-noted otherwise on the drawings.

B. Control wiring shall be sized such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

2.5 WIRE LUBRICATING COMPOUND

A. Lubricating compound shall be suitable for the wire insulation and conduit, and shall not harden or become adhesive.
PART 3 - EXECUTION

3.1 GENERAL

A. Install conductors in accordance with the NEC, as specified, and as shown on the drawings.

B. Install all conductors in raceway systems.

C. Splice conductors only in outlet boxes, junction boxes, pull boxes, manholes, or hand holes.

D. Conductors of different systems (e.g., 120 V and 277 V) shall not be installed in the same raceway.

E. In panelboards, cabinets, wireways, switches, enclosures, and equipment assemblies, neatly form, train, and tie the conductors with non-metallic ties.

F. For connections to motors, transformers, and vibrating equipment, stranded conductors shall be used only from the last fixed point of connection to the motors, transformers, or vibrating equipment.

G. Conductor and Cable Pulling:
   1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling. Use lubricants approved for the cable.
   2. Use nonmetallic pull ropes.
   3. Attach pull ropes by means of either woven basket grips or pulling eyes attached directly to the conductors.
   4. All conductors in a single conduit shall be pulled simultaneously.
   5. Do not exceed manufacturer’s recommended maximum pulling tensions and sidewall pressure values.

H. When stripping stranded conductors, use a tool that does not damage the conductor or remove conductor strands.

3.2 INSTALLATION IN HANDHOLES

A. Train the cables around the hand hole walls, but do not bend to a radius less than six times the overall cable diameter.

3.3 SPLICE AND TERMINATION INSTALLATION

A. Splices and terminations shall be mechanically and electrically secure, and tightened to manufacturer’s published torque values using a torque screwdriver or wrench.

B. Where the Owners Representative determines that unsatisfactory splices or terminations have been installed, replace the splices or terminations at no additional cost to the Owner.

3.4 CONDUCTOR IDENTIFICATION

A. Provide labels for each circuit conductor at every accessible point, including in control panels, distribution panelboards, switchboards, pull boxes and hand holes. Labels shall match identification on the drawings and be approved by the Owner’s Representative.

3.5 EXISTING CONDUCTORS

A. Unless specifically indicated on the plans, existing conductors shall not be reused.
3.6 CONTROL WIRING INSTALLATION
   A. Unless otherwise specified in other sections, install control wiring and connect to equipment to perform the required functions as specified or as shown on the drawings.

3.7 CONTROL WIRING IDENTIFICATION
   A. Install a permanent wire marker on each wire at each termination and accessible point.
   B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
   C. Wire markers shall retain their markings after cleaning.

3.8 ACCEPTANCE CHECKS AND TESTS
   A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
      2. Electrical tests:
         a. After installation but before connection to utilization devices, such as fixtures, motors, or appliances, test conductors phase-to-phase and phase-to-ground resistance with an insulation resistance tester. Existing conductors to be reused shall also be tested.
         b. Applied voltage shall be twice the system voltage plus 1000 volts DC. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300 V rated cable and 100 megohms for 600 V rated cable.
         c. Perform phase rotation test on all three-phase circuits.

---END---
SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of grounding and bonding equipment, indicated as grounding equipment in this section.

B. “Grounding electrode system” refers to grounding electrode conductors and all electrodes required or allowed by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.

C. The terms “connect” and “bond” are used interchangeably in this section and have the same meaning.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.

C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.

D. Section 26 22 00, LOW-VOLTAGE TRANSFORMERS: Low-voltage transformers.

E. Section 26 23 00, LOW-VOLTAGE SWITCHGEAR: Low-voltage switchgear.

F. Section 26 24 13, DISTRIBUTION SWITCHBOARDS: Low-voltage distribution switchboards.

G. Section 26 24 16, PANELBOARDS: Low-voltage panelboards.

H. Section 26 32 13, ENGINE GENERATORS: Engine generators.

I. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Automatic transfer switches.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit the following in PDF format, in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1. Shop Drawings:
   a. Submit sufficient information to demonstrate compliance with drawings and specifications.

   b. Submit plans showing the location of system grounding electrodes and connections, and the routing of above-ground and underground grounding electrode conductors.

2. Test Reports:
   a. Two weeks prior to the final inspection, submit ground resistance field test reports to the Owners Representative.
3. Certifications:
   a. Certification by the Contractor that the grounding equipment has been properly installed and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. American Society for Testing and Materials (ASTM):
   - B1-07 Standard Specification for Hard-Drawn Copper Wire
   - B3-07 Standard Specification for Soft or Annealed Copper Wire
   - B8-11 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

D. National Fire Protection Association (NFPA):
   - 70-11 National Electrical Code (NEC)
   - 70E-12 National Electrical Safety Code

E. Underwriters Laboratories, Inc. (UL):
   - 44-10 Thermoset-Insulated Wires and Cables
   - 83-08 Thermoplastic-Insulated Wires and Cables
   - 467-07 Grounding and Bonding Equipment

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment grounding conductors shall be insulated stranded copper, except that sizes No. 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors.

B. Bonding conductors shall be bare stranded copper, except that sizes No. 10 AWG and smaller shall be bare solid copper. Bonding conductors shall be stranded for final connection to motors, transformers, and vibrating equipment.

C. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.

D. Insulation: THHN-THWN.

2.2 GROUND RODS

A. Copper clad steel, 0.75 inch diameter by 10 feet long.

B. Quantity of rods shall be as shown on the drawings, and as required to obtain the specified ground resistance.
2.3 CONCRETE ENCASED ELECTRODE
   A. Concrete encased electrode shall be No. 4 AWG bare copper wire, installed per NEC.

2.4 GROUND CONNECTIONS
   A. Below Grade and Inaccessible Locations: Exothermic-welded type connectors.
   B. Above Grade:
      1. Bonding Jumpers: Listed for use with aluminum and copper conductors. For wire sizes No. 8 AWG and larger, use compression-type connectors. For wire sizes smaller than No. 8 AWG, use mechanical type lugs. Connectors or lugs shall use zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
      2. Connection to Canopy Steel: Exothermic-welded type connectors (verify acceptability with Structural Engineer prior to connecting).
      3. Connection to Grounding Bus Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
      4. Connection to Equipment Rack and Cabinet Ground Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Connect to 2"x4" (Nominal) grounding pad brazed to each equipment skid at diagonal corners.
      5. Connection to Equipment CNG Equipment: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Connect to 2"x4" (Nominal) grounding pad brazed to each equipment skid at diagonal corners.

2.6 GROUND TERMINAL BLOCKS
   A. At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

2.7 GROUNDING BUS BAR
   A. Pre-drilled rectangular copper bar with stand-off insulators, minimum 0.25 inch thick x 4 inches high in cross-section, length as shown on the drawings.

PART 3 - EXECUTION
3.1 GENERAL
   A. Install grounding equipment in accordance with the NEC, as shown on the drawings, and as specified herein.
   B. System Grounding:
      1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformer.
      2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
C. Equipment Grounding: Metallic piping, building structural steel, electrical enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

A. Make grounding connections, which are normally buried or otherwise inaccessible, by exothermic weld.

3.3 SECONDARY VOLTAGE EQUIPMENT AND CIRCUITS

A. Switchgear, Switchboards, Unit Substations, Panelboards, Motor Control Centers, Engine-Generators, Automatic Transfer Switches, and other electrical equipment:
   1. Connect the equipment grounding conductors to the ground bus.
   2. Connect metallic conduits by grounding bushings and equipment grounding conductor to the equipment ground bus.

B. Transformers:
   1. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to the ground bar at the service equipment.

3.4 RACEWAY

A. Conduit Systems:
   1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
   2. Non-metallic conduit systems shall contain an equipment grounding conductor.
   3. Metallic conduit that only contains a grounding conductor, and is provided for its mechanical protection, shall be bonded to that conductor at the entrance and exit from the conduit.
   4. Metallic conduits which terminate to an electrical equipment housing shall be provided with grounding bushings. Connect bushings with a equipment grounding conductor to the equipment ground bus.

B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders, and power and lighting branch circuits.

C. Boxes, Cabinets, Enclosures, and Panelboards:
   1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes.
   2. Provide lugs in each box and enclosure for equipment grounding conductor termination.

D. Wireway Systems:
   1. Bond the metallic structures of wireway to provide electrical continuity throughout the wireway system, by connecting a No. 6 AWG bonding jumper at all intermediate metallic enclosures and across all section junctions.
   2. Install insulated No. 6 AWG bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 50 feet.
3. Use insulated No. 6 AWG bonding jumpers to ground or bond metallic wireway at each end for all intermediate metallic enclosures and across all section junctions.

E. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.

F. Ground lighting fixtures to the equipment grounding conductor of the wiring system. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

G. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

3.5 OUTDOOR METALLIC FENCES AROUND ELECTRICAL EQUIPMENT

A. Where existing sections of fencing are added, removed, or relocated, provide a grounding conductor (matching existing size) between fencing parts to ensure existing, relocated, and new sections are electrically continuous.

3.6 CORROSION INHIBITORS

A. When making grounding and bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.7 CONDUCTIVE PIPING

A. Bond all conductive piping systems to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

3.8 GROUND RESISTANCE

A. Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications or additions to the grounding electrode system necessary for compliance without additional cost to the Owner. Final tests shall ensure that this requirement is met.

B. Grounding system resistance shall comply with the electric utility company ground resistance requirements.

3.9 GROUND ROD INSTALLATION

A. For outdoor installations, drive each rod vertically in the earth, until top of rod is 610 mm (24 inches) below final grade.

B. Where buried or permanently concealed ground connections are required, make the connections by the exothermic process, to form solid metal joints. Make accessible ground connections with mechanical pressure-type ground connectors.

C. Where rock or impenetrable soil prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified ground resistance.

3.10 ACCEPTANCE CHECKS AND TESTS

A. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
B. Below-grade connections shall be visually inspected by the Owners Representative prior to backfilling. The Contractor shall notify the Owners Representative 24 hours before the connections are ready for inspection.

---END---
SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION
A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes, to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.
B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

1.2 RELATED WORK
A. Section 07 60 00, FLASHING AND SHEET METAL: Fabrications for the deflection of water away from the building envelope at penetrations.
B. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
C. Section 07 92 00, JOINT SEALANTS: Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.
D. Section 09 91 00, PAINTING: Identification and painting of conduit and other devices.
E. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Conduits bracing.
F. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
G. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
H. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Underground conduits.
I. Section 31 20 00, EARTHWORK: Bedding of conduits.

1.3 QUALITY ASSURANCE
Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 APPLICABLE PUBLICATIONS
A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. American National Standards Institute (ANSI):
C80.1-05  Electrical Rigid Steel Conduit
C80.3-05  Steel Electrical Metal Tubing
C80.6-05  Electrical Intermediate Metal Conduit

C. National Fire Protection Association (NFPA):
   70-11  National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL):
   1-05  Flexible Metal Conduit
   5-11  Surface Metal Raceway and Fittings
   6-07  Electrical Rigid Metal Conduit - Steel
   50-95 Enclosures for Electrical Equipment
   360-13 Liquid-Tight Flexible Steel Conduit
   467-13 Grounding and Bonding Equipment
   514A-13 Metallic Outlet Boxes
   514B-12 Conduit, Tubing, and Cable Fittings
   514C-07 Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
   651-11 Schedule 40 and 80 Rigid PVC Conduit and Fittings
   797-07 Electrical Metallic Tubing

E. National Electrical Manufacturers Association (NEMA):
   TC-2-13 Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
   TC-3-13 PVC Fittings for Use with Rigid PVC Conduit and Tubing
   FB1-12 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit,
   Electrical Metallic Tubing and Cable
   FB2.10-13 Selection and Installation Guidelines for Fittings for use
   with Non-Flexible Conduit or Tubing (Rigid Metal Conduit,
   Intermediate Metallic Conduit, and Electrical Metallic
   Tubing)
   FB2.20-12 Selection and Installation Guidelines for Fittings for use
   with Flexible Electrical Conduit and Cable

F. American Iron and Steel Institute (AISI):
   S100-2007 North American Specification for the Design of Cold-
   Formed Steel Structural Members

PART 2 - PRODUCTS
2.1 MATERIAL

A. Conduit Size: In accordance with the NEC, but not less than 19 mm (0.75-inch) unless
   otherwise shown.

B. Conduit:
2. Rigid Steel Conduit (RMC or RGS): Shall conform to UL 6 and ANSI C80.1.

3. Electrical Metallic Tubing (EMT): Shall conform to UL 797 and ANSI C80.3.
   Maximum size not to exceed 105 mm (4 inches) and shall be permitted only with cable rated 600 V or less.

4. Liquid-tight Flexible Metal Conduit: Shall conform to UL 360.

5. Direct Burial Plastic Conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).

C. Conduit Fittings:
   1. Rigid Steel and Intermediate Metallic Conduit Fittings:
      a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
      b. Standard threaded couplings, locknuts, bushings, conduit bodies, and elbows: Only steel or malleable iron materials are acceptable.
      c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
      d. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
      e. Erickson (UnionType) and Set Screw Type Couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
      f. Sealing Fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. Size for maximum 25% fill and, where required, provide a reducing fitting to allow attachment to smaller conduits.
   2. Electrical Metallic Tubing Fittings:
      a. Fittings and conduit bodies shall meet the requirements of UL 514B, ANSI C80.3, and NEMA FB1.
      b. Only steel or malleable iron materials are acceptable.
      c. Compression Couplings and Connectors: Concrete-tight and rain-tight, with connectors having insulated throats.
      d. Indent-type connectors or couplings are prohibited.
      e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
   3. Liquidtight Flexible Metal Conduit Fittings:
      a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
b. Only steel or malleable iron materials are acceptable.

c. Fittings must incorporate a threaded grounding cone, a steel or plastic
   compression ring, and a gland for tightening. Connectors shall have insulated
   throats.

4. Direct Burial Plastic Conduit Fittings: Fittings shall meet the requirements of UL
   514C and NEMA TC3.

5. Expansion and Deflection Couplings:
   a. Conform to UL 467 and UL 514B.
   b. Accommodate a 19 mm (0.75-inch) deflection, expansion, or contraction in any
      direction, and allow 30 degree angular deflections.
   c. Include internal flexible metal braid, sized to guarantee conduit ground continuity
      and a low-impedance path for fault currents, in accordance with UL 467 and the
      NEC tables for equipment grounding conductors.
   d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat-resistant
      molded rubber material with stainless steel jacket clamps.

D. Conduit Supports:
   1. Parts and Hardware: Zinc coat or provide equivalent corrosion protection.
   2. Individual Conduit Hangers: Designed for the purpose, having a preassembled
      closure bolt and nut, and provisions for receiving a hanger rod.
   3. Multiple Conduit (Trapeze) Hangers: Not less than 38 mm x 38 mm (1.5 x 1.5
      inches), 12-gauge steel, cold-formed, lipped channels; with not less than 9 mm
      (0.375-inch) diameter steel hanger rods.
   4. Solid Masonry and Concrete Anchors: Selfdrilling expansion shields, or machine bolt
      expansion.

E. Outlet, Junction, and Pull Boxes:
   1. UL-50 and UL-514A.
   2. Rustproof cast metal where required by the NEC or shown on drawings.
   3. Sheet Metal Boxes: Galvanized steel, except where shown on drawings.

F. Metal Wireways: Equip with hinged covers, except as shown on drawings. Include
   couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and
   other fittings to match and mate with wireways as required for a complete system.

PART 3 - EXECUTION

3.1 PENETRATIONS

A. Cutting or Holes:
   1. Cut holes in advance where they should be placed in the structural elements, such
      as ribs or beams. Obtain the approval of the structural Engineer prior to drilling
through structural elements.

2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammers, impact electric, hand, or manual hammer-type drills are not allowed, except when permitted by the structural Engineer where working space is limited.

B. Firestop: Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING.

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal the gap around conduit to render it watertight, as specified in Section 07 92 00, JOINT SEALANTS.

3.2 INSTALLATION, GENERAL

A. In accordance with UL, NEC, NEMA, as shown on drawings, and as specified herein.

B. Install conduit as follows:

1. In complete mechanically and electrically continuous runs before pulling in cables or wires.

2. Unless otherwise indicated on the drawings or specified herein, installation of all conduits shall be concealed within finished walls, floors, and ceilings.

3. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new conduits.

4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.

5. Cut conduits square, ream, remove burrs, and draw up tight.

6. Independently support conduit at 2.4 M (8 feet) on centers with specified materials and as shown on drawings.

7. Do not use suspended ceilings, suspended ceiling supporting members, lighting fixtures, other conduits, cable tray, boxes, piping, or ducts to support conduits and conduit runs.

8. Support within 300 mm (12 inches) of changes of direction, and within 300 mm (12 inches) of each enclosure to which connected.

9. Close ends of empty conduits with plugs or caps at the roughin stage until wires are pulled in, to prevent entry of debris.

10. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid steel conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to
junction box covers.

11. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.

12. Conduit bodies shall only be used for changes in direction, and shall not contain splices.

13. Do not use aluminum conduits in wet locations.

C. Conduit Bends:
   1. Make bends with standard conduit bending machines.
   2. Conduit hickey may be used for slight offsets and for straightening stubbed out conduits.
   3. Bending of conduits with a pipe tee or vise is prohibited.

D. Layout and Home runs:
   4. Install conduit with wiring, including home runs, as shown on drawings.
   5. Deviations: Make only where necessary to avoid interference and only after drawings showing the proposed deviations have been submitted and approved by the Project Manager.

3.3 CONCEALED WORK INSTALLATION

A. In Concrete:
   1. Conduit: Rigid steel. Do not install EMT in concrete slabs that are in contact with soil, gravel, or vapor barriers.
   2. Align and run conduit in direct lines.
   3. Install conduit through concrete beams only:
      a. Where shown on the structural drawings.
      b. As approved by the structural Engineer prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
   4. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
      a. Conduit outside diameter larger than one-third of the slab thickness is prohibited.
      b. Space between conduits in slabs: Approximately six conduit diameters apart, and one conduit diameter at conduit crossings.
      c. Install conduits approximately in the center of the slab so that there will be a minimum of 19 mm (0.75-inch) of concrete around the conduits.
   5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to ensure low resistance ground continuity through the conduits. Tightening setscrews with pliers is prohibited.

3.4 EXPOSED WORK INSTALLATION
A. Conduit for Conductors 600 V and Below: Rigid steel, IMC, rigid aluminum or EMT.
   Mixing different types of conduits in the system is prohibited.
B. Align and run conduit parallel or perpendicular to structure lines.
C. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
D. Support horizontal or vertical runs at not over 2.4 M (8 feet) intervals.
E. Surface Metal Raceways: Use only where shown on drawings.
F. Painting:
   1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.
   2. Paint above grade sections of PVC conduits.
   3. Paint above grade sections of sealtight flexible metal conduit.

3.5 DIRECT BURIAL INSTALLATION

Refer to Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION.

3.6 HAZARDOUS LOCATIONS

A. Use rigid steel conduit only.
B. Install UL approved sealing fittings that prevent passage of explosive vapors in hazardous areas equipped with explosion-proof lighting fixtures, switches, and receptacles, as required by the NEC.

