SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings.
2. Foundation walls.
3. Slabs-on-grade.
4. Sinker and Anchor Blocks.

1.02 DEFINITIONS

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

1.03 SUBMITTALS

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

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.

©COPYRIGHT 2012 CH2M HILL

E. Welding certificates.

F. Qualification Data: For testing agency.

G. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

H. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Waterstops.
6. Curing compounds.
7. Floor and slab treatments.
8. Bonding agents.
9. Adhesives.
10. Vapor retarders.
11. Semirigid joint filler.
12. Joint-filler strips.
13. Repair materials.

I. Floor surface flatness and levelness measurements to determine compliance with specified tolerances, as noted in the Plans.

J. Field quality-control test reports.

K. Minutes of preinstallation conference.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94 requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

©COPYRIGHT 2012 CH2M HILL

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated, as documented according to ASTM E548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

G. Concrete Testing Service: Contractor shall engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

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

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Concrete subcontractor.

©COPYRIGHT 2012 CH2M HILL

2. Review special inspection and testing and inspecting agency procedures for field quality control, curing procedures, construction contraction and isolation joints, and joint-filler strips, forms and form removal limitations, vapor-retarder installation, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.02 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
   a. High-density overlay, Class 1 or better.
   b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.

©COPYRIGHT 2012 CH2M HILL

c. Structural 1, B-B or better; mill oiled and edge sealed.
d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

E. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

F. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

G. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.03 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615, Grade 60, deformed and Grade 40 deformed bars for welding only.

B. Plain-Steel Wire: ASTM A82, galvanized.

C. Deformed-Steel Welded Wire Reinforcement: ASTM A497, flat sheet.

©COPYRIGHT 2012 CH2M HILL

2.04 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A615, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

C. Reinforcement Tie Wire – Shall be non-corrosive (hot-dipped galvanized).

2.05 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C150, Types I or III, gray. Supplement with the following:
   a. Fly Ash: ASTM C618, Class F.
   b. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.

B. Silica Fume: ASTM C1240, amorphous silica.

C. Normal-Weight Aggregates: ASTM C33, Class 1N coarse aggregate or better, graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Water: ASTM C94 and potable.

2.06 ADMIXTURES

A. Air-Entraining Admixture: ASTM C260.

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.

©COPYRIGHT 2012 CH2M HILL

C. Mix designs to be used for concrete flatwork with a hand trowel. Finish shall contain no entrained air, and a maximum of 3 percent entrapped air.

1. Water-Reducing Admixture: ASTM C494, Type A.
2. Retarding Admixture: ASTM C494, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017, Type II.

D. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494, Type C.

1. Available Products:
   a. Boral Material Technologies, Inc.; Boral BCN.
   b. Euclid Chemical Company (The); Eucon CIA.
   c. Grace Construction Products, W. R. Grace & Co.; DCI.
   d. Master Builders, Inc.; Rheocrete CNI.
   e. Sika Corporation; Sika CNI.

E. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

1. Available Products:
   a. Axim Concrete Technologies; Catexol 1000CI.
   b. Boral Material Technologies, Inc.; Boral BCN2.
   c. Grace Construction Products, W. R. Grace & Co.; DCI-S.
   d. Master Builders, Inc.; Rheocrete 222+.
   e. Sika Corporation; FerroGard-901.

2.07 VAPOR RETARDERS

A. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

B. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D448, 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 C33 for fine aggregates.

©COPYRIGHT 2012 CH2M HILL

2.08 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.
   k. Meadows, W. R., Inc.; Sealtight Evapre.
   l. Metalcrete Industries; Waterhold.
   m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
   n. Sika Corporation, Inc.; SikaFilm.
   o. Symons Corporation, a Dayton Superior Company; Finishing Aid.
   p. Unitex; Pro-Film.
   q. US Mix Products Company; US Spec Monofilm ER.
   r. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 ounces/square yards when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Available Products:
   a. Anti-Hydro International, Inc.; AH Clear Cure WB.
   b. Burke by Edoco; Spartan Cote WB II.
   c. ChemMasters; Safe-Cure & Seal 20.
   d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Cure and Seal WB.
   e. Dayton Superior Corporation; Safe Cure and Seal (J-18).

©COPYRIGHT 2012 CH2M HILL

f. Euclid Chemical Company (The); Aqua Cure VOX.
g. Kaufman Products, Inc.; Cure & Seal 309 Emulsion.
h. Lambert Corporation; Glazecote Sealer-20.
i. L&M Construction Chemicals, Inc.; Dress & Seal WB.
j. Meadows, W. R., Inc.; Vocomp-20.
k. Metalcrete Industries; Metcure.
l. Nox-Crete Products Group, Kinsman Corporation; Cure & Seal 150E.
m. Symons Corporation, a Dayton Superior Company; Cure & Seal 18 Percent E.
n. Tamms Industries, Inc.; Clearseal WB 150.
o. Unitex; Hydro Seal.
p. US Mix Products Company; US Spec Hydrasheen 15 percent
q. Vexcon Chemicals, Inc.; Starseal 309.

2.09 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 per ASTM D2240.

C. Bonding Agent: ASTM C1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types I and II, non-load bearing 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.

©COPYRIGHT 2012 CH2M HILL

2.10 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 C150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
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 6,500 psi at 28 days when tested according to ASTM C109.

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 C150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
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 C109.

2.11 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.
2. Combined Fly Ash and Pozzolan: 25 percent.
3. Ground Granulated Blast-Furnace Slag: 50 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.

©COPYRIGHT 2012 CH2M HILL

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 0.10 percent by weight of cement.

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

1. Use high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

2.12 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings, Sinker Blocks and Anchor Block: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4,000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.38.
3. Slump Limit: 3 inches; 8 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.
5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size.

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

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Minimum Cementitious Materials Content: 564 lb/cu. yd.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Maximum Water-Cementitious Materials Ratio: 0.45.
5. Air Content: Air content of hard troweled finished floors shall not exceed 3 percent.

©COPYRIGHT 2012 CH2M HILL

2.13 FABRICATING REINFORCEMENT

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

2.14 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94, and furnish batch ticket information.

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

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cubic yard 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 cubic yard, increase mixing time by 15 seconds for each additional 1 cubic yard.
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

3.01 FORMWORK

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

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

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:

1. Class A, 1/8 inch for smooth-formed finished surfaces.
2. Class B, 1/4 inch for rough-formed finished surfaces.

©COPYRIGHT 2012 CH2M HILL

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.

3.02 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."

©COPYRIGHT 2012 CH2M HILL

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.

3.03 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 degrees 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.

3.04 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.