3.7 WET OR DAMP LOCATIONS

A. Use rigid steel or IMC conduits unless as shown on drawings.
B. Use rigid steel or within 1.5 M (5 feet) of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers, unless as shown on drawings. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely re-coat or re-tape any damaged areas of coating.
C. Conduits run on roof shall be supported with integral galvanized lipped steel channel, attached to UV-inhibited polycarbonate or polypropylene blocks every 2.4 M (8 feet) with 9 mm (3/8-inch) galvanized threaded rods, square washer and locknut. Conduits shall be attached to steel channel with conduit clamps.

3.8 MOTORS AND VIBRATING EQUIPMENT

A. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.
B. Use liquidtight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, inside air stream of HVAC units, and locations subject to seepage or dripping of oil, grease, or water.
C. Provide a green equipment grounding conductor with flexible and liquid-tight flexible metal conduit.
3.9 EXPANSION JOINTS

A. Provide conduits smaller than 75 mm (3 inch) with junction boxes on both sides of the expansion joint. Connect flexible metal conduits to junction boxes with sufficient slack to produce a 125 mm (5 inch) vertical drop midway between the ends of the flexible metal conduit. Flexible metal conduit shall have a green insulated copper bonding jumper installed. In lieu of this flexible metal conduit, expansion and deflection couplings as specified above are acceptable.

B. Seismic Areas: In seismic areas, provide conduits rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 375 mm (15 inches) of slack flexible conduit. Flexible conduit shall have a copper bonding jumper installed.

3.10 CONDUIT SUPPORTS

A. Safe working load shall not exceed one-quarter of proof test load of fastening devices.

B. Use pipe straps or individual conduit hangers for supporting individual conduits.

C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and an additional 90 kg (200 lbs). Attach each conduit with Ubolts or other approved fasteners.

D. Support conduit independently of junction boxes, pull-boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.

E. Fasteners and Supports in Solid Masonry and Concrete:
   1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
   2. Existing Construction:
      a. Steel expansion anchors not less than 6 mm (0.25-inch) bolt size and not less than 28 mm (1.125 inch) in embedment.
      b. Power set fasteners not less than 6 mm (0.25-inch) diameter with depth of penetration not less than 75 mm (3 inch).
      c. Use vibration and shock-resistant anchors and fasteners for attaching to concrete ceilings.

F. Hollow Masonry: Toggle bolts.

G. Bolts supported only by plaster or gypsum wallboard are not acceptable.

H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
K. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.
L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.11 BOX INSTALLATION
A. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operations or where more than the equivalent of 4-90 degree bends are necessary.
B. Locate pull boxes so that covers are accessible and easily removed.
C. Remove only knockouts as required. Plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
D. Minimum size of outlet boxes for ground fault circuit interrupter (GFCI) receptacles is 100 mm (4 inches) square x 55 mm (2.125 inches) deep, with device covers for the wall material and thickness involved.
E. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIGFA JB No. 1."
F. On all branch circuit junction box covers, identify the circuits with black marker.

---END---
SECTION 26 05 41 - UNDERGROUND ELECTRICAL CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of underground ducts and raceways, and precast manholes and pull boxes to form a complete underground electrical raceway system.

B. The terms “duct” and “conduit” are used interchangeably in this section.

1.2 RELATED WORK

A. Section 07 92 00, JOINT SEALANTS: Sealing of conduit penetrations.

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Coordinate layout and installation of ducts, manholes, and pull boxes with final arrangement of other utilities, site grading, and surface features.

1.4 SUBMITTALS

A. Submit the documentation following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1. Shop Drawings:
   a. Submit sufficient information to demonstrate compliance with drawings and specifications.
   b. Submit information on manholes, pull boxes, ducts, and hardware.
   c. Proposed deviations from the drawings shall be clearly marked on the submittals. If it is necessary to locate manholes, pull boxes, or duct banks at locations other than shown on the drawings, show the proposed locations accurately on scaled site drawings, and submit to the Owners Representative for approval prior to construction.

2. Certifications: Two weeks prior to the final inspection, submit the following.
   a. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
   b. Certification by the Contractor that the materials have been properly installed, connected, and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
B. American Concrete Institute (ACI):

Building Code Requirements for Structural Concrete

318-11/318M-11 Building Code Requirements for Structural Concrete & Commentary

SP-66-04 ACI Detailing Manual

C. American National Standards Institute (ANSI):

77-10 Underground Enclosure Integrity

D. American Society for Testing and Materials (ASTM):

C478-12 Standard Specification for Precast Reinforced Concrete Manhole Sections

C858-10e1 Underground Precast Concrete Utility Structures

C990-09 Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants.

E. National Electrical Manufacturers Association (NEMA):

TC 2-03 Electrical Polyvinyl Chloride (PVC) Conduit

TC 3-04 Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit And Tubing

TC 6 & 8-03 Polyvinyl Chloride (PVC) Plastic Utilities Duct For Underground Installations

TC 9-04 Fittings For Polyvinyl Chloride (PVC) Plastic Utilities Duct For Underground Installation

F. National Fire Protection Association (NFPA):

70-11 National Electrical Code (NEC)

G. Underwriters Laboratories, Inc. (UL):

651-11 Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

651A-11 Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit

651B-07 Continuous Length HDPE Conduit

PART 2 - PRODUCTS

2.1 PULL BOXES

A. General: Size as indicated on the drawings. Provide pull boxes with weatherproof, non-skid covers with recessed hook eyes, secured with corrosion- and tamper-resistant hardware. Cover material shall be identical to pullbox material. Covers shall have molded lettering, ELECTRIC.

2.2 DUCTS

A. Number and sizes shall be as shown on the drawings.

B. Ducts (direct-burial):
1. Plastic duct:
   a. Schedule 40 PVC conduit.
   b. Duct shall be suitable for use with 75˚ C (167˚ F) rated conductors.

2.3 GROUNDING
   A. Ground Rods and Ground Wire: Per Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

2.4 WARNING TAPE
   A. 4-mil polyethylene 75 mm (3 inches) wide detectable tape, red with black letters,
      imprinted with “CAUTION - BURIED ELECTRIC CABLE BELOW” or similar.
   B. Individual Spare Conduits: Install a #12 AWG in each spare conduit over its full length.
      Secure it at both ends to prevent movement after installation.

2.5 PULL ROPE FOR SPARE DUCTS
   A. Plastic with 890 N (200 lb) minimum tensile strength.

PART 3 - EXECUTION

3.1 PULLBOX INSTALLATION
   A. Assembly and installation shall be per the requirements of the manufacturer.
      1. Install pull boxes level and plumb.
      2. Units shall be installed on a 300 mm (12 inches) thick level bed of 90% compacted
         granular fill, well-graded from the 25 mm (1 inches) sieve to the No. 4 sieve.
         Granular fill shall be compacted with a minimum of four passes with a plate
         compactor.
   B. Access: Ensure the top of frames and covers are flush with future concrete paving.

3.2 TRENCHING
   A. Before performing trenching work at existing facilities, a Ground Penetrating Radar
      Survey shall be carefully performed by a certified technician to reveal all existing
      underground ducts, conduits, cables, and other utility systems.
   B. Work with extreme care near existing ducts, conduits, and other utilities to avoid
      damaging them.
   C. Cut the trenches neatly and uniformly.
   D. Individual conduits to be installed under existing paved areas and roads that cannot be
      disturbed shall be jacked into place using rigid metal conduit, or bored using plastic
      utilities duct or PVC conduit, as approved by the Owners Representative.

3.3 DUCT INSTALLATION
   A. General Requirements:
      1. Ducts shall be in accordance with the NEC, as shown on the drawings, and as
         specified.
      2. Join and terminate ducts with fittings recommended by the manufacturer.
      3. Slope ducts to drain towards pull boxes, and away from building and equipment
         entrances. Pitch not less than 100 mm (4 inch) in 30 M (100 feet).
4. Stub-ups and sweeps to equipment mounted on outdoor concrete slabs shall be galvanized rigid metal conduit half-lap wrapped with PVC tape.

5. Install insulated grounding bushings on the conduit terminations.

6. Radius for sweeps shall be sufficient to accomplish pulls without damage. Minimum radius shall be six times conduit diameter.

7. All multiple conduit runs shall have conduit spacers. Spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of 75 mm (3 inches) above the bottom of the trench. Spacer spacing shall not exceed 1.5 M (5 feet). Provide nonferrous tie wires to secure spacers to conduits.

8. Duct lines shall be installed no less than 300 mm (12 inches) from other utility systems, such as water, sewer, chilled water.

9. Clearances between individual ducts:
   a. For similar services, not less than 75 mm (3 inches).
   b. For power and signal services, not less than 150 mm (6 inches).

10. Duct lines shall terminate at window openings in manhole walls as shown on the drawings. All ducts shall be fitted with end bells.

11. Couple the ducts with proper couplings. Stagger couplings in rows and layers to ensure maximum strength and rigidity of the duct bank.

12. Keep ducts clean of earth, sand, or gravel, and seal with tapered plugs upon completion of each portion of the work.

13. Spare Ducts: Where spare ducts are shown, they shall have a nylon pull rope and #12 AWG insulated conductor installed. They shall be capped at each end and labeled as to location of the other end.

14. Duct Identification: Place continuous strip of warning tape approximately 300 mm (12 inches) above ducts before backfilling trenches. Warning tape shall be preprinted with proper identification.

16. Duct Sealing: Seal ducts, including spare ducts, at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of foreign objects and material, moisture, and gases.

B. Direct-Burial Ducts:

1. All ducts shall be direct-burial except where concrete encasement is noted on the drawings.

2. Tops of ducts shall be:
   a. Not less than 600 mm (24 inches) and not less than shown on the drawings, below finished grade.
   b. Not less than 750 mm (30 inches) and not less than shown on the drawings, below roads and other paved surfaces.
   c. Additional burial depth shall be required in order to accomplish NEC-required minimum bend radius of ducts.

3. Do not kink the ducts. Compaction shall not deform the ducts.
3.4 ACCEPTANCE CHECKS AND TESTS

A. Duct Testing and Cleaning:

1. Upon completion of the duct installation, a standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material left in the duct, and to test for out-of-round conditions.

2. The mandrel shall be not less than 300 mm (12 inches) long, and shall have a diameter not less than 13 mm (0.5 inch) less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The diameter of the brush shall be the same as, or slightly larger than, the diameter of the duct.

3. If testing reveals obstructions or out-of-round conditions, the Contractor shall replace affected section(s) of duct and retest to the satisfaction of the Owners Representative.

4. Mandrel pulls shall be witnessed by the Owners Representative.
SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION
A. The requirements of this Section apply to all sections of Division 26.
B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

1.2 RELATED WORK
A. Section 01 00 00 GENERAL REQUIREMENTS.
B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY
A. This Section includes requirements for commissioning the Facility electrical systems, related subsystems and related equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS
A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS
A. Commissioning of a system or systems specified in Division 26 is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 26, is required in cooperation with the Project Manager.
B. The Facility electrical systems commissioning will include the systems listed in Section 01 19 00 General Commissioning Requirements:

1.6 SUBMITTALS
A. The commissioning process requires review of selected Submittals that pertain to the systems to be commissioned. The Project Manager will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved.
by the Project Manager prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.

B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)
PART 3 - EXECUTION

3.1 CONSTRUCTION INSPECTIONS
   A. Commissioning of Electrical systems will require inspection of individual elements of the electrical systems construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 19 00 and the Commissioning plan to schedule electrical systems inspections as required to support the Commissioning Process.

3.2 PRE-FUNCTIONAL CHECKLISTS
   A. The Contractor shall complete Pre-functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Equipment Manufacturer will prepare Pre-functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the Project Manager and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and re-submission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and re-submission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.3 CONTRACTORS TESTS
   A. Contractor tests as required by other sections of Division 26 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days’ notice of testing. The Commissioning Agent will witness selected
Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.

3.5 TRAINING OF OWNER'S PERSONNEL

A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Project Manager and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 19 00. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 26 Sections for additional Contractor training requirements.

--- END ---
SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of low-voltage dry-type general-purpose transformers, indicated as transformers in this section.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.

C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit electronic copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1. Shop Drawings:
   a. Submit sufficient information to demonstrate compliance with drawings and specifications.

   b. Include electrical ratings (including impedance voltage), dimensions, mounting details, materials, required clearances, terminations, weight, temperature rise, wiring and connection diagrams, plan, front, side, and rear elevations, accessories, and device nameplate data.

   c. Certification from the manufacturer that representative transformers have been seismically tested to International Building Code requirements. Certification shall be based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data or other methods.

2. Manuals:
   a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals.
1) Include information for testing, repair, troubleshooting, assembly, disassembly, and factory recommended/required periodic maintenance procedures and frequency.

1.5 APPLICABLE PUBLICATIONS

A. National Fire Protection Association (NFPA):
   70-14 National Electrical Code (NEC)

B. National Electrical Manufacturers Association (NEMA):
   TR 1-13 Transformers, Step Voltage Regulators and Reactors
   ST 20-14 Dry Type Transformers for General Applications

C. Underwriters Laboratories, Inc. (UL):
   UL 506-08 Standard for Specialty Transformers
   UL 1561-11 Dry-Type General Purpose and Power Transformers

PART 2 - PRODUCTS

2.1 TRANSFORMERS

A. Unless otherwise specified, transformers shall be in accordance with NEMA, NEC, UL and as shown on the drawings.

B. Transformers shall have the following features:

   1. Self-cooled by natural convection, isolating windings, and outdoor dry-type. Auto-transformers will not be accepted.

   2. Rating and winding connections shall be as shown on the drawings.

   3. Ratings shown on the drawings are for continuous duty without the use of cooling fans.

   4. Copper or Aluminum windings.

   5. Insulation systems:
      a. UL rated 220 °C (428 °F) system with an average maximum rise by resistance of 150 °C (302 °F) in a maximum ambient of 40 °C (104 °F).

   6. Core and coil assemblies:
      a. Rigidly braced to withstand the stresses caused by short-circuit currents and rough handling during shipment.
      b. Cores shall be grain-oriented, non-aging, and silicon steel.
      c. Coils shall be continuous windings without splices except for taps.
      d. Coil loss and core loss shall be minimized for efficient operation.
      e. Primary and secondary tap connections shall be brazed or pressure type.
      f. Coil windings shall have end filters or tie-downs for maximum strength.

   7. Average audible sound levels shall comply with NEMA.
8. If not shown on drawings, nominal impedance shall be as permitted by NEMA.

9. All transformers shall have two 2.5% full capacity taps above, and four 2.5% full capacity taps below normal rated primary voltage.

10. Core assemblies shall be grounded to their enclosures with adequate flexible ground straps.

11. Enclosures:
   a. Comprised of not less than code gauge steel.
   b. Outdoor enclosures shall be NEMA 3R.
   c. Temperature rise at hottest spot shall conform to NEMA Standards, and shall not bake and peel off the enclosure paint after the transformer has been placed in service.
   d. Ventilation openings shall prevent accidental access to live components.
   e. The enclosure at the factory shall be thoroughly cleaned and painted with manufacturer's prime coat and standard finish.

12. Standard NEMA features and accessories, including ground pad, lifting provisions, and nameplate with the wiring diagram and sound level indicated.

13. Dimensions and configurations shall conform to the spaces designated for their installations.


PART 3 - EXECUTION
3.1 INSTALLATION

A. Installation of transformers shall be in accordance with the NEC, as recommended by the equipment manufacturer and as shown on the drawings.

B. Anchor transformers with rustproof bolts, nuts, and washers, in accordance with manufacturer’s instructions, and as shown on drawings.

C. Transformers shall be anchored and braced per manufacturers installation instructions for the seismic area of the project.

D. Exterior Location: Mount transformers on a concrete slab as detailed by the structural Engineer. Provide conduit turn-ups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75 mm (3 inches) above slab surface.

E. Install transformers with manufacturer's recommended clearance from wall and adjacent equipment for air circulation. Minimum clearance shall be 150 mm (6 inches).

F. Install transformers on vibration pads designed to suppress transformer noise and vibrations.
3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform tests in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests:
   a. Compare equipment nameplate data with specifications and approved shop drawings.
   b. Inspect physical and mechanical condition.
   c. Inspect all field-installed bolted electrical connections, using the calibrated torque-wrench method to verify tightness of accessible bolted electrical connections.
   d. Perform specific inspections and mechanical tests as recommended by manufacturer.
   e. Verify correct equipment grounding.
   f. Verify proper secondary phase-to-phase and phase-to-neutral voltage after energizing and prior to connection to loads.

3.3 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks, settings, and tests, the contractor shall demonstrate that the transformers are in good operating condition, and properly performing the intended function.

---END---
SECTION 26 24 16 – PANELBOARDS

PART 1 – GENERAL

1.1 DESCRIPTION
A. This section specifies the furnishing, installation, and connection of panelboards.

1.2 RELATED WORK
A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.

1.3 QUALITY ASSURANCE
A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS
A. Submit electronic copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
   1. Shop Drawings:
      a. Submit sufficient information to demonstrate compliance with drawings and specifications.
      b. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, circuit breakers, wiring and connection diagrams, accessories, and nameplate data.
   2. Manuals:
      a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering circuit breakers and replacement parts.
         1) Include schematic diagrams, with all terminals identified, matching terminal identification in the panelboards.
         2) Include information for testing, repair, troubleshooting, assembly, and disassembly.
      b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.

1.5 APPLICABLE PUBLICATIONS
A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
B. International Code Council (ICC):
C. National Electrical Manufacturers Association (NEMA):
   PB 1-11  Panelboards
   250-08  Enclosures for Electrical Equipment (1,000V Maximum)

D. National Fire Protection Association (NFPA):
   70-11  National Electrical Code (NEC)
   70E-12  Standard for Electrical Safety in the Workplace

E. Underwriters Laboratories, Inc. (UL):
   50-95  Enclosures for Electrical Equipment
   67-09  Panelboards
   489-09  Molded Case Circuit Breakers and Circuit Breaker Enclosures

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Panelboards shall be in accordance with NEC, NEMA, UL, as specified, and as shown on the drawings.

B. Panelboards shall have main breaker or main lugs, bus size, voltage, phases, number of circuit breaker mounting spaces, top or bottom feed, flush or surface mounting, branch circuit breakers, and accessories as shown on the drawings.

C. Panelboards shall be completely factory-assembled with molded case circuit breakers and integral accessories as shown on the drawings or specified herein.

D. Non-reduced size aluminum bus bars, rigidly supported on molded insulators, and fabricated for bolt-on type circuit breakers.

E. Bus bar connections to the branch circuit breakers shall be the “distributed phase” or “phase sequence” type.

F. Mechanical lugs furnished with panelboards shall be cast, stamped, or machined metal alloys listed for use with the conductors to which they will be connected.

G. Neutral bus shall be 100% rated, mounted on insulated supports.

H. Grounding bus bar shall be equipped with screws or lugs for the connection of equipment grounding conductors.

I. Bus bars shall be braced for the available short-circuit current as shown on the drawings, but not be less than 10,000 A symmetrical for 120/208 V and 120/240 V panelboards, and 14,000 A symmetrical for 277/480 V panelboards.

2.2 ENCLOSURES AND TRIMS

A. Enclosures:
   1. Provide galvanized steel enclosures, with NEMA rating as shown on the drawings or as required for the environmental conditions in which installed.
   2. Enclosures shall not have ventilating openings.
   3. Enclosures may be of one-piece formed steel or of formed sheet steel with end and side panels welded, riveted, or bolted as required.
4. Provide manufacturer’s standard option for pre-punched knockouts on top and bottom end walls.

5. Include removable inner dead front cover, independent of the panelboard cover.

B. Trims:
   2. Interior hinged door with hand-operated latch or latches, as required to provide access only to circuit breaker operating handles, not to energized parts.
   3. Outer hinged door shall be securely mounted to the panelboard enclosure with factory bolts, screws, clips, or other fasteners, requiring a key or tool for entry. Hand-operated latches are not acceptable.

2.3 MOLDED CASE CIRCUIT BREAKERS

A. Circuit breakers shall be per UL, NEC, as shown on the drawings, and as specified.

B. Circuit breakers shall be bolt-on type.

D. Circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips.

E. Circuit breaker features shall be as follows:
   1. A rugged, integral housing of molded insulating material.
   2. Silver alloy contacts.
   3. Arc quenchers and phase barriers for each pole.
   4. Quick-make, quick-break, operating mechanisms.
   5. A trip element for each pole, thermal magnetic type with long time delay and instantaneous characteristics, a common trip bar for all poles and a single operator.
   6. Electrically and mechanically trip free.
   7. An operating handle which indicates closed, tripped, and open positions.
   8. An overload on one pole of a multi-pole breaker shall automatically cause all the poles of the breaker to open.
   9. Ground fault current interrupting breakers, shunt trip breakers, lighting control breakers (including accessories to switch line currents), or other accessory devices or functions shall be provided where shown on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the manufacturer’s instructions, the NEC, as shown on the drawings, and as specified.

B. Locate panelboards so that the present and future conduits can be conveniently connected.

C. Panelboards shall be listed for the specific seismic area of installation and shall be installed in strict accordance with the manufacturer’s instructions.
D. Install a printed schedule of circuits in each panelboard after approval by the Owners Representative. Schedules shall reflect final load descriptions connected to each circuit breaker. Schedules shall be printed on the panelboard directory cards and be installed in the appropriate panelboards.

E. Mount panelboards such that the maximum height of the top circuit breaker above the finished floor shall not exceed 1980 mm (78 inches).

F. Provide blank cover for each unused circuit breaker mounting space.

G. Panelboard enclosures shall not be used for conductors feeding through, spliced, or tapping off to other enclosures or devices.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests:
   a. Compare equipment nameplate data with specifications and approved shop drawings.
   b. Inspect physical, electrical, and mechanical condition.
   c. Verify appropriate anchorage and required area clearances.
   d. Verify that circuit breaker sizes and types correspond to approved shop drawings.
   e. To verify tightness of accessible bolted electrical connections, use the calibrated torque-wrench method or perform thermographic survey while energized.

3.3 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks, settings, and tests, the Contractor shall demonstrate that the panelboards are in good operating condition and properly performing the intended function.

---END---
SECTION 26 27 26 - WIRING DEVICES

PART 1 – GENERAL

1.1 DESCRIPTION
A. This section specifies the furnishing, installation, connection and testing of wiring devices.

1.2 RELATED WORK
A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Cables and wiring.
C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.

1.3 QUALITY ASSURANCE
A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS
A. Submit PDF electronic copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1. Shop Drawings:
   a. Submit sufficient information to demonstrate compliance with drawings and specifications.
   b. Include electrical ratings, dimensions, mounting details, construction materials, grade, and termination information.

2. Manuals:
   a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets and information for ordering replacement parts.
   b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.

3. Certifications: Two weeks prior to final inspection, submit the following.
   a. Certification by the manufacturer that the wiring devices conform to the requirements of the drawings and specifications.
b. Certification by the Contractor that the wiring devices have been properly installed and adjusted.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

B. National Fire Protection Association (NFPA):
   70-14 National Electrical Code (NEC)

C. National Electrical Manufacturers Association (NEMA):
   WD 1-10 General Color Requirements for Wiring Devices
   WD 6-12 Wiring Devices – Dimensional Specifications

D. Underwriter’s Laboratories, Inc. (UL):
   20-10 General-Use Snap Switches
   231-08 Power Outlets
   467-13 Grounding and Bonding Equipment
   498-12 Attachment Plugs and Receptacles
   943-15 Ground-Fault Circuit-Interrupters

PART 2 - PRODUCTS

2.1 RECEPTACLES

A. General: All receptacles shall comply with NEMA, NFPA, UL, and as shown on the drawings.

1. Mounting straps shall be nickel plated brass, brass, nickel plated steel or galvanized steel with break-off plaster ears, and shall include a self-grounding feature. Terminal screws shall be brass, plated steel.

2. Receptacles shall have provisions for back wiring with separate metal clamp type terminals (four minimum) and side wiring from four captively held binding screws.

B. Duplex Receptacles - Single phase, 20 ampere, 120 volts, 2-pole, 3-wire, NEMA 5-20R, with break-off feature for two-circuit operation.

1. Bodies shall be ivory in color.

2. Switched duplex receptacles shall be wired so that only the top receptacle is switched. The lower receptacle shall be unswitched.

3. Ground Fault Current Interrupter (GFCI) Duplex Receptacles: Shall be an integral unit suitable for mounting in a standard outlet box. GFCI receptacles shall be self-test receptacles in accordance with UL 943.

   a. Ground fault interrupter shall consist of a differential current transformer, self-test, solid state sensing circuitry and a circuit interrupter switch. Device shall have
nominal sensitivity to ground leakage current of 4-6 milliamperes and shall
function to interrupt the current supply for any value of ground leakage current
above five milliamperes (+ or – 1 milliampere) on the load side of the device.
Device shall have a minimum nominal tripping time of 0.025 second.
b. Self-test function shall be automatically initiated within 5 seconds after power is
activated to the receptacles. Self-test function shall be periodically and
automatically performed every 3 hours or less.
c. End-of-life indicator light shall be a persistent flashing or blinking light to indicate
that the GFCI receptacle is no longer in service.
D. Receptacles; 20, 30, and 50 ampere, 250 Volts: Shall be complete with appropriate cord
grip plug.
E. Weatherproof Receptacles: Shall consist of a duplex receptacle, mounted in box with a
gasketed, weatherproof, cast metal cover plate and cap over each receptacle opening.
The cap shall be permanently attached to the cover plate and be weatherproof with or
without a plug inserted.

2.2 TOGGLE SWITCHES
A. Toggle switches shall be totally enclosed tumbler type with nylon bodies. Handles shall
be ivory in color unless otherwise specified or shown on the drawings.
  1. Switches shall not be installed in hazardous locations.
  2. Shall be single unit toggle, butt contact, quiet AC type, heavy-duty general-purpose
use with an integral self grounding mounting strap with break-off plaster ears and
provisions for back wiring with separate metal wiring clamps and side wiring with
captively held binding screws.
  3. Switches shall be rated 20 amperes at 120-277 Volts AC.

2.3 WALL PLATES
A. Wall plates for switches and receptacles shall be steel. Oversize plates are not
acceptable.
B. Color shall be ivory unless otherwise specified.
C. For receptacles or switches mounted adjacent to each other, wall plates shall be
common for each group of receptacles or switches.

PART 3 - EXECUTION
3.1 INSTALLATION
A. Installation shall be in accordance with the NEC and as shown as on the drawings.
B. Install wiring devices after wall construction and painting is complete.
C. The ground terminal of each wiring device shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the branch circuit equipment grounding conductor.

D. Outlet boxes for toggle switches shall be mounted as desired by the owner, but outside of any hazardous area.

E. Provide barriers in multi-gang outlet boxes to comply with the NEC.

F. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with box openings aligned with the face of the surrounding finish material.

G. Install wall switches 1.2 M (48 inches) above floor, with the toggle OFF position down.

H. Install receptacles 450 mm (18 inches) above grade. Install specific-use receptacles at heights shown on the drawings.

J. When required or recommended by the manufacturer, use a torque screwdriver. Tighten unused terminal screws.

K. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform manufacturer's required field checks in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests:
   a. Inspect physical and electrical condition.
   c. Test wiring devices for damaged conductors, high circuit resistance, poor connections, inadequate fault current path, defective devices, or similar problems using a portable receptacle tester. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.
   d. Test GFCI receptacles.

---END---
SECTION 26 36 23 - AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of open-transition automatic transfer switches with bypass isolation, indicated as automatic transfer switches or ATS in this section.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.

C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personal safety and to provide a low impedance path for possible ground fault currents.

D. Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.

1.3 QUALITY ASSURANCE

A. QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. A factory-authorized representative shall be capable of providing emergency maintenance and repairs at the project site within 24 hours maximum of notification.

1.4 FACTORY TESTS

A. Automatic transfer switches shall be thoroughly tested at the factory to ensure that there are no electrical or mechanical defects. Tests shall be conducted per UL standards. Factory tests shall be certified, and shall include the following tests:

1. Visual inspection to verify that each ATS is as specified.
2. Mechanical test to verify that ATS sections are free of mechanical hindrances.
3. Insulation resistance test to ensure electrical integrity and continuity of entire system.
4. Main switch contact resistance test.
5. Electrical tests to verify complete system electrical operation.

B. Furnish electronic copies of certified manufacturer's factory test reports to the Owners Representative prior to shipment of the ATS to ensure that the ATS has been successfully tested as specified.

1.5 SUBMITTALS

A. Submit electronic copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1. Shop Drawings:
a. Submit sufficient information to demonstrate compliance with drawings and specifications and acceptability for the seismic area of installation.

b. Include voltage rating, continuous current rating, number of phases, withstand and closing rating, dimensions, weights, mounting details, conduit entry provisions, front view, side view, equipment and device arrangement, elementary and interconnection wiring diagrams, factory relay settings, and accessories.

c. Complete nameplate data, including manufacturer’s name and catalog number.

d. A copy of the markings that are to appear on the automatic transfer switches when installed.

e. Certification from the manufacturer that representative ATS have been seismically tested to International Building Code requirements. Certification shall be based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data or other methods.

2. Manuals:

a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.

   1) Schematic signal and control diagrams, with all terminals identified, matching terminal identification in the automatic transfer switches.

   2) Include information for testing, repair, troubleshooting, assembly, disassembly, and factory recommended/required periodic maintenance procedures and frequency.

   3) Provide a replacement and spare parts list. Include a list of tools and instruments for testing and maintenance purposes.

b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.

   1) Include complete "As Installed" diagrams that indicate all pieces of equipment and their interconnecting wiring.

   2) Include complete diagrams of the internal wiring for each piece of equipment, including "As Installed" revisions of the diagrams.

   3) The wiring diagrams shall identify the terminals to facilitate installation, maintenance, operation, and testing.

3. Certifications:

a. When submitting the shop drawings, submit a certified test report from a recognized independent testing laboratory that a representative sample has passed UL 1008 prototype testing.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. Institute of Electrical and Electronic Engineers (IEEE):
446-95 Emergency and Standby Power Systems for Industrial and Commercial Applications

C37.90.1-02 Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

C62.41.1-02 Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits

C62.41.2-02 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

C. International Code Council (ICC):
   IBC-12 International Building Code

D. National Electrical Manufacturers Association (NEMA):
   250-08 Enclosures for Electrical Equipment (1000 Volts Maximum)
   ICS 6-06 Enclosures
   ICS 4-10 Application Guideline for Terminal Blocks
   MG 1-11 Motors and Generators

E. National Fire Protection Association (NFPA):
   70–11 National Electrical Code (NEC)
   110-10 Emergency and Standby Power Systems

F. Underwriters Laboratories, Inc. (UL):
   50-95 Enclosures for Electrical Equipment
   508-99 Industrial Control Equipment
   891-07 Switchboards
   1008-07 Transfer Switch Equipment

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Automatic transfer switches shall comply with UL, NEMA, NEC, ANSI, IEEE, and NFPA, and have the following features:

1. Automatic transfer switches shall be open transition switches, 4-pole, fixed mounting, electrically operated, mechanically held open contact type, with integral overcurrent protection.

2. Automatic transfer switches shall be completely factory-assembled and wired such that only external circuit connections are required in the field.

3. Each automatic transfer switch shall be equipped with an integral bypass/isolation switch.

4. Ratings:
   a. Phases, voltage, continuous current, poles, and withstand and closing ratings shall be as shown on the drawings.
b. Transfer switches are to be rated for continuous duty at specified continuous current rating on 60Hz systems.

c. Maximum automatic transfer switch rating: 2000 A.

5. Markings:
   a. Markings shall be in accordance with UL 1008.

6. Tests:
   a. Automatic transfer switches shall be tested in accordance with UL 1008. The contacts of the transfer switch shall not weld during the performance of withstand and closing tests when used with the upstream overcurrent device and available fault current specified.

7. Surge Withstand Test:
   a. Automatic transfer switches utilizing solid-state devices in sensing, relaying, operating, or communication equipment or circuits shall comply with IEEE C37.90.1.

8. Housing:
   a. Enclose automatic transfer switches in wall- or floor-mounted steel cabinets, with metal gauge not less than No. 14, in accordance with UL 508, or in a switchboard assembly in accordance with UL 891, as shown on the drawings.
   b. Enclosure shall be constructed so that personnel are protected from energized bypass-isolation components during automatic transfer switch maintenance.
   c. Automatic transfer switch components shall be removable without disconnecting external source or load power conductors.
   d. Finish: Cabinets shall be given a phosphate treatment, painted with rust-inhibiting primer, and finish-painted with the manufacturer's standard enamel or lacquer finish.
   e. Viewing Ports: Provide viewing ports so that contacts may be inspected without disassembly.

9. Operating Mechanism:
   a. Actuated by an electrical operator.
   b. Electrically and mechanically interlocked so that the main contact cannot be closed simultaneously in either normal and emergency position.
   c. Normal and emergency main contacts shall be mechanically locked in position by the operating linkage upon completion of transfer. Release of the locking mechanism shall be possible only by normal operating action.
   d. Contact transfer time shall not exceed six cycles.
   e. Operating mechanism components and mechanical interlocks shall be insulated or grounded.

10. Contacts:
    a. Main contacts: Silver alloy.
    b. Neutral contacts: Silver alloy, with the same current rating as phase contacts.
c. Current carrying capacity of arcing contacts shall not be used in the determination of the automatic transfer switch rating, and shall be separate from the main contacts.

d. Main and arcing contacts shall be visible for inspection with cabinet door open and barrier covers removed.

11. Manual Operator:
   a. Capable of operation by one person in either direction under no load.

12. Replaceable Parts:
   a. Include the main and arcing contacts individually or as units, as well as relays, and control devices.
   b. Automatic transfer switch contacts and accessories shall be replaceable from the front without removing the switch from the cabinet and without removing main conductors.

13. Sensing Features:
   a. Under-voltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100% of nominal, and dropout voltage is adjustable from 75 to 98% of pickup value. Factory set for pickup at 90% and dropout at 85%.
   b. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
   c. Voltage/Frequency Lockout Relay: Prevent premature transfer to the engine-generator. Pickup voltage shall be adjustable from 85 to 100% of nominal. Factory set for pickup at 90%. Pickup frequency shall be adjustable from 90 to 100% of nominal. Factory set for pickup at 95%.
   d. Time Delay for Re-transfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained under-voltage of emergency source, provided normal supply has been restored.
   e. Test Switch: Simulate normal-source failure.
   f. Switch-Position Indication: Indicate source to which load is connected.
   g. Source-Available Indication: Supervise sources via transfer switch normal- and emergency-source sensing circuits.
   h. Normal Power Indication: Indicate "Normal Source Available."
   j. Transfer Override Control: Overrides automatic re-transfer control so that automatic transfer switch shall remain connected to emergency power source regardless of condition of normal source. Control panel shall indicate override status.
   k. Engine Starting Contacts: One isolated and normally closed and one isolated and normally open; rated 5 A at 30 V DC minimum.
l. Engine Shutdown Contacts: Time delay adjustable from zero to 15 minutes, and factory set for 5 minutes. Contacts shall initiate shutdown at remote engine-generator controls after re-transfer of load to normal source.

m. Engine-Generator Exerciser: Programmable exerciser starts engine-generator(s) and transfers load to them from normal source for a preset time, then re-transfers and shuts down engine-generator(s) after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period.

14. Controls:

a. Controls shall provide indication of switch status and be equipped with alarm diagnostics.

b. Controls shall control operation of the automatic transfer switches.

15. Factory Wiring: Train and bundle factory wiring and label either by color-code or by numbered/lettered wire markers. Labels shall match those on the shop drawings.

16. Annunciation, Control, and Programming Interface Components: Devices for communicating with remote programming devices, annunciators, or control panels and paralleling switchgear shall have open-protocol communication capability matched with remote device.

17. Motor Disconnect and Timing Relay: Controls designated starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to the automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit in-rush and seal currents are rated for actual currents to be encountered.

2.2 SEQUENCE OF OPERATION

A. The specified voltage decrease in one or more phases of the normal power source shall initiate the transfer sequence. The automatic transfer switch shall start the engine-generator(s) after a specified time delay to permit override of momentary dips in the normal power source.

B. The automatic transfer switch shall transfer the load from normal to emergency standby source when the frequency and voltage of the engine-generator has attained the specified percent of rated value.

C. Transfer to Equipment Branch Loads: Automatic transfer switches for Equipment Branch loads shall transfer their loads to the engine-generator on a time-delayed, staggered basis, after the Emergency System switches have transferred. Only those switches with deficient normal source voltage shall transfer.

D. Re-transfer to Normal (All Loads): Automatic transfer switches shall re-transfer the load from emergency to normal source upon restoration of normal supply in all phases to the specified percent or more of normal voltage, and after a specified time delay. Should the emergency source fail during this time, the automatic transfer switches shall immediately transfer to the normal source whenever it becomes available. After restoring to normal source, the engine-generator(s) shall continue to run unloaded for a specified interval before shut-down.
2.3 BYPASS-ISOLATION SWITCH

A. Provide each automatic transfer switch with two-way bypass-isolation manual type switch. The bypass-isolation switch shall permit load by-pass to either normal or standby power source and complete isolation of the automatic transfer switch, independent of transfer switch position. Bypass and isolation shall be possible under all conditions including when the automatic transfer switch is removed from service.

B. Operation: The bypass-isolation switch shall have provisions for operation by one person through the movement of a maximum of two handles at a common dead front panel in no more than 15 seconds. Provide a lock, which must energize to unlock the bypass switch, to prevent bypassing to a dead source. Provide means to prevent simultaneous connection between normal and standby sources.

1. Bypass to normal (or emergency): Operation of bypass handle shall allow direct connection of the load to the normal (or emergency) source, without load interruption or by using a break-before-make design or provide separate load interrupter contacts to momentarily interrupt the load.
   a. Ensure continuity of auxiliary circuits necessary for proper operation of the system.
   b. A red indicating lamp shall light when the automatic transfer switch is bypassed.
   c. Bypassing source to source: If the power source is lost while in the bypass position, bypass to the alternate source shall be achievable without re-energizing the automatic transfer switch service and load connections.