©COPYRIGHT 2012 CH2M HILL

3.05 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.

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.

3.06 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

©COPYRIGHT 2012 CH2M HILL

6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least 1/4 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.

3.07 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.

©COPYRIGHT 2012 CH2M HILL

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

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

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

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. 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.

©COPYRIGHT 2012 CH2M HILL

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.08 FINISHING FORMED SURFACES

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

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

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

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

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

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

©COPYRIGHT 2012 CH2M HILL

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.

3.09 FINISHING 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 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.

3.10 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.

3.11 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.

©COPYRIGHT 2012 CH2M HILL

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 pounds/square foot by h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

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

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

©COPYRIGHT 2012 CH2M HILL

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
   a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.12 LIQUID FLOOR TREATMENTS

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

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than seven days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.13 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one month. 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.

©COPYRIGHT 2012 CH2M HILL

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.

3.14 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.

©COPYRIGHT 2012 CH2M HILL

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.

3.15 FIELD QUALITY CONTROL

A. Testing and Inspecting: Contractor shall engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

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

©COPYRIGHT 2012 CH2M HILL

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 (By Contractor): 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 cubic yard, but less than 25 cubic. yards, plus one set for each additional 50 cubic yards or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cubic yard 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 C143; 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 C231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C1064; one test hourly when air temperature is 40 degrees F and below and when 80 degrees F and above, and one test for each composite sample.
6. Unit Weight: ASTM C567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C31.
   a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
8. Compressive-Strength Tests: ASTM C39; 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.

©COPYRIGHT 2012 CH2M HILL

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 C42 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 does not comply with the Contract Documents.

E. Contractor shall measure floor and slab flatness and levelness according to ASTM E1155 within 24 hours of finishing.

END OF SECTION

©COPYRIGHT 2012 CH2M HILL

Page Intentionally Left Blank

©COPYRIGHT 2012 CH2M HILL

SECTION 04 10 00
MORTAR

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Mortar for unit masonry.

B. Grout for reinforced masonry.

1.02 SUBMITTALS

A. Product Data: Manufacturer's product data for each type material, including certifications that each type complies with specified requirements.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver masonry materials to project in undamaged condition.

B. Store cementitious materials off the ground, under cover and in dry location.

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

PART 2 PRODUCTS

2.01 MATERIALS

A. Portland Cement: ASTM C150, Type I. Provide natural color or white cement as required to produce required mortar color.

B. Masonry Cement: ASTM C91.

C. Hydrated Lime: ASTM C207, Type S.

D. Aggregate for Mortar: ASTM C144.

E. Aggregate for Grout: ASTM C404.

F. Colored Mortar Pigments:

1. Characteristics: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes.
2. Source Products/Manufacturers:
   a. SGS Mortar Colors; Solomon Grind-Chem Services, Inc.
   b. True Tone Mortar Colors; Davis Colors, A Subsidiary of Rockwood Industries, Inc.

©COPYRIGHT 2013 CH2M HILL

G. Water: Clean and potable.

2.02 MIXES

A. Do not add admixtures including coloring pigments, air-entraining agents, accelerators, retarders, water repellent agents, anti-freeze compounds or other admixtures, unless otherwise indicated.

B. Do not use calcium chloride in mortar or grout.

C. Mixing: Combine and thoroughly mix cementitious, water and aggregates in a mechanical batch mixer.

1. Measure materials by volume or equivalent weight.
2. Add maximum amount of water allowed to produce workable consistency. If mortar stiffens due to evaporation or absorption, re-temper by adding water and re-mix.
3. Do not use mortar and grout after 1-1/2 hours of initial mixing or after it has begun to set.
4. Grout shall have a slump of 8 to 11 inches at time of placement.

D. Mortar: Comply with ASTM C270, Proportion Specification, for types of mortar required. Limit cementitious materials in mortar to portland cement-lime. Design mixes as follows:

1. Type S Mortar: For reinforced masonry, including masonry below-grade and in contact with earth.
2. Type N Mortar: For exterior, above-grade loadbearing and non-loadbearing walls; for interior loadbearing walls; and for other applications where another type is not indicated.

E. Colored Pigmented Mortar: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10, by weight.

F. Grout: Comply with ASTM C476 for fine or coarse consistency. Design mix as follows:

1. Fine Grout: For grout spaces less than 2 in. in horizontal direction.
2. Coarse Grout: For grout spaces 2 in. or more in least horizontal dimension.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation of mortar and grout is specified in Sections 04 22 00.

©COPYRIGHT 2013 CH2M HILL

3.02 FIELD QUALITY CONTROL

A. Contractor shall coordinate with Contractor's testing laboratory to perform types of masonry field quality control tests for masonry indicated.

B. Field Compressive Test for Mortar: Perform 4 tests prior to start of construction; during construction perform 4 tests for each 25 cubic yards of mortar used in reinforced grouted masonry. Test 2 at 7 days and 2 at 28 days.

1. Spread mortar on masonry units between 1/2 - 3/4 in. thick and allow to stand for one minute, then remove mortar and place in a 2 in. by 4 in. cylinder in two layers, compressing mortar into cylinder using a flat end stick. Lightly tap mold on opposite sides, level off, and immediately cover molds.
2. Keep molds damp until taken to laboratory. After 48 hours set, deliver to laboratory, cap specimens, and place in fog room until tested in damp condition.
3. Perform tests in accordance with ASTM C91.

C. Field Compressive Test for Grout: Perform 4 tests prior to start of construction; during construction perform 4 tests for each 25 cubic yards of grout. Test 2 at 7 days and 2 at 28 days.

1. On a flat non-absorbent base, form a space approximately 3 in. by 3 in. x 6 in. high, using masonry units having same moisture condition as those being laid. Line space with a permeable paper or porous separator so that water may pass through liner into masonry units.
2. Thoroughly mix or agitate grout to obtain a fully representative mix and place into molds in 2 layers, and puddle each layer to eliminate air bubbles. Level off and immediately cover molds and keep damp until taken to laboratory.
3. After 48 hours set, deliver to laboratory, cap specimens, and place them in fog room until tested in damp condition.
4. Perform tests in accordance with ASTM C39.

END OF SECTION

©COPYRIGHT 2013 CH2M HILL

Page Intentionally Left Blank

©COPYRIGHT 2013 CH2M HILL

SECTION 04 22 00
CONCRETE UNIT MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete unit masonry.

1.02 QUALITY ASSURANCE

A. Fire Performance Characteristics: Where indicated, provide materials and construction which are identical to those of assemblies whose fire endurance has been determined by testing in compliance with ASTM E119.