2. Isolation: Operation of the isolating handle shall isolate all live power conductors to the automatic transfer switch without interruption of the load.
   a. Interlocking: Provide interlocking as part of the bypass-isolation switch to eliminate personnel-controlled sequence of operation, and to prevent operation to the isolation position until the bypass function has been completed.
   b. Padlocking: Include provisions to padlock the isolating handle in the isolated position.
   c. Visual verification: The isolation blades shall be visible in the isolated position.

3. Testing: It shall be possible to test (normal electrical operation) the automatic transfer switch and engine-generator(s) with the isolation contacts closed and the load bypassed without interruption of power to the load.

C. Ratings: The electrical capabilities and ratings of the bypass-isolation switch shall be compatible with those of the associated automatic transfer switch, including any required additional withstand tests.

2.5 CONTROL SYSTEM

A. Include the following functions for indicated automatic transfer switches:

1. Indication of sources available, as defined by actual pickup and dropout settings of automatic transfer switch controls.
2. Indication of automatic transfer switch position.
3. Indication of automatic transfer switch in test mode.
4. Indication of failure of communication link.
5. Key-switch or user-code access to control functions of panel.
6. Control of automatic transfer switch test initiation.
7. Control of automatic transfer switch operation in either direction.
8. Control of time-delay bypass for transfer to normal source.

B. Control system shall include the following features:
   1. Touchscreen type operator interface.
   2. Control and indication means grouped together for each automatic transfer switch.
   3. Mounting: Steel cabinet, flush or surface mounted, as shown on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install automatic transfer switches in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.

B. Anchor automatic transfer switches with rustproof bolts, nuts, and washers not less than 12 mm (1/2 inch) diameter, in accordance with manufacturer’s instructions, and as shown on drawings, including requirements for seismic bracing.

D. Mount automatic transfer switches on concrete slab as specified by the structural Engineer. The top of the concrete slab shall be approximately 100 mm (4 inches) above finished floor. Edges above floor shall have 12.5 mm (1/2 inch) chamfer. The slab shall be of adequate size to project at least 100 mm (8 inches) beyond the equipment. Provide conduit turn-ups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75 mm (3 inches) above slab surface.

3.2 ACCEPTANCE CHECKS AND TESTS

A. An authorized representative of the automatic transfer switch manufacturer shall technically supervise and participate during all of the field adjustments and tests. Major adjustments and field tests shall be witnessed by the Owners Representative. The manufacturer’s representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer’s recommendations.

B. Perform manufacturer’s required field tests in accordance with the manufacturer’s recommendations. In addition, include the following:

   1. Visual Inspection and Tests:
      a. Compare equipment nameplate data with specifications and approved shop drawings.
      b. Inspect physical, electrical, and mechanical condition.
      c. Confirm correct application of manufacturer’s recommended lubricants.
      d. Verify appropriate anchorage, required area clearances, and correct alignment.
      e. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey while energized.
      f. Verify grounding connections.
      g. Verify ratings of sensors.
      h. Vacuum-clean enclosure interior. Clean enclosure exterior.
i. Exercise all active components.

j. Verify that manual transfer warning signs are properly placed.

k. Verify the correct operation of all sensing devices, alarms, and indicating devices.

2. Electrical tests:
   a. Perform insulation-resistance tests.
   b. After energizing circuits, demonstrate the interlocking sequence and operational function for each automatic transfer switch at least three times.
      1) Test bypass-isolation unit functional modes and related automatic transfer switch operations.
      2) Power failure of normal source shall be simulated by opening upstream protective device. This test shall be performed a minimum of five times.
      3) Power failure of emergency source with normal source available shall be simulated by opening upstream protective device for emergency source. This test shall be performed a minimum of five times.
      4) Low phase-to-ground voltage shall be simulated for each phase of normal source.
      5) Operation and settings shall be verified for specified automatic transfer switch operational feature, such as override time delay, transfer time delay, return time delay, engine shutdown time delay, exerciser, auxiliary contacts, and supplemental features.
      6) Verify pickup and dropout voltages by data readout or inspection of control settings.
      7) Verify that bypass and isolation functions perform correctly, including the physical removal of the automatic transfer switch while in bypass mode.
   c. Ground-fault tests: Verify that operation of automatic transfer switches shall not cause nuisance tripping or alarms of ground fault protection on either source.
   d. When any defects are detected, correct the defects and repeat the tests as requested by the Owners Representative at no additional cost to the Owner.

3.3 VERIFY FIELD SETTINGS
A. The automatic transfer switch settings shall be verified in the field by an authorized representative of the manufacturer.

3.4 FOLLOW-UP VERIFICATION
A. Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the automatic transfer switches are in good operating condition and properly performing the intended function.

3.5 INSTRUCTION
A. Furnish the services of a factory-trained technician for one 4-hour training period for instructing personnel in the maintenance and operation of the automatic transfer switches, on the dates requested by the Owners Representative.

---END---
SECTION 26 41 00 – FACILITY LIGHTNING PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION
   A. This section specifies the furnishing and installation of a complete UL master labeled lightning protection system.

1.2 RELATED WORK
   A. Section 07 60 00, FLASHING AND SHEET METAL: Penetrations through the roof.
   B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
   C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground faults.

1.3 QUALITY ASSURANCE
   A. Refer to Paragraph, QUALIFICATIONS, (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS
   A. Submit the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
      1. Shop Drawings:
         a. Submit sufficient information to demonstrate compliance with drawings and specifications.
         b. Show locations of air terminals, connections to required metal surfaces, and grounding means.
         c. Show the mounting hardware and materials used to attach air terminals and conductors to the structure.
      2. Certifications: Two weeks prior to final inspection, submit the following.
         a. Certification by the manufacturer that the lightning protection system conforms to the requirements of the drawings and specifications.
         b. Certification by the Contractor that the lightning protection system has been properly installed and inspected.
         c. Certification that the lightning protection system has been inspected by a UL representative and has been approved by UL without variation.

1.5 APPLICABLE PUBLICATIONS
   A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
B. National Fire Protection Association (NFPA):

70-11 National Electrical Code (NEC)
780-11 Standard for the Installation of Lightning Protection Systems

C. Underwriters Laboratories, Inc. (UL):

96-05 Lightning Protection Components
96A-07 Installation Requirements for Lightning Protection Systems
467-07 Standard for Grounding and Bonding Equipment

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Lightning protection components shall conform to NFPA 780 and UL 96, for use on Class I structures. Aluminum materials are not allowed.

1. Class I conductors: Copper.
2. Class I air terminals: Solid copper, 460 mm (18 inches) long, not less than 9.5 mm (3/8 inch) diameter, with sharp nickel-plated points.
3. Ground rods: Copper-clad steel, 0.75 in (19 mm) diameter by 3 m (10 feet) long.
4. Bonding plates: Bronze, 50 square cm (8 square inches).
5. Through roof connectors: Solid copper riser bar, length and type as required to accommodate roof structure and flashing requirements.
6. Anchors and fasteners: Bronze bolt and clamp type shall be used for all applications except for membrane roof. Adhesive type are allowed only for attachment to membrane roof materials, using adhesive that is compatible with the membrane material.
7. Connectors: Bronze clamp-type connectors shall be used for roof conductor splices, and the connection of the roof conductor to air terminals and bonding plates. Crimp-type connectors are not allowed.
8. Exothermic welds: Exothermic welds shall be used for connection of the ground ring to ground rods and column steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be coordinated with the roofing manufacturer and installer.
B. Install the conductors as inconspicuously as practical.
C. Make connections of dissimilar metal with bimetallic type fittings to prevent electrolytic action.
D. Install ground rods and ground plates not less than 600 mm (2 feet) deep and a distance not less than 900 mm (3 feet) nor more than 2.5 m (8 feet) from the nearest point of the structure. Exothermically weld conductors between ground rods, ground plates, and columns in the presence of the Project Manager.

E. Connect roof conductors to all metallic projections and equipment above the roof as indicated on the drawings.

F. Connect exterior metal surfaces, located within 900 mm (3 feet) of the conductors, to the conductors to prevent flash-overs.

G. Maintain horizontal or downward coursing of main conductor and insure that all bends have at least an 200 mm (8 inches) radius and do not exceed 90 degrees.

H. Conductors shall be rigidly fastened every 900 mm (3 feet) along the roof.

I. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure.

J. Install air terminal bases, cable holders and other roof-system supporting means without piercing membrane or metal roofs.

K. Use through-roof connectors for penetration of the roof system. Flashing shall be provided by canopy contractor in accordance with Section 07 60 00, FLASHING AND SHEET METAL.

L. A counterpoise or ground ring, where shown, shall be of No. 4/0 copper cable having suitable resistance to corrosion and shall be laid around the perimeter of the structure in a trench not less than 600 mm (2 feet) deep at a distance not less than 900 mm (3 feet) nor more than 2.5 M (8 feet) from the nearest point of the structure.

M. Where shown, use the structural steel framework or reinforcing steel as the down conductor.
   1. Weld or bond the non-electrically-continuous sections together and make them electrically continuous.
   2. Verify the electrical continuity by measuring the ground resistances to earth at the ground level, at the top of the canopy structure, and at intermediate points with a sensitive ohmmeter. Compare the resistance readings.
   3. Connect the air terminals together with an exterior conductor connected to the structural steel framework at not more than 18 m (60 foot) intervals.
   4. Install ground connections to earth at not more than 18 m (60 foot) intervals around the perimeter of the structure.
   5. Weld or braze bonding plates to cleaned sections of the steel and connect the conductors to the plates.
6. Do not pierce the structural steel in any manner. Connections to the structural steel shall conform to UL 96A.

N. Where the drawings show the new lightning protection system connected to an existing lightning protection system with or without a UL master label, the new portion of the lightning protection system requires UL inspection and a Letter of Findings.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Test the ground resistance to earth by standard methods and conform to the ground resistance requirements specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

B. A UL representative shall inspect the lightning protection system. Obtain and install a UL numbered master label for each of the lightning protection systems at the location directed by the UL representative and the Project Manager.

---END---
SECTION 26 56 00 – EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION
This section specifies the furnishing, installation, and connection of exterior fixtures, poles, and supports. The terms “lighting fixtures”, “fixture” and “luminaire” are used interchangeably.

1.2 RELATED WORK
A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low voltage power and lighting wiring.
C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits, fittings, and boxes for raceway systems.
E. Section 26 09 23, LIGHTING CONTROLS: Controls for exterior lighting.

1.3 QUALITY ASSURANCE
A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS
A. Submit PDF Electronic copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
   1. Shop Drawings:
      a. Submit the following information for each type of lighting fixture designated on the LIGHTING FIXTURE SCHEDULE, arranged in order of lighting fixture designation.
      b. Material and construction details, include information on housing and optics system.
      c. Physical dimensions and description.
      d. Wiring schematic and connection diagram.
      e. Installation details.
      g. For LED lighting fixtures, submit US DOE LED Lighting Facts label, and IES L70 rated life.
   2. Manuals:
a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.

b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.

3. Certifications: Two weeks prior to final inspection, submit the following.
   a. Certification by the Contractor that the exterior lighting systems have been properly installed and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. Aluminum Association Inc. (AA):
   AAH35.1-06         Alloy and Temper Designation Systems for Aluminum

C. American Society for Testing and Materials (ASTM):
   A123/A123M-12      Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
   A153/A153M-09      Zinc Coating (Hot-Dip) on Iron and Steel Hardware
   B108-03a-08        Aluminum-Alloy Permanent Mold Castings

D. Illuminating Engineering Society of North America (IESNA):
   HB-9-00            Lighting Handbook
   LM-79-08           Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products
   LM-80-08           Approved Method for Measuring Lumen Maintenance of LED Light Sources

E. National Electrical Manufacturers Association (NEMA):
   ICS 2-00 (R2005)   Controllers, Contactors and Overload Relays Rated 600 Volts
   ICS 6-93 (R2006)   Enclosures

F. National Fire Protection Association (NFPA):
   70-11              National Electrical Code (NEC)

G. Underwriters Laboratories, Inc. (UL):
   1598-08            Luminaires
   8750-09..............Light Emitting Diode (LED) Equipment for Use in Lighting Products
PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

Luminaires, materials and equipment shall be in accordance with NEC, UL, ANSI, and as shown on the drawings and specified.

2.2 LUMINAIRES

A. Luminaires shall be weatherproof, heavy duty, outdoor types designed for efficient light utilization, adequate dissipation of lamp and ballast heat, and safe cleaning and re-lamping.

B. Illumination distribution patterns, BUG ratings and cutoff types as defined by the IESNA shall be similar to the fixtures specified on the drawings.

C. Lenses shall be frame-mounted and similar to the fixtures specified on the drawings. Attach the frame to the luminaire housing by hinges or chain. Use heat and aging-resistant, resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

D. Pre-wire internal components to terminal strips at the factory.

E. Materials shall be rustproof. Latches and fittings shall be non-ferrous metal.

F. Provide manufacturer’s standard finish, as scheduled on the drawings.

2.3 LAMPS

A. LED sources shall meet the following requirements:

1. Operating temperature rating shall be between -40 degrees C (-40 degrees F) and 50 degrees C (120 degrees F).

2. Correlated Color Temperature (CCT): 3500K.


4. The manufacturer shall have performed reliability tests on the LEDs luminaires complying with Illuminating Engineering Society (IES) LM79 for photometric performance and LM80 for lumen maintenance and L70 life.

2.4 LED DRIVERS

A. LED drivers shall meet the following requirements:

1. Drivers shall have a minimum efficiency of 85%.

2. Starting Temperature: -40 degrees C (-40 degrees F).

3. Input Voltage: 120 to 480 (±10%) volt.

4. Power Supplies: Class I or II output.

5. Surge Protection: The system must survive 250 repetitive strikes of “C Low” (C Low: 6kV/1.2 x 50 μs, 10kA/8 x 20 μs) waveforms at 1-minute intervals with less than 10% degradation in clamping voltage. “C Low” waveforms are as defined in IEEE/ASNI C62.41.2-2002, Scenario 1 Location Category C.

6. Power Factor (PF): ≥ 0.90.
7. Total Harmonic Distortion (THD): \( \leq 20\% \).
9. Drivers shall be reduction of hazardous substances (ROHS)-compliant.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lighting in accordance with the NEC, as shown on the drawings, and in accordance with manufacturer’s recommendations.

3.2 GROUNDING

Ground non-current-carrying parts of equipment as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS. Where copper grounding conductor is connected to a metal other than copper, provide specially-treated or lined connectors suitable and listed for this purpose.

3.3 ACCEPTANCE CHECKS AND TESTS

Verify operation after installing luminaires and energizing circuits.

---END---
SECTION 280500 - ELECTRONIC SYSTEMS GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Part 1 Includes:

1. Related Documents
2. Summary and related sections
3. References
4. Definitions
5. System Description and General Responsibilities
6. Coordination
7. Quality Assurance
8. Submittals
9. Delivery, Storage, and Handling
10. Site Conditions
11. Sequencing and Scheduling
12. Warranty
13. Extra Materials
14. Software Service Agreement

B. Part 2 Includes:

1. Product Options and Substitutions
2. Materials and Equipment
3. Equipment Modifications
4. Fabrication
5. Source Quality Control
6. Firestopping/Sealant Materials

C. Part 3 Includes:

1. Examination
2. Installation
3. Field Quality Control
4. Cleaning
5. Training

D. Related Sections:

1. 280513 Conductors and Cables
2. 280514 Fiber Optics
3. 280528 Raceways and Boxes
4. 281300 Access Control System
5. 281500 Electronic Systems and Components
6. 282300 Video Surveillance (CCTV) System

1.3 REFERENCES

A. Codes compliance - Comply with the established project edition of the following codes as applicable:

1. Southern Nevada Electrical Code (NFPA 70) SNEC
2. National Fire Alarm Codes (NFPA 72) NFAC
3. Southern Nevada Building Code SNBC
4. All State, County and City codes and ordinances

B. Standards Compliance - Comply with the following standards as applicable:

1. American National Standards Institute ANSI
2. American Society for Testing and Materials ASTM
3. Electrical Testing Laboratories ETL
4. Factory Mutual FM
5. Federal Aviation Agency FAA
6. Federal Communications Commission FCC
7. Institute of Elect. and Electronics Engineers IEEE
8. National Electrical Contractors Association NECA
9. National Electrical Manufacturers Association NEMA
10. National Fire Protection Association NFPA
11. Occupational Safety Health Act OSHA
12. Underwriter's Laboratories UL

1.4 DEFINITIONS

A. By Others or By Other Trades: By persons or parties other than the Division 28 Contractor. In this context the words “by others or by other trades” shall not be interpreted to mean “not in contract (NIC)”.

B. Certified: Equipment has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards and found to be safe for use in a specified manner; production is periodically inspected by a nationally recognized testing laboratory; and it bears a label, tag, or other record of certification.

C. Concealed: Not visible or readily accessible such as, embedded in masonry or other construction installed behind wall furring with double partitions or above hung ceilings, in crawl spaces, in shafts.

D. Conveniently Accessible: Capable of being serviced without climbing or crawling under or over obstacles, and with adequate working clearance both front and back.

E. Damage: Visible or invisible abuse that negatively affects performance or appearance and creates defective materials or workmanship.

F. Defective Materials or Workmanship: Operational failures, performance below minimum requirements, evidence that the system will not be reasonably maintainable, errors in documentation, abnormal operations, unsafe conditions, or similar unsatisfactory performance.

G. Contractor: Company holding the contract or agreement with the Owner or its representative. The Contractor may, when permitted, sub-contract Work described in this Section to which the term contractor may apply.

H. Exposed: Not concealed.

I. Failure: Any deviation from intended system operation and performance, as determined by the Contract Documents and subsequent submittals and the Owner’s Representative.

J. Furnish: Purchase and deliver to the Project site complete with every necessary appurtenance, support, and accessory required for operation.

K. Install: Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the Project.

L. Labeled: Equipment embodies a valid label, symbol, or other identifying maker of a nationally recognized testing laboratory such as Underwriters’ Laboratories, Inc., the laboratory makes...
periodic inspections of the production of such equipment, and the labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.

M. Listed: Equipment is mentioned in a list which is published by a nationally recognized laboratory which makes periodic inspection of the production of such equipment or states that such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.

N. Nationally Recognized Testing Laboratory: A testing laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

O. Provide: Furnish and install, completely ready for use, including all accessories required for operation.

1.5 SYSTEM DESCRIPTION AND GENERAL RESPONSIBILITIES

A. The Contractor is responsible for the Work of the following Sections, as governed by the general requirements of this Section:

1. 280500 Electronic Systems General Requirements
2. 280513 Conductors and Cables
3. 280514 Fiber Optics
4. 280528 Raceways and Boxes
5. 281300 Access Control System
6. 281500 Electronic Systems and Components
7. 282300 Video Surveillance (CCTV) System

B. Combined Prescriptive and Performance Design Requirements

1. Divisions 28 includes a combination of prescriptive and performance specifications. Compliance with the performance specifications, as well as coordination and integration of the prescription requirements, will require substantial design work on the part of the Contractor.

2. The performance requirements are intended to establish overall system performance requirements, satisfy the operational requirements, and establish the inter-coordination requirements for the Division 28 systems.

3. The prescriptive requirements establish the minimum quality, characteristics, and types of components, equipment, and materials to be used to achieve the stated system performance requirements. The Contractor is advised, however, that prescriptive specifications have not been provided to satisfy all of the specified performance requirements.

4. The Contractor shall carefully consider all of the requirements for each of the Division 28 systems when preparing its bid. Any questions regarding the intent of these requirements, the scope of the systems or their coordination requirements must be submitted in writing prior to bidding in accordance with the Instructions to Bidders.
Contractor shall have no claim for either extra compensation or extra time on the grounds that it did not understand the scope or the requirements of the Division 28 work, and/or the coordination requirements of the Division 28 work with the work of the other Divisions.

5. Compliance with the project requirements will be progressively monitored and adjusted through the submittal process, Shop Test, Performance Test and Continuous Operational Test.

C. Drawing Interpretation

1. The Drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions or detail drawings. The Drawings utilize riser, block, installation and schematic diagrams and symbols to outline the Work to be provided. These drawings do not have any dimensional significance, nor do they delineate every item required for the intended Work. No interpretation shall be made from the limitations of symbols and diagrams that any elements necessary for complete Work are excluded.

2. The Work shall be provided in accordance with the intent expressed on the Drawings and Specifications, and in conformance with the actual building architectural and structural conditions. When in conflict, field conditions take precedence over the Contract Documents.

3. The meaning of abbreviations shall be the same whether in lower case letters or without periods.

4. The use of words in the singular shall not be considered as singular where other indications denote that more than one item is referred to.

5. Details that appear on the Contract Documents which are specific with regard to the dimensioning and positioning of the Work, are intended only for the purpose of establishing general feasibility. They do not replace engineering or field coordination by the contractor for the Work.

D. Provide all parts and equipment for a complete and operational system for the Work of Divisions 28 as described herein and shown on the drawings.

E. Furnish and install all trenching and backfill, duct banks, conduits, raceways, sleeves, boxes, gutters, shelves, enclosures, shelf and enclosure supports, backboards, pull ropes (in unused or spare conduits) required to make all systems fully operational, including components not shown on the Drawings, but necessary for fully operational systems.

F. Furnish, install, terminate, test, dress, and identify all wire and cable required to make systems fully operational, including all wire, fiber, proximity devices, request to exit devices, and cabling not shown on the Drawings, but necessary for fully operational systems.

G. Recognize that the Work entails a considerable amount of custom integration between individual systems, as well as the design and implementation of many system and component interfaces. Take full responsibility for the complete design, installation, and performance of the total integrated system, including integration between systems and various interfaces, in order to achieve the specified operational features and system performance requirements.

H. Recognize that the Work entails a considerable amount of custom-written and custom-tailored software, both high-level language applications and hardware-specific drivers. Take full responsibility for the performance of the total software suite, including the software embedded...
in manufactured equipment, in order to achieve the specified operational features and system performance requirements.

I. It is the sole responsibility of the Contractor to ensure that all equipment supplied under this specification is 100% compatible with the existing systems, devices, raceways, and/or wiring installed in this facility and shall be integrable/compatible with all RTC security systems. The Contractor shall install, configure and program the systems described in these Specification to ensure that the new systems and the existing systems operate as one seamless entity.

J. Extensive interface to the existing on-line facility security and life safety systems is required as part of this Work. All connections to the existing systems shall be thoroughly detailed in submittals and approved prior to commencing of any work.

K. If it is necessary to temporarily remove or disconnect any part of the existing systems or equipment for the purposes of interfacing and connecting new equipment, the Contractor shall reinstall and make fully operational all equipment and devices removed or disconnected. Any and all system cutovers and interruptions must be pre-approved and carefully coordinated with Owner and Facility.

L. Fully test the systems, demonstrate their satisfactory operation, and train maintenance and operating personnel, as specified in this Section and the Sections governed by this Section.

1.6 COORDINATION

A. Coordinate with the Owner and all other trades as required to ensure that the entire Work of this Project will be carried out in an orderly, complete, and coordinated fashion.

B. Coordinate the installation all security devices with the existing lighting and ventilation in all equipment rooms and control stations to avoid any possible interference and to enhance system function.

C. Coordinate with the Work of all applicable Divisions and Drawings for the required electrical and mechanical control interfaces to the work of this section.

D. Coordinate with the Owner all electrical work including, but not limited to, the required number, size, type and exact locations of all system line voltage circuits, electrical junction boxes and power receptacles. Circuits used to supply energy to any device or equipment associated with the Security Electronic and Life Safety Systems shall be derived from an emergency-generator-supplied source where available.

E. If applicable, provide coordination drawings of security device plate mounting templates and internal frame conduits to the hollow metal frame manufacturer/supplier to facilitate frame preparation for electronic devices. Rework all frames for which device mounting has not been coordinated at Contractor’s expenses.

F. If applicable, obtain product data and wiring schematic information from the Contractors/manufacturers for all approved locking and door monitoring hardware. Coordinate with the Contractors to properly wire, terminate and test all electrically controlled and monitored door/gate hardware.

1.7 QUALITY ASSURANCE

A. Divisions 28 requires contractors with similar work experience and specific licenses and certifications to perform the work of this section. Specific requirements are identified in the related sections. Contractors must be certified or licensed at the time of bid where
Manufacture certification or licensure is required. Required licenses and certifications shall be submitted within 3 days of being selected as the apparent low bidder.

B. The Division 28 contractor shall have had experience in the design and installation of similar systems of similar project sizes and similar integration as this project to be considered qualified.

C. The Contractor shall be responsible for all costs incurred including costs incurred by the Owner and its representatives for failure to provide the experience and key personnel as specified.

1. Deductive change orders may be issued as a result of the failure to properly engineer the work prior to construction or improperly installed work that results in costs incurred to the Owner. Examples of incurred costs are rejection of submittals for failure to follow specifications or failure to properly engineer the work; re-inspection of rejected work.

D. The Divisions 28 contractor shall maintain a local service center with qualified service technicians for the duration of the Warranty period.

E. The Divisions 28 Contractor shall have a Southern Nevada Contractors License C-10 and/or C-7 for the respective work.

F. Key Project Personnel must have work experience with projects of similar size and complexity. Systems experience shall be demonstrated for the Key Project Personnel. Résumés of prospective key personal shall be submitted within 30 days of contract award.

1. Project Manager Qualifications
   a. Bachelor of Science Degree from ABET accredited college in Construction Management or related engineering field or,
   b. Five years experience with projects of similar size and complexity.

2. Project Engineer Qualifications
   a. Licensed Professional Electrical Engineer or,
   b. Bachelor of Science Degree from ABET accredited college in Electronics Engineering field and two years experience with systems to be provided, or
   c. Technical Trade School Degree, Associate of Science Degree, or bachelor’s degree and a minimum of six years of demonstrated experience with the systems to be provided.

3. The approved Project Manager shall represent the Contractor at all times in all project matters and shall be responsible for the administrative work including but not limited to, the following:
   a. Representation at all project meetings.
   b. Progress schedule and progress reporting.
   c. Payment schedule of values and pay requests.
   d. Representation and management of all employees and sub-contractors.
e. Conduction of on-site performance and acceptance testing.

4. The approved Project Engineer shall be qualified and shall be responsible for technical work including but not limited to, the following:

   a. Preparation and signature of all engineering, shop drawings, and product data submittals.

   b. System fabrication, field installation work, and testing.

5. Consider all qualification and experience materials submitted as binding. Obtain the Owner’s approval in writing prior to any deviations from the minimum requirements in organization, personnel, work plan, quality control plan, procurement plan or other declaration within the qualification submittal. Key project personnel substituted prior to or during the Work must meet the specification requirements and obtain the Owner’s approval.

G. Regulatory Requirements and Standards:

1. References to the Southern Nevada Electrical Code (SNEC) and National Fire Alarm Code (NFAC) are a minimum installation requirement standard. Drawings and Specifications shall govern in those instances where requirements are greater than those specified in the NFAC.

2. Obtain and pay for all permits and inspections required by all legal authorities and agencies having jurisdiction for the Work. The certificates of all such permits and inspections shall be delivered to the Owner.

1.8 SUBMITTALS

A. Submit under provisions of General Conditions, Submittals.

B. Contractor is advised that approval or acceptance of product data or shop drawing submittals does not release the contractor from providing all necessary documentation per submittal requirements, nor does it obviate contractor from additional design and coordination throughout the project.

C. CPM Schedule

   1. Submit a Critical Path Method Schedule within 30 days of the Notice to Proceed.

   2. At a minimum show tasks by area such as by building, by floor or other appropriate designations.

   3. Include tasks that are not part of the work of this section but that may affect this section such as work by other trades or contractors or Owner review time.

   4. Include tasks that are not part of the work of this section but that may affect this section such as work by other trades or contractors or Owner review time.

D. Submittal Matrix

   1. Prepare and submit a matrix of submittals by type vs. section of all submittals to be made by the Division 28 contractor within 10 days of the Notice to Proceed.
2. Utilize the list of required submittals listed at the end of this section as a starting point. Add columns for expected delivery dates and each specification section. If a listed submittal is not required for a specific section, indicate such with an “N/A” or other means in the column and row cross point.

E. Schedule of Values

1. Submit a Schedule of Values (SOV) based on the CPM schedule and Submittal Matrix that reflect the value of the systems and installation of work for this Division.

2. That approved SOV will be used as a basis for progress payments.

F. Product Data:

1. Product data is required for all materials and equipment. Include complete bill of materials for each section with the product data submittal.

2. Cross-reference submitted items to the Specifications using their related sections and paragraph numbers.

3. Submit complete product data for all system components in a single, bound submittal of one or more volumes. Provide a table of contents and labeled divider tabs for each section. Partial submittals for individual sections will be returned without review.

4. Include descriptive literature, catalog cuts, illustrations, schematics, technical data sheets, and test data necessary for the Owner’s Representative to ascertain that proposed equipment and materials comply with specification requirements. Include manufacturer’s name, model, and catalog or part numbers. Catalog cuts shall be legible and shall clearly identify equipment being submitted.

5. Include required calculations, I/O points lists, system zone schedules, and other tabular data as necessary to clarify system sizing and configuration. Do not, however, consider such submittals as a substitute for complete shop drawings.

6. Disclosure of Product Deviations: Specifically identify and tabulate any and all deviations from the contract documents including all system functions and features. Reference the corresponding specification sections and paragraph/article numbers. All variances and deviations will be reviewed for acceptance or rejection. It will be the Contractor’s sole responsibilities to comply with all other contract requirements not revealed in the disclosure of product deviations.

G. Shop Drawings:

1. Shop drawings are required for all systems and component assemblies.

2. AutoCAD “.dwg” files of the Contract Drawings may be made available upon request. These files may be used as a first step in the preparation of shop drawings. Do not consider the drawing plots from such files as a substitute for the shop drawings that are to be prepared by the contractor.

3. Shop drawings will not be accepted or considered unless they are submitted as a complete package for each specification section. Partial submittals covering less than a whole system or with incomplete interfaces to other systems will be rejected.
4. Standard manufacturer’s drawings may not be used as shop drawings unless specifically modified for use on this project.

5. Each drawing requires a unique drawing number and revision level. Revisions shall be dated and referenced per submittal number. Delta numbers and clouds on the drawings shall be used in all instances where changes have been made to the previous submittal.

6. At a minimum, include the following shop drawings:

   a. Floor Plans: Scaled drawings showing equipment and all device locations in plan view. Include wire and cable types and quantities, raceway sizing and routing. Routing information shall indicate where rated assemblies are penetrated. Separate into as many plan series as needed to prevent overlapping information. These drawings shall be fully coordinated with other trades prior to submittal. Show relationships to adjacent surrounding structures.

   b. Equipment and Control Room Plans and Elevations: Scaled, dimensioned drawings showing security equipment layouts in security equipment rooms, electrical/security closets, and control rooms. Include electrical J-boxes and receptacles, power, conduit sizing and routing, metal gutters, wiring ducts, cable trays, and supports. Indicate all other non-security cabinets, enclosures, and equipment within the room.

   c. Cabinet, Enclosure, and Rack Elevations: Scaled, dimensioned drawings for each system equipment cabinet, enclosure, and rack showing component and equipment mounting, wire and cable routing and separation, connector and terminal block locations and labeling, and all necessary fabrication details.

   d. System Block Diagrams: Single line block diagrams showing the general relationship between system components and the interconnection between systems. Use these drawings as a reference for the Single line diagrams and point-to-point diagrams by cross-referencing the shop drawing number of those diagrams on these drawings.

   e. Single Line Diagrams: Interconnection diagrams for the riser and trunk wiring between equipment cabinets, enclosures racks and major components. Use the same equipment designations as the floor plans and block diagrams.

   f. Point-to-Point Diagrams: Drawings which show the wiring of each component or device of each individual system. Include details of power supply, grounding, shielding, shield grounding, surge protection, fusing, connector pin-outs, terminal assignments, and similar wiring and connection details. Use the same component and device designations as the floor plans and other shop drawings.

   g. Schematic Diagrams: Drawings which show the component wiring of a system to include but not limited to door position switches, request to exit devices, resistors, diodes, transistors, relays, etc. Required for all custom systems and modified commercial products.

   h. Device Installation Diagrams: Details which show the installation and wiring termination of each field device in each individual system. Include settings for dipswitches, jumpers, addresses, port assignments, etc. of all devices.

   i. All other shop drawings necessary to install, fabricate, locate, identify, test, service, and repair the systems provided.
7. Shop drawings approved by the Owner are representative OR by the Consultant Engineer is not a release from Contract requirements as defined by the Drawings, Specifications, and Governing Codes and Regulations.

H. Samples:

1. Field Samples:

   a. Wires and Cables: Submit a one (1) foot sample length of each wire and cable type to be used with the cable identification clearly shown.

   b. Submit all required samples along with the product data submittal for review and approval prior to installation.

   c. If all wire samples can not be submitted at the same time, submit samples with a complete list of all cables to be used noting samples which have been submitted. Update the list with each subsequent sample submittal.

2. Devices/Equipment:

   a. Provide licenses for all devices, request to exit, proximity, access control, reader interface modules, workstations. Assure all installed devices are licensed properly to assure a compatible and operable system. Provide the RTC with (2) additional licenses for all equipment and devices installed.

   b. Submit sample assemblies of each of the following devices or equipment along with the product data submittal for review and approval by the Owner’s Representative:

      1) Substituted products if requested by Owner.
      2) Custom component, board, equipment or assembly.
      3) Tone generator (each type)
      4) Demonstrate each type of proposed tone generator to the Owner’s Representative. Distinctive tones shall be used for each application or function and shall remain consistent throughout the project.
      5) Duress Station

3. Disposition: Submitted samples become property of the Owner and will not be returned.

4. Approval of any custom or modified assemblies shall be required. Submit technical information with samples.

I. Test Procedures:

1. Initial Performance Testing: Submit test procedures, forms, and checklists for point-by-point testing. Include a listing for each individual system, each control station and control panel, each equipment room, and each major system component. At a minimum, forms shall include columns for operational/non-operational status, remarks, workmanship, and date corrected. Submit a sample format for approval by the Owner’s Representative a minimum of 20 days prior to testing.

2. Performance Testing: Submit test forms which are identical to or similar to the accepted Initial Performance Testing forms. Obtain approval from the Owner’s Representative for any changes in test procedure or forms.
3. Continuous Operational/Functional Testing: Submit a detailed test procedure for the continuous functional testing described generally in this Section. Submit for approval by the Owner's Representative a minimum of 15 days prior to testing.

J. Test Results:
   1. Initial Performance Testing: Submit completed test results for point-by-point testing to the Owner's Representative five days prior to scheduled Performance Testing.
   2. Performance Testing: Submit completed test results prior to or with the request to begin the Continuous Operational Test.
   3. Continuous Operational Test: Submit completed test results prior to or with the request for Substantial Completion.

K. Record (As-Built) Documents:
   1. Provide and submit As Built drawings noting the actual configuration of installed devices, security equipment, data room layouts to the entity with jurisdiction prior to the scheduling of any inspections. These drawings shall be wet sealed prior to submission and shall document the changes from the Bid Drawings.
   2. Maintain a current record set of as-built drawings on the job and as construction and installation progress; show the actual installed location of all items, material, and equipment.
   3. Accurately record actual routing of all conduits including sizes and types.
   4. The as-built drawings shall be available to the Owner's Representative for review and will be required for evaluation of progress payments.
   5. Submit as-built shop drawings created from the approved shop drawings and updated from the site as-built drawing set and any other drawings required depicting the as-built conditions of the installed work.
   6. As-Built drawings shall be DWG format.

L. Operational Manuals:
   1. Submit the (3) identical manuals, which shall contain the Theory of Operation, start up, shut down and emergency procedures, and the manufacturer's operating instructions.
   2. Subdivide the manual by section with tab dividers. Provide a table of contents which identifies each section and the contents therein.

M. Maintenance Manuals:
   1. Submit three (3) complete sets of maintenance documents as described in this Section. For documents of sizes greater than 11 x 17 inches, prints and electronic copy shall be furnished.
   2. Manuals shall include the following as a minimum requirement:
a. Technical system description.

b. System schematics.

c. Detailed wiring diagrams to identify cabling, termination, and routing.

d. Panel assembly drawings to identify location of components, terminal strips, and equipment as required to correlate with system drawings.

e. Descriptions and drawings as required to maintain equipment from the board to the component level.

f. Description of software and user programmable functions. Procedures for user programmable functions shall be included.

g. A complete printout of each unique system program.

3. For systems where the program resides on electronic media or other similar storage medium, furnish a copy of the media, or similar medium, to the Owner's Representative. Provide all required system licenses as well as (2) additional licenses prior to Substantial Completion.

4. Where multiple systems are combined into a single integrated system, documentation shall include a description of the integrated system and the details of the interfaces between systems.

5. Provide a list of current telephone numbers and addresses of all material vendors and equipment manufacturers who have supplied components in this Project. Include separate service telephone list and purchasing telephone list cross-referencing with each component.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect all materials and equipment from damage during storage at the site and throughout the construction period. Protect equipment and materials during shipment and storage against physical damage, dirt, dust, moisture, cold, rain, and any foreign substances that may damage the equipment.

B. Prevent damage from rain, dirt, sun and ground water by storing the equipment on elevated supports and covering them on all sides with securely fastened protective rigid or flexible waterproof coverings.

C. Protect conduit by storing it on elevated supports and capping the ends with suitable closure material to prevent dirt accumulation.

D. Protect all fabricated and/or installed materials and equipment against dust, dirt, moisture, physical damage, metal debris, and any foreign substances that may damage the equipment.

E. Protect painted surfaces with removable heavy Kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.

F. Replace equipment determined by the Owner's Representative to be damaged. Repaint and finish damaged paint on equipment and materials with the same quality of paint and workmanship used by manufacturer so that repaired areas are not obvious.
1.10 SITE CONDITIONS

A. Site Investigation

1. Prior to submitting a bid, the Contractor shall perform a site survey of all related existing systems and submit any potential problems of the design documents that may increase the installation cost of the project.

2. Survey all locations to assure that the existing equipment on site, e.g. switch port, network switches, etc are sufficient to support the new and reinstalled CCTV cameras and ACAM equipment. These switches and equipment are located in all data room locations. In addition, this survey shall verify where work is to be performed and verify existing conditions prior to shop drawing submittals.