B. Single Source Responsibility: Obtain exposed masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.

1.03 SUBMITTALS

A. Product Data: Manufacturer's product data for each type of masonry unit, and other manufactured products, including certifications that each type complies with specified requirements.

B. Shop Drawings: Cutting and setting drawings for stone trim showing sizes, profiles and locations of each unit required.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver masonry materials to project in undamaged condition.

B. Store and handle masonry units to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion or other causes.

PART 2 PRODUCTS

2.01 SOURCE PRODUCTS/MANUFACTURERS

A. Listed Source Products/Manufacturers are subject to compliance with the requirements, products that may be incorporated into the Work include but are not limited to those listed.

©COPYRIGHT 2012 CH2M HILL

2.02 CONCRETE MASONRY UNITS

A. Concrete Block:

1. Grade N.
2. Nominal Face Dimensions: 16 in. long x 8 in. high x thicknesses indicated.
3. Type II, nonmoisture-controlled units.
4. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.
5. Hollow Loadbearing Block: ASTM C90, normal weight aggregate.

PART 3 EXECUTION

3.01 PREPARATION

A. Do not wet concrete masonry units.

B. Before placing, remove loose rust and other coatings from reinforcing.

3.02 INSTALLATION

A. Build chases and recesses as shown or required for the work of other trades. Provide not less than 8 in. of masonry between adjacent chases and recesses.

B. Cut masonry units using dry cutting motor driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining work. Use full size units without cutting where possible.

C. Lay masonry in running bond with vertical joint in each course centered on units in courses above and below. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4 in. horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Rake back 1/2 unit length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly and remove loose masonry units and mortar prior to laying fresh masonry.

E. As the work progresses, build in items specified under this and other sections of these specifications. Fill in solidly with masonry around built in items.

F. Fill cores in hollow concrete masonry units with grout 3 courses under bearing plates, beams, lintels, posts and similar items, unless otherwise indicated.

©COPYRIGHT 2012 CH2M HILL

G. Mortar Bedding and Jointing:

1. Lay solid masonry units with completely filled bed and head joint.
2. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting courses to cells or cavities to be reinforced or filled with concrete or grout.
3. Maintain 3/8 in. joint widths, except for minor variations required to maintain bond alignment.
4. Cut joints flush for masonry walls which are to be concealed or to be covered by other materials, unless otherwise indicated.
5. Tool exposed joints slightly concave using a jointer larger than joint thickness, unless otherwise indicated.

H. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners or jambs to shift adjacent stretcher units which have been set in position.

I. Place steel reinforcement and grout cells and bond beams as work progresses.

1. Install reinforcing with clear distances of 1-1/2 in. min. between vertical bars and 1/2 in. min. between bars and unit surfaces.
2. Fully grout cavities, cells, and pilasters of masonry walls containing steel reinforcement.
3. Use coarse grout where grout space is 2 in. or more in width and use fine grout where less than 2 in.
4. Install grout in lifts not to exceed 5 ft., as wall is built, stopping pour at 1-1/2 in. below top of masonry joint when grouting is stopped for one hour or more.

3.03 TOLERANCES

A. Maximum variation from plumb in vertical lines and surfaces of columns, walls and arrises:

1. 1/4 in. in 10 ft.
2. 3/8 in. in a story height not to exceed 20 ft.
3. 1/2 in. in 40 ft. or more.

B. Maximum variation from plumb for external corners, expansion joints and other conspicuous lines:

1. 1/4 in. in 20 ft.
2. 1/2 in. in 40 ft. or more.

©COPYRIGHT 2012 CH2M HILL

C. Maximum variation from level of grades for exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines:

1. 1/4 in. in a bay, or 20 ft. maximum.
2. 1/2 in. in 40 ft. or more.

D. Maximum variation from plan location of related portions of columns, walls and partitions:

1. 1/2 in. in a bay, or 20 ft. maximum.
2. 3/4 in. in 40 ft. or more.

E. Maximum variation in cross-sectional dimensions of columns and thicknesses of walls from dimensions shown on Drawings:

1. Minus 1/4 in.
2. Plus 1/2 in.

3.04 REPAIR, POINTING AND CLEANING

A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.

B. During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints including corners, openings and adjacent work to provide a neat, uniform appearance, prepared for application of sealants.

C. After mortar is thoroughly set and cured, remove large mortar particles by hand with wooden paddles and non-metallic scrape hoes or chisels.

D. Clean limestone units to comply with recommendations in "ILI Handbook" published by Indiana Limestone Institute of America.

3.05 PROTECTION

A. During erection, cover top of walls with waterproof sheeting at end of each day's work.

1. Cover partially completed structures when work is not in progress.
2. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

B. Do not apply uniform loading for at least 12 hours after building masonry walls.

©COPYRIGHT 2012 CH2M HILL

C. Do not apply concentrated loads for at least 3 days after building masonry walls.

D. Prevent grout or mortar or soil from staining the face of masonry to be left exposed or painted. Remove immediately grout or mortar in contact with such masonry.

E. Protect base of walls from rain splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.

F. Do not lay masonry units which are wet.

G. Protect completed masonry and masonry not being worked on in the following manner. Temperature ranges indicated apply to mean daily air temperatures except for grouted masonry. For grouted masonry, temperature ranges apply to anticipated minimum night temperatures.

1. 40 to 32 degF: Protect masonry from rain or snow for at least 24 hours by covering with weather resistive membrane.

END OF SECTION

©COPYRIGHT 2012 CH2M HILL

Page Intentionally Left Blank

©COPYRIGHT 2012 CH2M HILL

SECTION 04 30 00
REINFORCED UNIT MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Reinforcing for reinforced unit masonry.

B. Installation of reinforced unit masonry.

1.02 QUALITY ASSURANCE

A. Masonry Inspector shall be certified by ACI in accordance with 530 - Latest Edition.

1.03 SUBMITTALS

A. Mill Certificates: Steel producer's certificates of mill analysis, tensile and bend tests for reinforcement steel required for project.

B. Shop Drawings: Fabrication, bending, and placement of reinforcement bars.

1. Comply with ACI 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures, and ACI 530 - Latest Edition/ASCE-5-05/TMS 402-05 Building Code Requirements for Masonry Structures, with Specification and Commentary.
2. Show bar schedules, diagrams of bent bars, stirrup spacing, lateral ties and other arrangements and assemblies as required for fabrication and placement of reinforcement for unit masonry work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials specified in other Sections:

1. Concrete: Refer to Section 03 30 00.
2. CMU: Refer to Section 04 22 00.
3. Mortar and Grout: Refer to Section 04 10 00.

B. Reinforcement Bars: ASTM A615, deformed bars, Grade 60. Shop-fabricate reinforcement bars which are shown to be bent or hooked.

©COPYRIGHT 2012 CH2M HILL

PART 3 EXECUTION

3.01 PLACING REINFORCEMENT

A. Clean reinforcement of loose rust, mill scale, earth, or other materials which will reduce bond to mortar and grout.

B. Position reinforcement accurately at the spacing indicated. Support and secure vertical bars against displacement.

C. Horizontal reinforcement may be placed as the masonry work progresses. Where vertical bars are shown in close proximity, provide a clear distance between bars of one inch, except for columns and pilasters provide 1-1/2 in. clear distance between bars.

D. Splice reinforcement bars where shown; do not splice at other points unless approved by the Architect/Engineer. In splicing bars or attaching to dowels, lap ends, place in contact and wire tie.

3.02 INSTALLATION

A. Refer to Section 04 22 00 for general installation requirements of unit masonry.

B. Provide formwork and shores as required for temporary support of reinforced masonry elements.

1. Construct formwork to conform to shape, line and dimensions shown. Make sufficiently tight to prevent leakage of mortar, grout, and concrete.
2. Brace, tie and support as required to maintain position and shape during construction and curing of reinforced masonry.

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

D. Lay CMU units with full face shell mortar beds. Fill vertical head joints solidly with mortar from face of unit to a distance behind face equal to not less than the thickness of longitudinal face shells. Solidly bed cross-webs of starting courses and where adjacent to reinforced cores and cells.

E. Use special shaped units where shown, and as required for corners, jambs, sash, control joints, lintels, bond beams and other special conditions.

F. Maintain vertical continuity of core or cell cavities, which are to be reinforced and grouted, to provide minimum clear dimension indicated and to provide minimum clearance and grout coverage for vertical reinforcement bars.

©COPYRIGHT 2012 CH2M HILL

G. Where horizontal reinforced bond beams are shown, use special shaped units to allow for placement of continuous horizontal reinforcement bars.

H. Where bonded pilaster construction is indicated, lay wall and pilaster units together to maximum pour height specified.

I. Grouting:

1. Use Fine Grout per ASTM C476 for filling spaces less than 2 in. in one or both horizontal directions.
2. Use Coarse Grout per ASTM C476 for filling 2 in. spaces or larger in both horizontal directions.

J. Low-Lift Grouting:

1. Provide minimum clear dimension of 2 in. and clear area of 8 sq. in. in vertical cores to be grouted.
2. Place vertical reinforcement prior to laying of CMU. Extend above elevation of maximum pour height as required for splicing. Support in position at max. 10 ft. intervals.
3. Lay CMU to maximum pour height of 5 ft.
4. Pour grout using chute or container with spout. Rod or vibrate grout during placing. Place grout continuously; do not interrupt pouring of grout for more than one hour. Terminate grout pours 1-1/2 in. below top course of pour.
5. Bond Beams: Stop grout in vertical cells 1-1/2 in. below bond beam course. Place horizontal reinforcement in bond beams; lap at corners and intersections as shown. Place grout in bond beam course before filling vertical cores above bond beam.

3.03 FIELD QUALITY CONTROL

A. Contractor shall provide a qualified, certified structural masonry inspection. Masonry construction shall be accomplished under a continual Level B Quality Assurance in accordance with the provisions of ACI 530/ASCE5/MS402 Chapter 1, Section 1.15. Reports shall be submitted to the Engineer.

B. Inspector will provide written certification that structural masonry has been installed in conformance with ACI-530 - latest edition and the Contract Documents.

C. Employ of Masonry Inspector at Owner’s expense.

END OF SECTION

©COPYRIGHT 2012 CH2M HILL

Page Intentionally Left Blank

©COPYRIGHT 2012 CH2M HILL

SECTION 23 13 00
FUEL-OIL STORAGE AND DISTRIBUTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Storage tanks, tank accessories, piping, valves, and specialties for fuel-oil distribution outside.

1.02 DESCRIPTION OF WORK

A. Provide complete fuel oil storage and distribution system, including 1,000 gallon aboveground storage tank, containment piping, leak monitoring fuel dispenser and all accessories.

1.03 DEFINITIONS

A. AST: Aboveground, fuel-oil storage tank(s).

1.04 SYSTEM PERFORMANCE REQUIREMENTS

A. Aboveground, Fuel-Oil Distribution Piping Minimum Working-Pressure Rating: 150 psig.

B. Double-Contained-Piping, Carrier-Pipe Minimum Working-Pressure Rating: 150 psig.

C. Double-Contained-Piping, Secondary-Containment Conduit Minimum Working-Pressure Rating: 5 psig.

D. Fill Piping Minimum Working-Pressure Rating: 100 psig.

E. Minimum Test-Pressure Rating for Inner Tank, Smaller Than 12-Ft Width and Cross-Section: 5 psig.

F. Minimum Test-Pressure Rating for Containment Shell, Smaller Than 12-Ft Width and Cross-Section: 5 psig.

1.05 SUBMITTALS

A. Product Data: Include identification materials and devices; and sizes, dimensions, capacities, pressure ratings, and operating characteristics for the following:

1. Type and size of fuel-oil storage tank (Double wall coated – Base Bid).
2. Type and size of fuel-oil storage tank (Double wall stainless steel – Alternate Option).

©COPYRIGHT 2013 CH2M HILL

3. Submersible, fuel-oil pumps (with autosyphon valve and ball valve).
4. Fuel-oil storage tank accessories and specialty fittings.
5. General- and special-duty valves.
6. Liquid-level gage systems.
7. Clock guage.
8. Interstitial leak guage.
9. Hurricane Tie Down System and Float anchoring connections.
10. Shut off nozzle, swivel and breakaway.
11. Coating System.
12. Electrical Package required to power pumps and other electrical components for the tank system.
13. All stainless hose reel.
14. Stainless steel fill box with ROM door (Roll up).
15. 1-inch dia. marina hose.
16. Meter and Register.

B. Shop Drawings: Include storage tanks, pump nozzle, hose reel, storage box, doors, metering system, accessories, pipe sizes, valves, and specialties (including those listed above). Include details of underground piping, if required. Wiring Diagrams: For each item of equipment with electric power supply. Include ladder-type wiring diagrams for interlock and control wiring required for final installation. Differentiate between factory-installed and field-installed wiring.

C. Welding Certificates: Copies of certificates for welding procedures and personnel.

D. Test Reports: As specified in "Field Quality Control" Article.

E. Maintenance Data: For accessories and specialties to include in maintenance manuals specified in Division 1.

F. Anchorage Engineering: Submit signed and sealed anchorage calculation and details required to support the tank for both hurricane force winds in overturning and as well as uplift for empty tank from storm surge and flooding/buoyancy. Submit detail drawing with minimum use of stainless steel fasteners.