B. Existing Systems

1. It is the sole responsibility of the Contractor to ensure that all equipment supplied under this Specification is an extension of the existing safety-security systems, is 100% compatible with the existing systems and wiring installed in the facility and shall be compatible and integrable with existing RTC security systems. The Contractor shall investigate and verify the capability of existing equipment, e.g. switch ports, network switches, etc. can support the identified equipment on the contract drawings. The Contractor shall promptly identify any issues with existing equipment and be responsible for notifying the Owner and for inclusion of this equipment in the bid documents. The Contractor shall install, configure, and program the systems described in this Specification to ensure that the new and existing systems operate as one seamless entity.

2. Extensive interface to the existing facility security and communication systems is required as part of this Work. All connections to the existing systems shall be thoroughly detailed in submittals and approved prior to commencing any work.

3. If it is necessary to temporarily remove or disconnect any part of the existing systems or equipment for the purposes of interfacing and connecting new equipment, the Contractor shall reinstall and make fully operational all equipment and devices removed or disconnected. Any and all system cutovers and interruptions must be pre-approved and carefully coordinated with Owner and Facility.

C. Match Existing Conditions

1. New exposed conduit to match existing exposed conduit or surface.

2. Repair, patch, clean and paint existing surfaces that are damaged, disturbed or left in an unfinished or mismatching condition as a result of the work of this contract, to match the adjacent area.

D. Existing Equipment Disposition

1. Remove, refurbish, and re-install devices, equipment and materials specifically noted on the Drawings. During removal and storage, protect devices from damage.

2. Remove, package, and turnover all devices, equipment, and materials specifically noted on the Drawings to be removed and turnover to the Owner. During removal and storage, protect devices from damage.
3. Remove and dispose materials that are not to be reinstalled or turned over to the Owner.

4. Contractor shall abide by all facility rules.

E. Security Requirements

1. Special security requirements will be provided by the facility. Coordinate with owner.

2. Special requirements may include limited access to the work area by area or time; background checks of on-site personnel, restrictions of equipment and tools to include tool counts.

1.11 SEQUENCING AND SCHEDULING

A. General Requirements:

1. Do not begin the project without the Owner’s acceptance of proposed key project personnel for the Division 28 Work.

2. Prepare, review, and coordinate with the Owner’s Representative an approved construction (CPM) work schedule. Schedule work in areas and at times that will not interfere with scheduled activities as defined by the Owner’s Representative.

3. Do not procure any equipment without accepted product data submittals. Do not perform any field installation without accepted shop drawings. Do not begin any extensive software development or programming without accepted system, operational narratives, the required Owner’s coordination, and user’s requirements.

4. Pre-assemble control electronics, control panels, racks, and cabinets off-site as most practical.

5. Install system control equipment, control panels, cabinets, racks, and consoles only after major construction in the area in which they are to be installed has been completed and areas have been cleaned, painted, and sealed.

6. After systems installation and prior to point-by-point performance testing, thoroughly pre-test all devices and device wiring for proper performance. Then, thoroughly pre-test each system function in each state or condition under every operating mode.

B. Coordinate all work in the existing facility with the Phase 1/Phase 2 contractor(s) and the facility contact person.

1.12 WARRANTY

A. The Contractor is to provide a warranty for 60 months (5 years) from the Date of Substantial Completion of the work provided under this contract (including, but not limited to, software, hardware, and peripheral equipment) as a system, including interfaces to work by others for one year from the date of Acceptance of the Work. Specific Division 28 sections may require longer warranty periods. Divisions of work among various suppliers, vendors, installers, subcontractors, and other parties will not be recognized or accepted.

B. Extended Warranty: Submit to the Owner prior to the Date of Substantial Completion an itemized pricing for an Extended Service and Warranty for each year after the initial warranty period up to three (3) years. Describe whether all parts and labor are included in this offering.
C. Guarantee to repair and replace defective materials or workmanship during the warranty period including labor and materials.

D. An emergency maintenance (Warranty) request shall be defined as a system or portion of a system failure that affects building safety, security, and operation of critical components. Failure of a single component (i.e., smoke detector, intercom station, camera, or monitor) is not considered an emergency maintenance request.

E. Respond within four hours to an emergency maintenance request. Provide a twenty-four hour telephone contact number (24 hours per day, 365 days per year). Service response time is defined as the period between the placing of a service request and the arrival of a qualified technician capable of servicing the problem on-site.

F. Maintain a sufficient parts inventory at the project during the warranty period to meet the guaranteed system repair times.

G. Repair and make operational any defective materials or workmanship resulting from an emergency maintenance request within an 8-hour period from the time of the initial arrival of service personnel at the site. Correct non-emergency defective materials or workmanship within four (4) calendar days of receiving notice of the defect.

H. Where the equipment manufacturer's warranty covers a longer time period than that required by these Specifications, the manufacturer's warranty shall govern.

I. Replacement with new equipment refurbished is not acceptable.

1.13 EXTRA MATERIALS

A. Prior to Acceptance of the Work, deliver to the Owner all spare parts and extra materials required in each Section. All spare parts and extra materials shall be brand new in their original shipping boxes or packages and shall have one year material warranty remaining at the time of delivery. Extra materials shall be available to the Contractor to use as immediate replacements during the warranty period. All extra materials used for the warranty requirements shall be replaced by the Contractor. Provide the Owner with (2) additional equipment and device licenses prior to the date of Substantial Completion.

B. Special Tools:

1. Provide three of each type of security screw bits used.

2. Provide minimum of one of any specialty tools used.

C. Spare Parts:

1. Provide 25 of each type and size of security screw used.

2. Provide 2 additional Reader Interface devices used.

3. Provide 500 HiD Cards with the facility code as identified by the Owner.

1.14 SOFTWARE SERVICE AGREEMENT

A. Provide five (5) years of Software Service Agreement to support the software updates, firmware updates and any licensing renewal fees required during this five year time frame. These costs shall include all labor, software and shall be all inclusive for all existing and new
equipment installed at all RTC sites within this project and this agreement shall be executed on the date of Substantial Completion and be turned over to the Owner prior to this date.

B. Provide up to five (5) operator workstation licenses for this project. This operator workstation licenses shall be used as identified by the Owner and the licenses shall include five years of renewal at no cost to the Owner and shall be turned over to the Owner prior to Substantial Completion.

C. Technical Support: Beginning with Substantial Completion, provide software support for four (4) years at all RTC sites. This agreement shall include all software upgrades, all technical support and shall be all inclusive.

D. Upgrade Service: Update software to latest version at Project completion and provide continuous upgrades as these upgrades are identified and made available. Install and program software upgrades that become available within five (5) years from date of Substantial Completion. Upgrading software shall include operating system at all RTC Sites, e.g. Sunset Maintenance, Bonneville Transit Center, South Strip Transfer Terminal, Administration Building (600 S. Grand Central Parkway) and all Centennial Hills Transit Center, Westcliff Transit Center and Integrated Bus Maintenance Facility sites. These Upgrades shall include software (new and revised licenses, labor, equipment, testing, parts and any/all other related costs).

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Comply with the General and Supplementary Conditions and these specifications.

B. The products named in this section and the sections governed by this section establish minimum qualities that substitutions must meet to be considered acceptable. The specified products have also been used in preparing the drawings and specifications, and therefore establish the basis for equipment sizing, wire and cable design, power consumption, and other design parameters.

C. Substitution requests, if permitted, will be considered only if submitted in strict accordance with the followings:

1. Cross-reference submitted items to the Specifications using their related Section and paragraph number.

2. Submit complete product data, descriptive literature, catalog cuts, illustrations, schematics, technical data sheets, and test data necessary for the Owner’s Representative to ascertain that proposed equipment and materials comply with specification requirements. Include manufacturer’s name, model, and catalog or part numbers. Catalog cuts shall be legible and shall clearly identify equipment being submitted.

3. Disclosure of Product Deviations: Specifically identify and tabulate any and all deviations from the contract documents including all system functions and features. Reference the corresponding specification sections and paragraph/article numbers. All variances and deviations will be reviewed for acceptance or rejection. It will be the Contractor’s sole responsibilities to comply with all other contract requirements not revealed in the disclosure of product deviations.
D. The Contractor shall take full responsibility for all design, coordination, and cost associated with substitutions including, but not limited to:

1. Its integration into the total system including physical mounting space, electrical interconnection, signal wiring, power, quality, electromagnetic interference, communication protocols, and similar design considerations.

2. Any additional materials, equipment, components, accessories, items required for equivalent system operation and performance.

3. Any necessary changes to branch power circuits, circuit protective devices, and the Work of other trades.

4. Any modifications to wire, cable, and raceway design.

2.2 MATERIALS AND EQUIPMENT

A. All equipment and materials required for installation under these Specifications shall be new and without blemish or defect.

B. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacturing of such items, for which replacement parts are available. Specifications are prepared long in advance of project construction; the contractor is to use the newest model of the specified products available at bid time.

C. All material and equipment shall be listed, labeled, or certified by Underwriters' Laboratories, Inc., where such standards have been established. Equipment and material which are not covered by UL Standard will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe will be considered, if inspected or tested in accordance with national industrial standards such as NEMA or ANSI.

D. All parts of a system shall be the product of one manufacturer. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer. Constituent parts which are similar shall be the product of a single manufacturer.

E. All components of an assembled unit need not be products of the same manufacturer; however, all components must be acceptable to the Owner’s Representative. Components shall be compatible with each other and with the total assembly for the intended service.

2.3 EQUIPMENT MODIFICATIONS:

A. When standard manufactured equipment is modified from its original condition or factory options have been exercised identify the changes as noted below.

1. Clearly identify the modifications on the shop drawings.

2. Clearly identify each piece of modified equipment with a label, which states, “This unit has been modified...” and identify the modification or reference. Locate the label so that a service technician or factory service personal will be able to determine the equipment in use is non-standard and that modifications are required for service, testing and replacement.
3. Identify and describe the modifications on the Record Documents.

B. Equipment modification labels are not required for jumper or switch settings.

2.4 FABRICATION

A. Fabricate enclosures to easily accommodate interconnecting cables entering from above or below through the use of auxiliary gutters, cable trays, and conduits. Protect all metal cabinet edges where conductors cross and conduit ends with protective covering or bushing.

B. Group wires and cables by types, boards and modules, and maintain National Electrical Code clearances throughout the installation, including Class 1, Class 2, communications, and branch circuit power separations. Maintain sufficient and proper separation between microphone-level audio, line-level audio, high-level audio and video cables.

C. Uniformly organize equipment and cable routing throughout all enclosures, racks, and cabinets. Provide wiring ducts, wireways, wire posts, D rings, wire saddles to route and secure factory and field wiring. Provide routing for all wiring from point of entry to point of termination to maintain required separation, access to all components, and general organization to the wiring. Neatly dress, route and secure wiring.

D. Mechanically fasten cabinet raceways and cable clamps to enclosure rear panels, rack members, console members, or to other system components. The use of adhesive fasteners (without mechanical fastener) is not permitted. Furnish and install cable support posts where necessary to properly support cables.

E. No splices are permitted in cabinet raceways. Exception: Splice to cable shield when within two inches of cable termination is permitted.

F. Furnish and install metal grounding type outlet strips in each equipment cabinet, enclosure, and rack. Leave a minimum of two unused receptacles at each location for future expansion. Neatly shorten and dress power cords from individual equipment to the outlet strips.

G. Provide protection from accidental contact of all terminals or exposed conductors over 25 volts within enclosures that contain Class 2 wiring. Use non-conductive barriers, heat shrink or other acceptable methods. Tape of any kind is not permitted.

H. Provide an isolated ground bus within each equipment cabinet, enclosure, and rack for single point termination of audio and data shields and grounds.

2.5 SOURCE QUALITY CONTROL

A. Shop Inspections:

1. Have trained, qualified, quality assurance inspector regularly inspect shop assemblies. Inspect for quality of workmanship, neatness, part and wiring identification, conformance to codes and standards, and compliance with system Specifications and shop drawings.

2. The Owner's Representative shall have the right at all times to inspect or otherwise evaluate the Work performed or being performed and shall have access to the premises in which the Work is being performed.

3. The Owner's Representative may verify the inspections or re-inspect any item. The Owner reserves the right to reject materials and workmanship found unacceptable during inspections.
B. Shop Test and Demonstration

1. Shop Test and Demonstration shall be a major milestone that shall commence only after all shop assembly, system integration, and software development and programming is complete. Owner’s approval of the integrated shop test shall be obtained before any system components are shipped to the site for installation.

2. Perform a point-by-point system demonstration of the Integrated Security System including CCTV system, Duress Alarm System, Integrated Sequences of Operation, PLC system, control panels, Intercom, and Public Address system to show all systems functioning and communicating as a single integrated system.

3. Each input and output point, operational sequence, control panel, and PLC network will be tested. Provide sample field devices, approved mock up devices and jumpers to simulate actual field operation conditions. In addition, simulated system failure, response time, reset and boot up time, and other tests will be conducted as directed by the Owner.

4. Sample field devices including, but not limited to are, intercom stations, paging speakers, microphones, cameras, CCTV monitors, locks, and door position monitoring devices.

5. Notify the Owner a minimum of 15 working days prior to demonstration so that the Owner may witness the demonstration.

6. Conduct the demonstration in strict accordance with the test procedure accepted by the Owner. Demonstrate full compliance with the required operating modes and sequences of operation under all operating modes. Record demonstration/ test results on a report which shall include a list of all personnel witnessing the demonstration, test methods used, and a record of each specific test made.

7. If demonstration results are not in compliance with requirements, make necessary hardware and software changes, corrections, repairs, or adjustments at no additional cost to the Owner. If corrections cannot be made during the scheduled Shop Test and another shop test is required, the Contractor shall pay for all transportation, lodging and expenses of the Owner’s representatives’ (maximum seven people) attending the additional tests. This process shall continue until the systems are acceptable to the Owner.

2.6 FIRESTOPPING/SEALANT MATERIALS

A. Firestop and seal all penetrations of fire walls with minimum three hour sealant or Fire Stop Putty (FSP). This includes but is not limited to all raceway, conductor, sleeve and cable tray penetrations where penetrating device does not completely seal the hole.

B. Accepted Products: International Protective Coatings Corp. Flame Safe FSP 1100, Nelson FSP, Domtar Fire-Halt or approved equal from other manufacturers.

PART 3 EXECUTION

3.1 EXAMINATION

A. Carefully inspect the installed Work by other trades and verify that all such Work is complete to the point where installation of the Work of this division may properly commence.

B. In the event of discrepancy, immediately notify the Owner’s Representative. Do not proceed with installation in areas of discrepancy until such discrepancies have been fully resolved.
C. Install all equipment in accordance with all pertinent codes and regulations, the accepted
design, and the referenced standards.

3.2 INSTALLATION

A. Equipment Identification:

1. Install a nameplate on each individual equipment rack, enclosure, boxes, cabinet, and
significant equipment item.

2. Use identifiers and abbreviations defined in the Drawings whenever possible. Use plan
designation for labeling, unless indicated otherwise.

3. Nameplates shall be laminated black phonemic resin with a white core and engraved
lettering, a minimum of 1/4" high. Use fasteners to install nameplates. Do not fasten with
adhesives.

4. Engrave using upper case letters of uniform height; centered on device, cover plate, or
enclosure; with all characters made clearly and distinctly.

5. All equipment shall have the manufacturer’s name, address, and model number and
rating on a name plate securely affixed in a conspicuous place. All equipment shall bear
labels attesting to Underwriters Laboratories approval where subject to Underwriters
Laboratories label service.

6. Identify all field terminals and relays with device identification. Lettering shall be 3/16”
high minimum.

B. Equipment Installation:

1. Install all equipment in accordance with the manufacturer’s recommendations, and
accepted shop drawings. Provide all required licenses for equipment and devices.

2. Install all equipment in compliance with electrical code requirements, NECA’s "Standard
of Installation", and recognized industry practices.

3. If requested, submit structural and seismic mounting load calculations demonstrating
adequate support and bracing for seismic zone 4.

4. Do not attach electrical materials to roof decking, removable or knockout panels, or
temporary walls and partitions unless indicated otherwise. Use hangers and other
supports to support the equipment and materials, intended for this purpose.

5. Locate equipment as close as practical to the locations shown on the Drawings.

6. Maintain minimum 3-foot working clearances on each side of equipment or equipment
racks where access is required to inspect service or adjust.

7. Check equipment against available mounting space indicated on the drawings.
Coordinate location of equipment with existing devices to minimize interference. Bring all
conflicts or clearance problems to the attention of the Owner’s Representative during the
preparation of shop drawings.
8. Where the Owner’s Representative determines that equipment installation is not conveniently accessible for operation and maintenance, remove and reinstall equipment in a conveniently accessible manner at no extra cost.

3.3 FIELD QUALITY CONTROL

A. Initial Performance Testing:

1. Initial Performance Testing is to be conducted by the Contractor.

2. Point-by-point testing shall include the sequential operation of each system and control function in each of its operating modes. All tests are to be conducted and recorded per the accepted procedure and test forms.

3. Notify the Owner's Representative five (5) days in advance that this activity will be occurring.

B. Performance Testing:

1. Performance Testing is to be conducted by the Contractor and witnessed by the Owner's Representative.

2. Schedule point-by-point performance testing only after Initial Testing has been satisfactorily completed and all necessary corrections have been made. Provide the Owner’s Representative with a minimum of 5 working days notice with a request to schedule Performance Testing. Submit Initial Performance Test records prior to the scheduled Performance Test. Failure to submit test results as specified shall be cause to re-schedule testing.

3. Point-by-point testing shall include the sequential operation of each function in each of its operating modes, in addition to completion of all required performance testing and measurement.

4. Conduct point-by-point testing in the presence of Owner's Representative. Record test results on the accepted test checklist which shall include a list of all personnel witnessing the tests. If test results are not in compliance with requirements, make necessary changes or adjustments at no additional cost, and arrange for another test. This process shall continue until the systems are acceptable to the Owner's Representative.

5. Failure of any part of the system which precludes completion of system testing, which cannot be repaired in four (4) hours, shall be cause for terminating the test. Repeated failures which result in a cumulative time of eight (8) hours to effect repairs shall cause the system test to be declared unacceptable. Retesting of the entire system shall be rescheduled at the convenience of the Owner.

6. Performance Testing will also include inspections for contract document compliance, codes and standards compliance, and workmanship.

C. Continuous Functional/Operational Testing:

1. After completion and Owner Representative’s approval of the Performance Testing, conduct a 14-day operational test in order to demonstrate continuous system performance. The systems will not be accepted until they operate for 15 continuous days without a system failure. Restart the test period from the beginning after every confirmed system failure.
2. The Owner will provide staff to man and operate all control points during continuous operational testing. The Owner’s test personnel will simulate staff movement, generate alarms, and otherwise randomly operate as many functions as practical on a nearly continuous, 8-hour-shift basis. Provide jumpers and simulation programs to test alarms and other conditions that cannot be readily performed by test personnel. The test staff will record all suspected problems and provide these reports to the test committee.

3. The test committee will be composed of representatives from the Owner, Consultant, and Contractor, and will meet on a regular basis during testing to evaluate problem reports and determine if system failures have occurred. The Owner’s Representative will make the final determination for all disputed problems.