1.06 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of fuel-oil distribution components and are based on specific types and models indicated. Other manufacturers' products with equal performance characteristics may be considered.

B. Distribution Components: Listing/approval stamp, label, or other marking by testing agency acceptable to authorities having jurisdiction, including UL label.

©COPYRIGHT 2013 CH2M HILL

C. Electrical Devices, Components, and Equipment: Listed and labeled according to NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

D. Comply with ASME B31.1, "Process Piping," for fuel oil piping materials and joining requirements.

E. Comply with NFPA 30 and 3A, "Flammable and Combustible Liquids Code," and NFPA 31, "Installation of Oil Burning Equipment," for design and construction, installation, inspection, and testing of fuel-oil distribution system tanks, piping, and other components.

F. Comply with NFPA 70, "National Electrical Code," for electrical connections between wiring and electrically operated devices.

G. Comply with requirements of the EPA and state and local environmental-protection authorities having jurisdiction. Include recording of fuel-oil storage tanks and monitoring of tanks and piping.

H. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

I. Comply with UL 2085 Listed “Protected Tank.

J. Comply with ballistics and impact protection per UL 2085.

K. Both inner and outer steel tanks are to be built and comply to UL Standards.

L. Comply with National Fire Protection Association (NFPA) 30 and 30A.

M. Comply with International Fire Code.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Lift and support fuel-oil storage tanks only at designated lifting or supporting points, as shown on Shop Drawings. Do not move or lift tanks unless empty.

B. Preparation for Transport: Prepare storage tanks, accessories, valves, and specialties for shipping as follows:

1. Ensure that units are dry and internally protected against rust and corrosion.
2. Protect against damage to threaded ends, flange faces, and weld ends.
3. Set valves and specialties in position for handling that avoids damage to seats and operating parts.

©COPYRIGHT 2013 CH2M HILL

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

D. Store valves and specialties with end protectors in place, unless necessary for inspection; then reinstall for storage.

E. Store valves and specialties indoors and maintain temperature higher than ambient dew-point temperature. Support off ground or pavement in watertight enclosures if outdoor storage is necessary.

F. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor if stored inside.

G. Protect flanges, fittings, and piping specialties from moisture and dirt.

1.08 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

1.09 COORDINATION

A. Coordinate pipe materials, sizes, entry locations, and pressure requirements with all aspects and components of tank.

B. Coordinate installation and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Work Interruptions: Leave fuel-oil distribution piping in safe condition if interruptions in Work occur while alterations or repairs are being made to existing or new fuel oil piping.

1.10 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract

©COPYRIGHT 2013 CH2M HILL

Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, executed by fuel-oil storage tank manufacturer agreeing to repair or replace tanks that fail in materials or workmanship within specified warranty period, provided tanks are installed according to manufacturer's written instructions. Failures include structural failures of tanks, including cracking, breakup, and collapse; and failure due to external and internal corrosion if used for storage of fuel oils at temperatures not exceeding 150 degree F.

C. Warranty Period: 30 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 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. Double Wall Fire Protected Fuel-Oil Storage Tanks:
   a. Envirosafe – Fireguard.
   b. Approved Equal.
2. Fuel-Oil Tank Piping Specialties:
   a. Dover Corp.; OPW Fueling Components.
   b. Morrison Bros. Co.
   c. Clay & Bailey Mfg. Co.
3. Liquid-Level Gage Systems:
   a. Krueger Sentry Gauge Co.
   b. Tuthill Corp.; Emco Electronics Div.
   c. Pneumercator, Liquid Level Control Systems.
4. InterstitialLeak-Detection:
   a. Krueger Sentry Guage Co.
5. Fuel Dispensing System:
   a. Hose-Irpco w/ braided synthetic fiber with static wire.
   b. Prop Assembly – Fill Rite.
6. Flow Meter and Metering System:
   a. Total Control Systems.
   b. Approved Equal.

2.02 PIPING MATERIALS

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

©COPYRIGHT 2013 CH2M HILL

2.03 PIPES AND TUBES

A. Steel Pipe: ASTM A53, Schedule 40, Type S or E, Grade A or B, black.

B. RTRP: ASTM D2996 or ASTM D2997 and complying with UL 971.

1. 2- and 3-Inch NPS: 150-psig minimum working-pressure rating.
2. 4- and 6-Inch NPS: 125-psig minimum working-pressure rating. UL requirement for 6-inch NPS is waived.

2.04 PIPE AND TUBE FITTINGS

A. Steel, Welding Fittings: ASTM A 234, seamless or welded; ASME B16.9, butt-welding type or ASME B16.11, socket-welding type.

B. Steel, Threaded Fittings: ASME B16.11, with threads according to ASME B1.20.1.

C. Steel Flanges and Flanged Fittings: ASME B16.5.

2.05 PIPING SPECIALTIES

A. Tank, Pipe Connectors: Comply with UL 567.

B. Piping, Flexible Connectors: Fabricated from materials suitable for fuel-oil service, including 150-psig minimum working-pressure rating, and having threaded ends for 2-inch NPS and smaller and flanged ends for 2-1/2-inch NPS and larger. Stainless-Steel-Hose, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

2.06 VALVES

A. Bronze, Gate Valves: MSS SP-80, Type 2, Class 200. Include ends threaded according to ASME B1.20.1. Solder ends may be furnished for use with copper tube.

B. Bronze, Ball Valves: MSS SP-110; three-piece bolted-body; 400-psig-minimum, WOG, nonshock, working-pressure rating. Include full-port, cast-bronze, chrome-plated bronze ball; PTFE seats; lever handle; and threaded ends according to ASME B1.20.1. Solder ends may be furnished for use with copper tube.

C. Bronze, Check Valves: MSS SP-80, Type 3, Class 200. Include ends threaded according to ASME B1.20.1. Solder ends may be furnished for use with copper tube.

D. Bronze, Vertical Ball Check Valves: ASTM B61 or ASTM B62, two-piece construction; and 400-psig WOG, nonshock, working-pressure rating. Include

©COPYRIGHT 2013 CH2M HILL

integral bronze seats, replaceable stainless-steel ball, and threaded ends according to ASME B1.20.1.

E. UL Valves: UL 842, listed for fuel-oil service.

2.07 FUEL-OIL STORAGE TANKS

A. Description: UL 142 and UL 2085; 1,000 gallon, thermally insulated, fire-resistant, and protected; double-wall (Base Bid – Coated double-wall; Alternate Price - 304 Stainless Steel both walls); horizontal; Above Ground Storage Tank; with primary- and secondary containment walls, and insulation and interstitial space for leak-detection sensor.

1. Tank features shall include:
   a. Access ladder.
   b. Saddle supports with hurricane resistant tie-down requirements (Florida Building Code 2010).
   c. 7.5 gallon overspill container with lockable cap.
   d. Monitoring well with 2 inch cap.
   e. Emergency vent male with o-ring.
   f. Lifting Lugs.
   g. Access manway / manhole.
   h. 2 inches minimum diameter vent stack.
   i. Interstitial leak guage.
   j. Submersible pump 1 hp minimum with retrieval and support chains.
   k. 3/4-inch automatic shut-off nozzle, swivel, break away and 100 feet of marina grade hose (1 inch diameter).
   l. Hose reel with spring retrieval and capacity to support a minimum of 100 feet of hose.
   m. Fuel filtering system.
   n. All required accessories, fittings and piping to provide fully functional system.
   o. Manual shut-off valve in primary line between tank and meter.
   p. Metering System 682-15-SS-L-10.
   q. Grounded with connection to other grounding systems.

B. Fuel tank system shall include a 1,000 gallon tank on support saddles fastened to concrete slab. Access shall be gained to the fuel filling area by way of step landing with railings integral as part of the tank system. Tank system shall contain a stainless steel storage box to house on the center of the long portion of the tank, the metering system, shut off valve, filter and other safety devices as required in a weatherproof box, storage box shall have a aluminum roll-down doors (ROM Brand). Box shall be elevated above the ground to provide shelter for the hose reel and hose dispensing station which are to be placed directly below the storage box. Hose reel shall be spring loaded to permit easy retrieval of the hose from a length of up to 100 feet. General use will consist of reeling the hose to the outside of the yard, down the ramp system, onto the floating docks to

©COPYRIGHT 2013 CH2M HILL

service boats that will be docked along the floating dock area. Hose shall be durable, reinforced hose of a marina grade, permissible to be pulled around corners and objects without kinking, damaging, or tearing of the line. Interstitial space shall have a leak detection sensor. Tank shall have a fuel gauge capable of identifying manually the depth and capacity of the fuel within the system. Fuel nozzle shall be capable of dispensing fuel between 10 and 15 gallons per minute. Fuel metering system shall contain a total gallons dispensed per use, as well as total gallons dispensed over the lifetime of the meter. This will allow monitoring and regulation of the tank usage over its lifetime. Each meter gauge shall be able to be reset to “0” upon pressing a various sequence of buttons.

C. Construction: Fabricated with welded, stainless steel and insulation, and encased in insulation that will protect from fire and wind borne debris from hurricane and be suitable for operation at atmospheric pressure for storing fuel oil with specific gravity up to 1.1 and with test temperature according to UL 2085.

D. Exterior Finish: Stainless Steel, provide permanent signage indicating contents, fill port, external accessory labels, warnings, safety requirements, etc.

2.08 FUEL-OIL STORAGE TANK FITTINGS AND ACCESSORIES

A. Tank Manholes: 18 to 24-inch minimum diameter; bolted, flanged, and gasketed; centered on top of tank.

B. Threaded pipe connection fittings on top of tanks, for fill, vent, and gaging. Include cast-iron plugs for shipping.

C. Striker Plates: Inside tank, on bottom below fill.

D. Lifting Lugs: For handling and installation.

2.09 FUEL-OIL TANK SPECIALTY FITTINGS

A. Fitting Materials: Stainless Steel, malleable-iron, brass, or corrosion-resistant metal; suitable for fuel-oil service.

1. Surface, Flush-Mounted Fittings: Waterproof and suitable for fuel-oil truck traffic.
2. Aboveground-Mounted Fittings: Weatherproof.

B. Spill-Containment Fill Boxes: Flush mounting, with drainage feature to drain oil into tank, threaded fill-pipe connection, and wrench operation. Minimum capacity of 7 gallons.

C. Locking Fill Boxes: UL listed lockable stainless steel box mounted on tank 3 ft x 4 ft x 3 ft cross broken for easy drainage. Provide with a 2 inch vent with 3 ft x 3 ft (roll up) ROM door.

©COPYRIGHT 2013 CH2M HILL

D. Supply and Sounding Drop Tubes: Fuel-oil supply piping or fitting, inside tank, terminating 6 inches above bottom of tank, and with end cut at a 45- degree angle.

E. Suction Strainers, Check Valves, and Overfill Check Valves: Bronze or corrosion-resistant metal components.

F. Foot Valves and Antisiphon Valves: Poppet-type, bronze or corrosion-resistance metal components.

G. Weatherproof Vent Cap: Increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

H. Manhole Frames and Covers: Cast-iron or steel material, size as indicated. Furnish manhole units of adequate size for access to fittings if size is not indicated.

I. Monitoring Well Caps.

2.10 LIQUID-LEVEL GAGE SYSTEMS

A. Description: Calibrated, liquid-level gage system complying with UL 1238 with probes.

B. Probes: Made for tank mounting and suitable for use in fuel oil.

2.11 FUEL DISPENSER PUMP

A. Description: Submersible electric pump designed to mount in fuel storage tank. Pump shall have the following features:

1. Handle w/ dispenser.
2. Metering system.
3. Pull chain for retrieval.
4. 100 foot dispensing hose and nozzle.
5. Telescoping suction tube and spout.
6. On/Off lock built into handle.

2.12 SOURCE QUALITY CONTROL

A. Perform factory tests, according to UL 142, after fabrication and before shipment.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

A. Use flanges, unions, transition and special fittings, and valves with pressure ratings same or higher than system's pressure rating in aboveground and containment sump applications, unless otherwise indicated.

©COPYRIGHT 2013 CH2M HILL

B. Aboveground, Fuel Oil Piping and Vent Piping: Use the following:

1. 2-Inch NPS and Smaller: Copper tube, copper fittings, and brazed joints.
2. 2-1/2- to 4-Inch NPS: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.

3.02 VALVE APPLICATIONS

A. Valve types are to be the following:

1. Shutoff Duty: Use gate or ball valves.
2. Throttling Duty: Use ball valves.

3.03 JOINT CONSTRUCTION

A. Make joints in copper and steel carrier piping in accordance with manufacturer’s written instructions.

3.04 FUEL-OIL STORAGE TANK INSTALLATION

A. Install fuel-oil storage tanks according to manufacturer's written instructions and standards specified.

B. Install tank bases and supports and fasten to foundation per Specialty Engineers’ requirements and as approved by Owner/Engineer. Size and quantity of fasteners shall be per tank manufacturer to meet the design criteria indicated.