4. System failure is defined as any portion of the system that fails to operate as intended and cannot be corrected within 24 hours of the failure. Individual device failure such as a single camera or a single intercom station will not be a cause for system failure.

3.4 CLEANING

A. Comply with all bid document requirements.

B. Protect equipment during installation against entry of foreign matter on the inside. Vacuum clean all equipment both inside and outside before testing, operating and painting. Clean electrical connections with a suitable solvent prior to assembly.

C. Remove from the premises and dispose of all packing material and debris on a daily basis.

D. Upon completion of the Work, remove excess debris, materials, equipment, apparatus, tools and the like and leave the premises clean, neat and orderly.

E. Thoroughly polish all bright metal or plated Work and remove any pasted labels, dirt or stains from the equipment.

3.5 TRAINING

A. Provide on-site, project-specific training sessions for security system operations, maintenance, and programming with designated total hours as follows:

<table>
<thead>
<tr>
<th>System</th>
<th>Operational</th>
<th>Maintenance</th>
<th>Programming</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Electronic Components</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2. Video Surveillance (CCTV) System</td>
<td>10</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>3. Access Control System</td>
<td>10</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>4. Duress Alarm System</td>
<td>10</td>
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<td>0</td>
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</tbody>
</table>

B. All classroom training is to occur on site at a location provided by the Owner.

C. Professionally video tape all training sessions and furnish two forms of storage media (DVD and Flash Drive) to the Owner for use in future training sessions.

D. All training is to review the existing systems as they apply to the equipment and systems provided under this contract. All personnel being trained are expected to have basic experience for the existing systems.
E. Operational Training:

1. Train security staff in the operation of the System. Operational training shall include how to monitor and control the systems provided under this contract and how to respond to system events.

F. Maintenance Training:

1. Train Owner’s personnel in the basic user level maintenance and trouble shooting of the System. Structure training to identify the equipment and systems that can be serviced or reset by the on duty building engineer, how to identify systems that have failed or not working, and emergency shut down procedures.

2. Provide a combination of classroom sessions supported by audio/visual aids, and field sessions with personnel participating in hands-on preventative, corrective maintenance and reactive maintenance.

G. Programming Training:

1. Train Owner’s personnel in the site-specific programming and software trouble shooting of the System. Training will also include all user programmable features. Conduct training sessions using instructors who have been actively involved throughout construction and who are certified in writing by the manufacturers of the specific systems.

2. Provide a combination of classroom sessions supported by audio/visual aids, and field sessions with personnel participating in hands-on for programming changes, software uploading/downloading, trouble shooting, etc.

H. Submit an estimated training schedule 15 days prior to training for approval by the Owner’s Representative. Estimate classroom and hands-on hours required for all three types of training (operational, maintenance, and programming). Include a syllabus for each class session.

I. All training materials including Operational and Maintenance (O&M) Manuals shall be reviewed and approved prior to conducting the specific training.

END OF SECTION
SECTION 280513 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and all bid documents, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Building wire and cable.
2. Wiring connectors and connections.

B. Related Sections:

1. 280500 General Requirements
2. 280514 Fiber Optics
3. 280528 Raceways and Boxes
4. 281300 Access Control System
5. 281500 Electronic Systems and Components
6. 282300 Video Surveillance (CCTV) System

1.03 SYSTEM DESCRIPTION

A. Provide wiring and cables as described herein, shown on the drawings or as recommended by the manufacturer. When in conflict, the more stringent or greater requirements will take precedence as determined by the Engineer of Record.

B. Wires, cables, harnesses and connectors specifically described in another section or provided by or manufactured by a manufacturer in that section shall be provided by that section.

C. Wire size and features are minimum requirements, specific applications or manufacturers may have more stringent requirements which are to be provided at no additional cost to Owner.

1.04 SUBMITTALS

A. Comply with Section 280500 General Requirements

1.05 QUALITY ASSURANCE

A. Comply with Section 280500 General Requirements.

B. NEC Compliance: Comply with Article 725 (Class 2 Power-limited Circuits).
C. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten (10) years documented experience.

1.06 PROJECT CONDITIONS

A. Conductor sizes are based on copper.

B. Aluminum conductors shall not be used.

C. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

D. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1.07 COORDINATION

A. Coordinate Work with other trades.

B. Determine required separation between cable and other work.

C. Determine cable routing to avoid interference with other work.

2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide materials from listed manufacturers or approved equal.

B. Approved cable manufactures:
   1. Belden
   2. Corning
   3. Commscope
   4. Or Owner Approved Equal

2.02 CONNECTORS

A. Terminal Blocks:
   1. Type: DIN-rail-mounted, modular, screw terminals.
   2. Provide fused terminals where required or indicated.
   3. Accepted Manufacturers: Entrelec, Phoenix Contact, Weidmueller, or approved equal.

B. CCTV Video Connectors:
   1. Type: 75-ohm, commercial crimp-on, 3-piece BNC connectors.
   2. Body: Zinc outer piece and nickel center.

4. Accepted Products: Cambridge CPMC-78 series, AMP or approved equal from other manufacturers.

C. Data Connectors:

1. Type: Deluxe plastic, 9-pin, D sub-miniature hoods

2. Accepted Products: Cambridge HX series, AMP or approved equal from other manufacturers.

2.03 WIRES AND CABLES

A. Accepted Products: Belden, West Penn or approved equal.

B. Listings and Markings: UL listed and marked for flame resistance as follows:

1. General purpose: Electrical Code Type CM

2. Riser: Electrical Code Type CMR

3. Plenum: Electrical Code Type CMP

C. Communication and Control Cables:

1. Conductors: Stranded bare copper, size as indicated.

2. Insulation level: 300 VRMS.

3. Temperature level: 75° C.

4. Paired cables shall be twisted.

5. Shield (where indicated): 100% coverage aluminum polyester foil with drain wire.

D. Coaxial Cables:

1. Nominal impedance: 75 ohms.

2. Conductor: Stranded bare copper.

3. Dual shield: 100% coverage aluminum polyester tape with 95% coverage tinned copper braid.

4. Maximum attenuation at 10 MHz: 0.87 dB per 100 feet.

5. Insulation: Foam polyethylene, 300 VRMS.

6. Minimum temperature level: 75° C

E. Data Grade Cables:
1. Type: Twisted individually shielded pairs, quantity and size as indicated.
2. Conductors: Stranded bare copper.
3. Insulation level: 300 VRMS.
4. Minimum temperature level: 75° C
5. Maximum capacitance between conductors: 25 pf per foot.
6. Shield: 100% coverage aluminum polyester foil with drain wire.

F. Category 6 UTP
1. UL listed NEC type CM as defined in NEC Article 800
2. Complies with UL 1581 Test
3. Meets and Exceeds TIA/EIA 568-B.2 Specifications
4. Verified to Category 6 requirements by independent third party testing laboratory

G. Category 3 UTP
1. High pair count unshielded 24-AWG solid conductor twisted-pair core with a metallic sheath ARMM riser rated shall meet or exceed the ANSI/TIA-568B Commercial Building Standards for CAT3. The cable will be riser or plenum rated as dictated by National, State and Local Electrical and Building Codes.

3 - EXECUTION

3.01 INSTALLATION
A. Comply with Section 280500, General Requirements.
B. Comply with manufacturer's recommendations, procedures, and standards for the assembly, programming, and operation of the alarm system.
C. Coordinate closely with the door and frame contractor for proper installation of all door position sensors per manufacturer's recommendations.
D. Mount individual components to removable rear panels in wall-mounted cabinets using DIN rails, snap track or stand off-mounted PC boards, or properly sized mounting hardware.
E. Fuses: Provide over-current protection for control relay outputs and associated wiring.
F. Power Distribution:
   1. Hardwire each system power supply circuit to a line voltage transient voltage surge suppressor at its point of supply.
2. Coordinate with the electrical contractor for power capacities and circuit assignments in the electrical panel schedules and drawings for the alarm systems. Notify the Owner if additional power or circuits may be required.

3.02 WIRE TERMINATION, DRESSING, AND IDENTIFICATION:

A. Terminate or join all wires and cables with specified terminal blocks or connectors submitted and accepted for the specific termination. Acceptable termination and junction methods include:

1. Equipment or device terminal blocks (provided with equipment or device): Direct connection with stripped conductors.

2. Equipment or device screw terminals (provided with equipment or device): Two-crimp, spade lug on stripped conductors.

3. Device lead wires (provided with device): Two-crimp, insulated wire nut over conductors.

4. Equipment or device connector (provided with equipment or device): Provide mating connector.

5. Junctions and/or splices where indicated: Provide terminal blocks for control and communication cables and specified connector types for others.

B. Use the specific cable stripper for each cable and wire type. Use a 3-step-cut coax cable stripper on coaxial cables, a jacket stripper on jacketed cables, and the proper size stripper for individual conductors. Do not strip with a knife, scissors or other improper tool.

C. Use the proper crimping tool for each cable / connector combination. For example, crimp coaxial cables using a full-cycle ratchet crimp tool with the specific size hexagonal steel die for the cable type. Crimp D-subminiature connectors using a specific D-sub crimp tool, and so on.

D. For multi-pin connectors use the appropriate pin insertion and extraction tool.

E. Dress wires and cables to provide a neat and orderly appearance within all enclosures, equipment racks, cabinets, and consoles by routing in snap-cover, plastic wiring duct or other acceptable method. In locations where wiring duct is not feasible, organize by cable clamping, dressing and tie-wrapping.

F. Relieve strain on all loose wire bundles using tie-wrap supports fastened with machine screws or bolts. Do not use self-adhesive type supports.

G. Neatly form cable ends and apply shrinkable tubing to shielded cables or where necessary to secure the insulation against fraying or raveling.

H. Individually identify all conductors with a unique number located within 1-1/2-inch from its termination at both ends. Impress the number on a fixed length of white shrinkable tubing with a heat impression stamping machine, or other acceptable method.

I. Cross reference the interconnection diagrams of the record drawings with the installed cable identification numbers.
J. Route from source to termination in a uniform manner through raceways, cabinets, and equipment housings without breaking the insulation or deforming the cables. "Flying splices", meaning splices in wire bundles, raceways, or pull boxes are specifically prohibited. Splice only at junction box locations shown on the Drawings.

K. Obtain Owner's pre-approval for all exposed cable runs.

L. Maintain separation between Class 1, Class 2, communications, and branch circuit power wire and cable in accordance with the SNEC. Do not route microphone-level audio, line-level audio, or high-level audio in the same conduit or cable group.

M. Do not exceed the following cable pulling tensions or per manufacturer requirements:
   1. 24 AWG conductors: 4 lbs. per conductor.
   2. 22 AWG conductors: 7 lbs. per conductor.
   3. 20 AWG conductors: 12 lbs. per conductor.
   4. 18 AWG conductors: 19 lbs. per conductor.
   5. 16 AWG conductors: 30 lbs. per conductor.
   6. 14 AWG conductors: 48 lbs. per conductor.

N. Use a scale to measure tensions for typical cable pulls. If tensions are exceeded even momentarily or if cables are damaged, remove the cables. Install new cables either using an acceptable anti-friction agent or adding pull boxes to the run.

O. Install edge protection materials ("cat track") on the edges of holes, lips of ducts of any other point where wires or cables cross sharp metallic edges.

3.03 FIELD QUALITY CONTROL

A. Performance Testing:
   1. Comply with Section 280500, Performance Testing for:
      a. Initial Performance Testing.
      b. Performance Testing.
   2. Category 6 Cable Testing Requirements:
      a. Test results shall be submitted both hardcopy and soft formats. These two submissions shall also be accompanied by an affidavit, signed by a Contractor Official, stating that each basic link in the horizontal cabling system was tested and passed the required performance tests, with the official warranting the truth and accuracy of the two reports submitted.
      b. The hardcopy report is to be submitted in a labeled, 3-ring binder.
c. The machine readable report is to be submitted on CD. This submission must also include the software necessary to view the report. Software is not required if the submission is in a CSV format or directly readable by Microsoft Excel.

d. The test result database for the horizontal cabling system shall contain, at a minimum, the following information:
   a) Circuit id assigned to each basic link and OWNER id. Coordinate with OWNER for the assignment of this information.
   b) The wire map results indicating passage of tests for;
      c) Shorts,
      d) Opens,
      e) Miswires,
      f) Splits,
      g) Pairs,
      h) Crossed Pairs,
   i) End-to-end connectivity.
   e. The worst-case result, frequently at which it occurred, and the TIA limit for:
      a) Attenuation,
      b) NEXT,
      c) PSNEXT,
      d) Return loss,
      e) ELFTEXT,
      f) PSELFEXT.
   f. Note: CONTRACTOR shall provide calculated normalized attenuation (to 100 meters) as part of the submitted test data in addition to the attenuation reported by the test equipment.

g. The results for item ‘e’ above shall be provided for all pairs and pair combinations and for both directions of the link, as required by the TIA specifications for each test parameter.
   a) Length (in feet), propagation delay, delay skew.
   b) Results of ambient noise tests.
   c) Cable manufacturer, cable part number, cable type and NVP for the cable.
   d) Tester manufacturer, model, serial number, hardware version, software version.
   e) Tester auto test specifications used.
   f) Date of test.

3.04 TRAINING

A. Provide training in accordance with Section 280500, Demonstration.

   1. Provide Video of training.

END OF SECTION
SECTION 280514 - FIBER OPTICS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Fiber Optic Cable.
   2. Fiber Optic Connectors.
   3. Fiber Optic Patch Panel.
   4. Fiber Optic Jumper Cables.
   5. Fiber Optic Inner Duct.
   6. Fiber Video Transmitter and Receiver.
   7. Fiber Data Transmitter and Receiver.
   8. Fiber Video and Data Transmitter and Receiver.

B. Related Sections, shall include but not be limited to:
   1. 280500 General Requirements
   2. 280514 Fiber Optics
   3. 280528 Raceways and Boxes
   4. 281300 Access Control System
   5. 281500 Electronic Systems and Components
   6. 282300 Video Surveillance (CCTV) System

1.02 REFERENCES

A. CODES AND STANDARDS
   1. Underwriters Laboratories (UL).
   4. Occupational Safety and Health Administration (OSHA): National, state and local building and fire codes.
5. ANSI/TIA 455, standard Test Procedures for Fiber Optics, Current Issue.


7. ANSI/TIA -569, Commercial Building Standard for Telecommunications Pathways and Spaces, current issue


10. ANSI/TIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications current issue.


12. TIA TSB-95 Additional Transmission Performance Guidelines for 4-Pair 100 ohm Category 5e Cabling with Addendums.


14. IEEE 802.3 (Ethernet), 802.3Z (Gigabit Ethernet over optical fiber), 802.3ab (Gigabit Ethernet over 4 pair Category 5 or higher).


16. FCC Part 68.50.

17. National Electrical Manufacturer’s Association (NEMA).


1.03 SYSTEM DESCRIPTION

A. Design/Installation Requirements:

1. Provide and install pathway and cabling as required and assure all splices are fusion spliced or epoxy polishing as a minimum...

2. Furnish and install both single and multi-mode fiber from each IDF room/data closet/guard shack to the main data room. This single and multi-mode fiber shall be 24 count fiber cables and shall be installed from each IDF room/closet/shack to the main data room. The multi-mode fiber cable shall meet OM4 specifications/ requirements. Furnish and install all appropriate cables, connectors, patch cords, and cable management hardware internal to the cabinets/racks in each IDF room and main data room.

3. Install and functionally test all fiber equipment which shall include but is not limited to transmitters, receivers, patch panels, mounts, and racks. Refer to Part 3 for test requirements.
A. Conform to the requirements of Section 280500, General.

1.05 SITE CONDITIONS

A. Conduit routing shown on the Drawings is approximate, actual routing will depend on site conditions and code requirements. Conduit pathways to be field verified by the contractor.

1.06 QUALITY ASSURANCE

A. The Work of this section shall conform to Southern Nevada Code of Regulations and other applicable codes and standards.

B. Include in the material list submission, copies of manufacturer certifications that the installer is an authorized installer of the manufacturer products and has been adequately trained in the installation of those products.

C. System startup and testing shall be performed under the direct observation of the electrical engineer responsible for preparation of the Shop Drawings.

1.07 WARRANTY

A. Provide a minimum of 15 year system performance warranty for the installed data cabling system, components of the optical data backbone cable system, cables, connectors, and transmission speeds of 10 Gigabit/sec (1000 Base X) commencing upon the date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide Fiber Optics System’s equipment and components including, but not limited to, the following:

1. Fiber Optic Cables
   a. Corning
   b. Belden
   c. Commscope
   d. Or approved equal

2. Fiber Optic Connectors (Same as Fiber Optic Cables for End to End Solution)
   a. Corning
   b. Belden
   c. Commscope
3. Fiber Optic Patch Panel (Same as Fiber Optic Cables for End to End Solution)
   a. Corning
   b. Belden
   c. Commscope
   d. Or approved equal

4. Fiber Optic Jumper Cables
   a. Corning
   b. Belden
   c. Commscope
   d. Or approved equal

2.02 MULTI-MODE FIBER CABLES

A. Optical fiber shall be multimode, graded index, optical fiber wave guide with nominal 50 micron – core/cladding diameter. The optical fiber shall comply with OM4 specifications and requirements.

B. Mechanical and environmental specifications for multi-mode fiber distribution cables shall be indoor/outdoor, tight-buffered type cables. The cable shall meet the requirements of NEC Section 770. Confirm that the cable is listed for the specified application.

C. Cabled optical fibers shall meet the graded performance specifications of OM4/ ANSI/TIA 568. Attenuation shall be measured in accordance with ANSI/ TIA-455-46, -53, or -61. Information transmission capacity shall be measured in accordance with ANSI/ TIA-455-51 or -30. The cable shall be measured at 23 degrees C. and 5 degrees C.

D. Multi-mode fiber optic cable shall meet the following minimum performance requirements:
   1. Minimum bandwidth capability at 850 nm: 3500 MHz/kilometer.
   2. Minimum bandwidth capability at 1,300 nm: 500 MHz/kilometer.
   3. Maximum attenuation at 850 nm: 3.5 dB/kilometer.
   4. Maximum attenuation at 1,300 nm: One dB/kilometer.

E. Utilize gigabit enhanced 50 micron multi-mode fiber; provide performance warranty that the multi-mode optical cable will support 10 Gigabit - 1000 Base X gigabit Ethernet transmission up to 550 meters at 850 nm using SX optics.
A. Single-mode optical fibers shall be Class IV a dispersion-unshifted single-mode optical fibers and shall comply with ANSI/TIA-492. Fiber conductors shall have a nominal core diameter of 8.7 microns. Cables shall have transmission window centered at 1,310 nm and 1,550 nm wavelengths.

B. Mechanical and environmental specifications for single-mode fiber distribution cables shall be indoor/outdoor, tight-buffered type cables. Cables shall meet the requirements of NEC Section 770. Contractor shall confirm the cable is certified for the specified application.

C. Cabled optical fibers shall meet the attenuation performance specifications of table ANSI/TIA 568 A, Chapter 12, Table 12-3. Attenuation shall be measured in accordance with ANSI/TIA-455-78A or -61. Cables shall be measured at 23 degrees C. and 5 degrees C.