C. Set tanks on bases and supports.

D. Install piping connections and vent fittings.

E. Install ground connections.

F. Install tank leak-detection devices.

3.05 CONCRETE BASES

A. Construct concrete tank and equipment bases according to supported tank and equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3,000 psi, 28-day compressive-strength concrete.

B. Refer to Section 03 30 00, "Cast-in-Place Concrete" for concrete.

3.06 PIPING INSTALLATION

A. Install piping free of sags and bends.

B. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

C. Install fittings for changes in direction and branch connections.

©COPYRIGHT 2013 CH2M HILL

D. Assemble and install bulkhead fittings for pipe penetrations through storage tank sump sidewalls. Follow fitting manufacturer's written instructions and use components required for liquid-tight joints.

E. Install reductions in pipe sizes using eccentric reducer fittings. Install fitting with level side down.

F. Install piping, flexible connectors at piping connections to vibration-producing equipment. Use according to the following applications:

1. Steel Piping: Stainless-steel-hose, flexible connectors.
2. Copper Tubing: Bronze-hose, flexible connectors.
3. RTRP: Stainless-steel-hose or bronze-hose, flexible connectors.

G. Install double-contained piping according to manufacturer's written instructions for assembly, joining, trench preparation, and installation.

H. Install and terminate double-contained piping at fuel-oil storage tank containment sumps and at building.

3.07 VALVE INSTALLATIONS

A. Install valves in accessible locations. Protect valves from physical damage and install metal tag attached with metal chain indicating fuel oil piping systems.

3.08 CONNECTIONS

A. Connect fuel-oil distribution piping to fuel-oil storage tanks. Use pipe adapters or transition fittings compatible with both piping systems.

B. Connect vent, fill, sounding, gage, and other piping to fittings and specialty devices.

C. Piping Connections: Make piping connections as follows, unless otherwise indicated:

1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.
2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
3. Install dielectric unions to connect piping of dissimilar metals.

D. Make connections to liquid-level gage system where required.

E. Make connections to fuel-oil storage tank leak-detection system where required.

©COPYRIGHT 2013 CH2M HILL

F. Make electrical connections to pumps, control panels, liquid-level gages, and leak-detection and -monitoring devices.

G. Electrical wiring, disconnect switches, and motor controls are specified in Division 26.

H. Ground equipment and AST. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

I. Connect tank to concrete slab per approved shop drawings.

3.09 LABELING AND IDENTIFYING

A. Equipment: Install engraved, plastic-laminate equipment nameplates and signs on AST and equipment. Text of Signs: In addition to name of identified unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

B. Piping: Install pipe markers on aboveground piping.

C. Refer to Section 31 23 23, "Earthwork for Site" for warning tapes.

3.10 FIELD QUALITY CONTROL

A. Perform pressure test for tightness, with air, inert gas, or water according to NFPA 30 and NFPA 31 on tanks before installation. Apply soap solution to joints and check for leaks. Do not exceed the following:

1. Tanks Smaller Than 12-Ft Diameter: 5-psig test pressure.
2. Tanks 12-Ft Diameter and Larger: 3-psig test pressure.

B. Repair or replace defective tanks and retest until there are no leaks.

C. Test fuel-oil distribution piping according to NFPA 30 and NFPA 31. Remake leaks and defects with new materials and retest until there are no leaks.

D. Test and adjust leak-detection devices. Replace damaged and malfunctioning devices.

E. Report test results promptly in writing to Architect and authorities having jurisdiction.

3.11 ADJUSTING

A. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

©COPYRIGHT 2013 CH2M HILL

3.12 COMMISSIONING

A. Before activating system, perform these steps:

1. Verify that tests have been performed.
2. Open valves to fully open position.
3. Fill fuel-oil storage tanks with specified grade fuel oil.
4. Check leak-detection and -monitoring systems for proper operation.
5. Check corrosion-monitoring systems for proper operation

B. Engage a factory-authorized service representative for leak-detection system to train Owner's maintenance personnel to adjust, operate, and maintain systems.

1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining leak-detection devices.
2. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining tank system as a whole including all devices.
3. Review data in maintenance manuals. Refer to Division 01 Section related to "Contract Closeout."
4. Review data in maintenance manuals. Refer to Division 01 Section related to "Operation and Maintenance Data."
5. Schedule training with Owner with at least seven days' advance notice.

END OF SECTION

©COPYRIGHT 2013 CH2M HILL

Page Intentionally Left Blank

©COPYRIGHT 2013 CH2M HILL

SECTION 26 13 16.02B
PAD MOUNTED SWITCHGEAR

PART 1 GENERAL

1.01 THE SWITCHGEAR SHALL BE IN ACCORDANCE WITH THE SINGLE-LINE DIAGRAM, AND SHALL CONFORM TO THE FOLLOWING SPECIFICATION.

A. The switchgear shall consist of a gas-tight tank containing SF6 gas, load-interrupter switches and resettable fault interrupters with visible open gaps and integral visible grounds, and a microprocessor-based overcurrent control. Load-interrupter switch terminals shall be equipped with bushings rated 600 or 900 amperes continuous, and fault-interrupter terminals shall be equipped with bushing wells rated 200 amperes continuous or bushings rated 600 or 900 amperes continuous (as specified) to provide for elbow connection. Manual operating mechanisms and viewing windows shall be located on the opposite side of the tank from the bushings and bushing wells, so that operating personnel shall not be required to perform any routine operations in close proximity to high-voltage elbows and cables.

1.02 RATINGS

A. The ratings for the integrated switchgear shall be as designated below.

1.	Frequency, Hz	60
2.	Short-Circuit Current,	
3.	Amperes, RMS, Symmetrical	12,500
4.	Voltage Class, Kv	15.5
5.	Maximum Voltage, kV	15.5
6.	BIL Voltage, kV	95
7.	Main Bus Continuous Current, Amperes	600
8.	Three-Pole Load-Interrupter Switches	
9.	Continuous Current, Amperes	600
10.	Load Dropping Current, Amperes	600
	a. Fault Closing Current, Duty-Cycle	
	1) Three-Time, Amperes, RMS, Symmetrical1	2,500
	2) Three-Time, Amperes, Peak	32,500
	3) Ten-Time, Amperes, RMS, Symmetrical	12,500
	4) Ten-Time, Amperes, Peak	32,500
11.	Fault Interrupters:	
	a. Continuous Current, Amperes	200
	b. Load Dropping Current, Amperes	200
	c. Fault Interrupting Current, Duty-Cycle:	
	1) Three-Time, Amperes, RMS, Symmetrical	12,500
	2) Ten-Time, Amperes, RMS, Symmetrical	12,500