D. Single-mode fiber optic cable shall meet the following minimum performance requirements:

1. Maximum attenuation at 1,310 nm: 0.5 dB/kilometer (inside cables).
2. Maximum attenuation at 1,550 nm: 1.0 dB/kilometer (inside cables).

2.04 FIBER OPTIC PATCH PANEL

A. Replace rack mounted fiber bulkheads in customer fiber enclosure to support re-terminations as called out to LC.

2.05 FIBER OPTIC JUMPER CABLES

A. Multi-mode 50 micron or single-mode duplex cable, OFNR-rated. Length shall be 1 meter at minimum, pre-manufactured with SC-SC connectors with same transmission characteristics as the terminated fibers – see termination types.

B. Fiber optic patch cables shall be jacketed with polyvinyl chloride with yellow indicating a single-mode patch cable and orange indicating a multi-mode patch cable. The cable shall meet requirements of ANSI/TIA-568-B.3 except where more stringent requirements on bandwidth and attenuation are specified.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Backbone Cabling:

1. Proper bending radius and pulling strength requirements of cables shall be followed during handling and installation. Cables, splice cases, punch-down frames, LIUs, patch panels and supporting hardware shall be installed in accordance with manufacturer recommendations.
2. Interior innerduct and cable shall be Plenum or Riser rated, as required by applicable code regulation or standard. Riser rated innerduct as a minimum shall be installed on floor-to-floor fiber optic cabling.
3. Interior fiber shall be installed in conduit or raceway unless installed in the cable tray system where corrugated innerduct shall be used. Innerduct runs without conduit shall be
installed properly strapped and supported every 4 feet. Innerduct shall be rated for indoor or outdoor use as applicable.

4. Cables in panels, cabinets, trays, and racks shall be neatly grouped and strapped with sufficient service loop using tie-wrap cable straps. Cables and panels shall be clearly identified at both ends with a unique cable numbering system and in compliance with TIA 606.

5. All fiber optic strands shall be terminated using fusion splicing or epoxy polishing.

B. Racks/Cabinets:

1. Racks and cabinets shall be floor- or wall-mounted, as required, and provided with tip bars and additional accessories as required for a complete functional system. Racks and cabinets shall be seismically braced.

C. Labeling and Marking:

1. Provide complete cable location chart and as-built documentation in an envelope and attach to the inside rear doors of distribution frame cabinets in wiring spaces.

2. Mark distribution panels, cables and cover plates with computer-generated labels. Drops shall be labeled with the same identifier on the receptacle faceplate, inside the junction box, on the cable at the jack, on the cable at the patch panel, on the termination side of the patch panel, and on the patch side of the patch panel. Cable markers shall be located within 2 inches of the end of the cable jacket and shall be clearly readable. Panel labels shall be computer-generated and printed using a laser printer. A disk with the label files shall be submitted as part of the project record documents.

3. Cable Identification Methodology: Utilize the room numbers of the facility to identify individual drops for new and existing facilities. Room number shall be comprised of the first three digits of the numbering scheme. In large facilities requiring more than three digits or in facilities with alphanumeric room identifiers, adjust the numbering scheme accordingly. Identifiers shall be unique and in compliance with TIA 606.

3.02 CERTIFICATION AND TESTING OF CABELLING SYSTEM

A. Cables and termination hardware shall be 100 percent tested for defects in installation and to verify cable performance under installed conditions, these test results shall be submitted to the Owner for review no less than 14 calendar days after completion of all testing. Conductors of installed cables shall be verified. Defects in the cabling system installation including, but not limited to, cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100 percent effectiveness.

B. Contractor shall be Fluke CCIT Certified.

C. Contractor shall be certified in cabling manufacturer being installed for this project. Certification to be provided with submittal documentation.

D. Fiber Optics:

1. Terminate, test, and document multi-mode and single-mode fiber optic cables with connectors at the drop locations and on fiber optic patch panels.
2. Fiber optic cables shall meet ANSI TIA performance standards and shall be tested in accordance with applicable standards. Light source and power meter tests shall be dual wavelength and bi-directional, while OTDR tests shall be performed with sufficient launch cables installed at both ends of the fiber run to clearly identify the mated connectors.

   a. Multi-mode fiber optic cable runs shall be tested in both directions at both wavelengths with a power meter and light source combination that can verify distance and attenuation at each wavelength.

   b. Single-mode fiber optic cable runs less than or equal to 100m shall also be tested in both directions at both wavelengths with a power meter and light source combination that can verify distance and attenuation at each wavelength.

   c. Single-mode fiber optic cable runs greater than 100m shall be tested with an OTDR, light-source, and power meter.

   d. Manufactured reel test results will not be acceptable, Contractor shall provide the contractually required fiber test requirements/results.

   e. The RTC will accept fiber connectors to be either epoxy polish, field fusion splice or fusion spliced.

END OF SECTION
SECTION 280528 - RACEWAYS AND BOXES

PART 1  GENERAL

1.01  RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other specifications, apply to this Section.

1.02  SUMMARY

A. Section Includes:

1. Rigid Galvanized Steel Conduit (RGS).
2. Electrical Metallic Tubing (EMT).
3. Rigid Non-metallic Conduit (PVC).
4. Flexible Metal Electrical Conduit.
5. Liquid-tight Flexible Steel Conduit.
7. Cable Trays.
8. Fittings, Couplings, and Connectors.
10. Outdoor Outlet Boxes.
11. Indoor Outlet Boxes and Small Junction and Pull Boxes.
12. Firestopping/sealant materials

B. Related Sections:

1. 280500 Electronic Systems General Requirements
2. 280513 Conductors and Cables
3. 280514 Fiber Optics
4. 281300 Access Control System
5. 281500 Electronic Components
6. 282300 Video Surveillance (CCTV) System

1.03  REFERENCES
A. ANSI C80.2 Rigid and Steel Conduit.
B. ANSI C80.3 Electrical Metallic Tubing - Zinc Coated.
C. ANSI 870 Wireways, Auxiliary Gutters, and Associated Fittings.
D. NECA Standard of Installation.
E. NEMA FB 1 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit
F. NEMA OS 1 Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
G. SNEC Southern Nevada Electrical Code, (based on National Electrical Code)
H. UL 1 Flexible Metal Conduit.
I. UL 5 Surface Metal Raceways and Fittings.
J. UL 50 Cabinets and Boxes.
K. UL 360 Liquid-Tight Flexible Conduit.
L. UL 514A Metallic Outlet Boxes.
M. UL 514B Fittings for Conduit and Outlet Boxes.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Raceway Size: Use a minimum conduit inside diameter of 3/4-inch. Size conduit and raceway for a maximum cross-sectional fill area of 40%.
   2. Gutter, Wireway and Trough Size: Size for a maximum cross-sectional fill area of 20%.
   3. Raceway Support: For each support and group of fasteners provide strength equal to the maximum weight of the present load plus all future raceways for which the support provides space, times a safety factor. Except as otherwise indicated, use a safety factor greater than four (4) where necessary to provide a minimum safety allowance of 200 lbs. Provide additional support strength where required to prevent distortion of raceway during wire pulling.
   4. Equipment Ground Conductor (Green): Where indicated, shown or required, raceway sizes shall be adequate to include the circuit conductors, an equipment ground conductor and a neutral conductor in accordance with percentage of fill requirements as specified.

1.05 SUBMITTALS

A. Conform to the requirements of specifications.
B. Product Data: Submit manufacturer’s technical data for all items to be used including specifications, installation instructions and general recommendations.
C. Shop Drawings: Submit scale plan and elevation drawings of raceway systems showing layout and size of raceways, pull boxes and junction boxes within three (3) feet of equipment to be installed by this contract.

D. Record Drawings: Provide shop drawings showing as-built conditions of all raceways, termination boxes, junction boxes, pull boxes and installed equipment.

1.06 SITE CONDITIONS

A. Conduit routing shown on the Drawings is diagrammatic and approximate, actual routing will depend on site conditions and code requirements.

B. Coordinate with the Owner for approved locations of conduit and equipment installation in the existing facility.

PART 2 PRODUCTS

2.01 RACEWAY (WHERE OWNER APPROVED)


2.02 RIGID GALVANIZED STEEL CONDUIT (RGS)

A. Rigid steel conduit zinc coated shall conform to ANSI C80.2.

2.03 ELECTRICAL METALLIC TUBING (EMT)

A. EMT, zinc coated shall conform to ANSI C80.3.

2.04 RIGID NON-METALLIC CONDUIT (PVC)

A. Rigid non-metallic conduit shall be Schedule 40 PVC conduit manufactured in compliance with NEMA TC-2. PVC conduit shall be U.L. listed. Joints shall be solvent cement type.

B. Provide PVC elbows, bends, fittings and adapters as required for a complete installation. Provide solvent cement as recommended by the conduit manufacturer.

2.05 FLEXIBLE METAL ELECTRICAL CONDUIT (GREENFIELD)

A. Flexible metal electrical conduit shall conform to UL 1.

2.06 LIQUID-TIGHT FLEXIBLE STEEL CONDUIT

A. Liquid-tight flexible steel conduit shall conform to UL 360.

B. Sizes 1.25 inches and smaller: Provide with a continuous copper bonding conductor wound spirally between convolutions.

C. Sizes 1.5 inches and larger: Provide with an internal grounding conductor and grounding bushings.

D. Also known as Seal Tight flexible conduit.

2.07 GUTTERS, WIREWAYS AND TROUGHS
A. Use NEMA Type 12.

B. Use 14 gauge bodies and covers.

C. Use above and below wall-mounted enclosures and cabinets for the collection of field device conduits, wires, and cables.

D. Do not use in inaccessible locations.

2.08 CABLE TRAYS

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

2. Cooper B-Line, Inc.
4. GS Metals Corp.; GLOBETRAY Products.
5. MONO-SYSTEMS, Inc.
6. MPHusky.
7. PW Industries.
8. Wirewood; Field mate wire basket.

B. Materials and Finishes

1. Cable Trays, Fittings, and Accessories: Aluminum, complying with NEMA VE 1, Aluminum Association's Alloy 6063-T6 for rails, rungs, and cable trays, and Alloy 5052-H32 or Alloy 6061-T6 for fabricated parts; with chromium-zinc, ASTM F 1136, splice-plate fasteners, bolts, and screws

C. Cable Tray Accessories

1. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
2. Barrier Strips: Same materials and finishes as cable tray.
3. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

D. Warning Signs

1. Revise size of lettering in first paragraph below to suit 25-foot (7.6-m) viewing distance.

2. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."
2.09 FITTINGS, COUPLINGS AND CONNECTORS

A. Fittings for conduit and outlet boxes shall conform to UL 514B.

B. Surface metal electrical raceways and fittings shall conform to UL 5.

C. Use fittings listed and equally acceptable for specific conduit or raceway system used; e.g.: Use PVC coated fittings with PVC coated conduit.

D. For threaded rigid steel conduit, do not use threadless or compression type fittings.

E. For EMT, provide steel or malleable iron "concrete-tight" or "rain-tight" couplings and connectors. Use compression; set screw or stainless steel multiple locking type bodies. Do not use indentation type fittings.

F. Bushing and connectors shall be insulated type which maintain continuity of conduit grounding system. Insulating material shall be molded or locked into metallic body of the fitting. Bushings made entirely of nonmetallic material will not be allowed.

G. Set screw connectors and couplings body shall have wall thickness at least equal to wall thickness of conduit used. Couplings or conduit trade size ¾-inch through 2 inch shall have two set screws per fitting and 2.5-inch through 4-inch shall have four (4) set screws per fitting. Set screws shall be case hardened steel with hex head and cup point.

H. Provide flexible metal conduit fittings made of steel or malleable iron. Insulate with one (1) of the following types:

1. Wedge and screw type having an angular wedge fitting between the convolutions of the conduit.

2. Squeeze or clamp type having a bearing surface contoured to wrap around the conduit and clamped by one (1) or more screws.

3. Steel, multiple point type, for threading into internal wall of the conduit convolutions.

I. Liquid-tight flexible metal conduit shall incorporate a threaded grounding cone, steel, nylon or equal plastic compression ring and a gland for tightening. Fitting shall be steel or malleable iron with insulated throat, with male thread and locknut or male bushing with or without "O" ring seal.

J. Expansion fittings shall be hot-dipped galvanized malleable iron with a packing ring to prevent entrance of water, a pressure ring, a grounding ring and a separate external copper bonding jumper.

K. Inferior material such as "pot metal" shall not be used for any type of fitting.

L. All locknuts shall be the bonding type with sharp edges for digging into the metal wall of an enclosure.

2.010 SUPPORTING DEVICES

A. General: Provide supporting devices with manufacturer's standard materials, designed and constructed in accordance with published product information, for a complete installation.
B. Raceway Supports: Provide manufacturer’s standard supports including clevis hangers, riser clamps, and conduit straps, threaded C-clamps with retainers, ceiling trapeze, wall brackets and spring steel clamps.

C. Corrosion Resistance: Provide all supports, support hardware and fasteners hot-dipped galvanized or cadmium plated.

D. Fasteners: Provide fasteners as required by the type of wall or ceiling construction and the equipment to be supported by the fastener.

E. U-Channel Strut Systems: Provide minimum 12 gauge U-channel strut system for mounting and supporting electrical equipment. Fittings shall mate with the U-channel.

F. Fittings for Strut System: Galvanized steel end caps, conduit clamps, conduit hangers, U-bolts.

2.011 OUTDOOR OUTLET BOXES

A. Conform to NEMA FB 1, for fittings, cast metal boxes and conduit bodies.

B. Provide electrical boxes and fittings which are UL-listed and labeled, and conform to UL 50, UL 514A, UL 514B, and UL 514C.

C. Select covers for boxes of types appropriate for each use and location.

D. Provide gaskets for covers of boxes in damp locations.

E. Corrosion resistance: Provide galvanized or other equally acceptable corrosion resistant finish for all boxes, accessories and fittings.

2.012 INDOOR OUTLET BOXES AND SMALL JUNCTION- AND PULL-BOXES

A. Conform to NEMA OS 1 for sheet-steel outlet boxes, device boxes, covers and box supports. Provide minimum 4-inch square by 1.5-inch deep, one piece, deep-drawn, galvanized steel, outlet boxes for general use. Provide square cornered, straight sided gang boxes wherever required by SNEC or more than two (2) wiring devices are indicated in the same location. Provide boxes of increased depth where required by the project conditions.

B. Furnish with stamped knockouts in the back and sides.

C. Provide threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices.

D. Accessories: Provide outlet box accessories as required for each installation, including plaster covers, mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used and fulfilling requirements of individual wiring situations.

2.013 FIRESTOPPING/SEALANT MATERIALS

A. Accepted Products: International Protective Coatings Corp. FlameSafe® FSP 1100, Nelson FSP, Domtar Fire-Halt® or approved equal.

PART 3 EXECUTION
3.01 INSTALLATION

A. Penetrations:

1. Firestop and seal all penetrations of fire walls and floors with minimum three (3) hour sealant or Fire Stop Putty (FSP). This includes but is not limited to all raceway, conductor, sleeve and cable tray penetrations where penetrating device does not completely seal the hole.

2. Provide a suitable caulk for purposes of speech privacy and air flow restriction where a fire rated seal is not required.

B. Raceways and Fittings:

1. Comply with SNEC, for application, size, location and installation of each type of raceway.

2. Where not specifically shown on the drawings or specified, use the following guidelines for the selection of raceway types:
   a. RGS – Exposed exterior and wet locations. Areas subject to physical damage or vandalism.
   b. EMT – Concrete encased. Interior dry exposed locations.
   c. PVC –. Below grade or under concrete slab. Use metal risers.
   d. Flexible Metal – Use to connect to equipment that must be mechanically isolated or shifted to final position in indoor dry locations only. Use where conduit must be fished in building voids. Do not use in corrosive atmosphere.
   e. Liquid-Tight Flexible Metal – Use when flexible metal is required in wet or outdoor locations.

3. Install no more than the equivalent of three (3) 90-degree bends between boxes.

4. Conduit and EMT runs shall be mechanically and electrically continuous from service entrance to all outlets. Each conduit shall enter and be securely connected to a cabinet, junction box, pull box or outlet by means of a locknut on the outside and a bushing on the inside or by means of a liquid-tight, threaded, self-locking, cold-weld type wedge adapter.

5. Keep conduit at least 6 inches away from parallel runs of steam and hot-water pipes.

6. Level and square raceway runs.

7. Complete installation of electrical raceways before starting installation of cables/wires within raceways.

8. Provide supports for raceways as specified.

9. Prevent foreign matter from entering raceways; use temporary closure protection.

10. Make bends and offsets so the inside diameter is not effectively reduced.
11. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs offsets parallel.

12. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location.

13. Run raceways with a minimum number of bends. All bends shall have the longest possible radii.

14. Install exposed raceways parallel and perpendicular to nearby surfaces or exposed structural members, and follow the surface contours.

15. Run exposed, parallel or banked raceways together.

16. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs where they can be installed parallel.

17. Join and terminate raceways with fittings designed and equally acceptable for the purpose of the raceway system and make up tight.

18. Where the installation is such that joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system.

19. Make the set screws of threadless fittings up tight; do not use pliers. Compression fittings shall be tightened with two wrenches.

20. Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts so that the dished part is against the box.

21. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder.

22. Where chase nipples are used, align the raceway and coupling square to the box and tighten the chase nipple so no threads are exposed. Running threads are not allowed.

23. Install nylon pull strings in empty raceways. Leave not less than 12 inches of slack at each end of the conduit.

24. Horizontal cross runs of conduit or EMT may be installed in partitions only where explicitly permitted. Exposed horizontal runs, where permitted, shall be installed close to ceiling or ceiling beams.

25. Conduits and EMT connected to wall outlets shall be run in such a manner that they will not cross water, steam or waste pipes or radiator branches.

26. Conduits and EMT shall not be run through beams, except where clearly indicated on drawings or where permitted.

27. Conduits and raceways above suspended ceilings may be supported from the floor construction above or from the main ceiling support members, however, the finished installation shall not interfere with the removability of ceiling panels.

28. At building expansion joints, provide expansion fittings and cross at right angles to joint.
29. Provide conduits stubbed up through or from concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs, set flush with the finished floor. Where no equipment connections are made, install screwdriver-operated threaded flush brass plugs in conduit end.

30. Provide expansion fittings for all rigidly fastened conduits spanning a building expansion joint and if not otherwise provided, for all runs 1.5 inches or larger, exceeding 150 feet in length.

C. Cable Tray Installation

1. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.

2. Remove burrs and sharp edges from cable trays.

3. Fasten cable tray supports to building structure and install seismic restraints.
   a. Design each fastener and support to carry load indicated by seismic requirements.
   b. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
   c. Support bus assembly to prevent twisting from eccentric loading.
   d. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.
   e. Locate and install supports according to NEMA FG 1.

4. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.

5. Make cable tray connections using standard fittings.

6. Workspace: Install cable trays with enough space to permit access for installing cables.

7. Install barriers to separate cables of different systems, such as power, communications, and data processing.

8. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

D. Boxes and Fittings:

1. Coordination: Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work, and with general construction work.

2. Weatherproof: Provide weatherproof outlets for all interior and exterior locations exposed to weather or moisture.