©COPYRIGHT 2012 CH2M HILL

d. Fault Closing Current, Duty-Cycle
   1) Three-Time, Amperes, RMS, Symmetrical. 12,500
   2) Three-Time, Amperes, Peak 32,000
   3) Ten-Time, Amperes, RMS, Symmetrical 12,500
   4) Ten-Time, Amperes, Peak 32,500

SELECTION OF RATINGS		IEC			ANSI		
Frequency, Hz		50 or 60			50 or 60		
Short-Circuit Current, Amperes, RMS, Symmetrical		12 500			12 500		
Voltage Class, kV Maximum Voltage, kV BIL Voltage, kV		12 15.5 95	24 29 125	36 38 150	15.5 15.5 95	27 29 125	38 38 150
Main Bus Continuous Current, Amperes		630	630	630	600	600	600
Three-Pole Load-Interrupter Switches	Continuous Current, Amperes	630 630	630 630	630 630	600 600	600 600	600 600
	Load Dropping Current, Amperes	12	16	16	12	16	16
	Fault Closing Current, Duty-Cycle	500 32	000 41	000 41	500 32	000 41	000 41
	Three-Time, Amperes, RMS, Symmetrical	500 12	600 16	600 16	500 12	600 16	600 16
	Three-Time, Amperes, Peak	500 32	000 41	000 41	500 32	000 41	000 41
	Ten-Time, Amperes, RMS, Symmetrical	500	600	600	500	600	600
	Ten-Time, Amperes, Peak						

©COPYRIGHT 2012 CH2M HILL

Fault Interrupters	Continuous Current, Amperes	200□	200□	200□	200□	200□	200□
	Load Dropping Current, Amperes	200□	200□	200□	200□	200□	200□
	Fault Interrupting Current, Duty-Cycle	12 500	12 500	12 500 12 500	12 500	12 500	12 500
	Three-Time, Amperes, RMS, Symmetrical	12 500	12 500	12 500 32 000	12 500	12 500	12 500
	Ten-Time, Amperes, RMS, Symmetrical	12 500	12 500	12 500 32 500	12 500	12 500	12 500
	Fault Closing Current, Duty-Cycle	32 000	32 000		32 000	32 000	32 000
	Three-Time, Amperes, RMS, Symmetrical	12 500	12 500		12 500	12 500	12 500
	Three-Time, Amperes, Peak	32 500	32 500		32 500	32 500	32 500
	Ten-Time, Amperes, RMS, Symmetrical						
	Ten-Time, Amperes, Peak						

Frequency, Hz		50 or 60			50 or 60		
Short-Circuit Current, Amperes, RMS, Symmetrical		25 000			25 000		
Voltage Class, kV		12	24	36	15.5	27	38
Maximum Voltage, kV		15.5	29	38	15.5	29	38
BIL Voltage, kV		95	125	150	95	125	150
Main Bus Continuous Current, Amperes□		630	630	630	600	600	600
Three-Pole Load-Interrupter Switches	Continuous Current, Amperes□	630	630	630	600	600	600
	Load Dropping Current, Amperes□	630	630	630	600	600	600
	Fault Closing Current, Duty-Cycle	25 000	25 000	25 000	25 000	25 000	25 000
	Three-Time, Amperes, RMS, Symmetrical	65 000	65 000	65 000	65 000	65 000	65 000
	Three-Time, Amperes, Peak	16 000	16 000	16 000	16 000	16 000	16 000
	Ten-Time, Amperes, RMS, Symmetrical	41 600	41 600	41 600	41 600	41 600	41 600
	Ten-Time, Amperes, Peak						

©COPYRIGHT 2012 CH2M HILL

Fault Interrupters	Continuous Current, Amperes□	630	630	630	600	600	600
	Load Dropping Current, Amperes□	630	630	630	600	600	600
	Fault Interrupting Current, Duty-Cycle	25 000	25 000	25 000	25 000	25 000	25 000
	Three-Time, Amperes, RMS, Symmetrical	25 000	25 000	25 000	25 000	25 000	25 000
	Ten-Time, Amperes, RMS, Symmetrical	25 000	25 000	25 000	25 000	25 000	25 000
	Fault Closing Current, Duty-Cycle	65 000	65 000	65 000	65 000	65 000	65 000
	Three-Time, Amperes, RMS, Symmetrical	16 000	16 000	16 000	16 000	16 000	16 000
	Three-Time, Amperes, Peak	41 600	41 600	41 600	41 600	41 600	41 600
	Ten-Time, Amperes, RMS, Symmetrical						
	Ten-Time, Amperes, Peak						

□ Actual capabilities may be limited to lower values by the bushing inserts, elbows, and cables used on these units.

□ 1200-ampere bus rating is available.

□ 900-ampere load interrupting and fault interrupting ratings are available.

□ Ratings are 600 amperes (630 amperes for IEC) continuous and load dropping when the fault interrupters are furnished with 600-ampere bushings.

1.03 CERTIFICATION OF RATINGS

A. The manufacturer of the switchgear shall be completely and solely responsible for the performance of the load-interrupter switch and fault interrupter as well as the complete integrated assembly as rated.

B. The manufacturer shall furnish, upon request, certification of ratings of the load-interrupter switch, fault interrupter, and the integrated switchgear assembly consisting of switches and fault interrupters in combination with the gas-tight tank.

1.04 COMPLIANCE WITH STANDARDS AND CODES

A. The switchgear shall conform to or exceed the applicable requirements of the following standards and codes:

1. The applicable portions of ANSI C57.12.28, covering enclosure integrity for pad-mounted equipment.

©COPYRIGHT 2012 CH2M HILL

2. The applicable portions of ANSI C37.71, ANSI C37.72, ANSI C37.73, IEC 56, and IEC 265-1 (Class A), which specify test procedures and sequences for the load-interrupter switches, fault interrupters, and the complete switchgear assembly.

PART 2 CONSTRUCTION

2.01 SF6-GAS INSULATION

A. The SF6 gas shall conform to ASTM D2472.

B. The switchgear shall be filled with SF6 gas to a pressure of 7 psig at 68º F.

C. The gas-tight tank shall be evacuated prior to filling with SF6 gas to minimize moisture in the tank.

D. The switchgear shall withstand system voltage at a gas pressure of 0 psig at 68º F.

E. A gas-fill valve shall be provided.

F. A temperature-compensated pressure gauge shall be provided that is color coded to show the operating range. The gauge shall be mounted inside the gas-tight tank (visible through a large viewing window) to provide consistent pressure readings regardless of the temperature or altitude at the installation site.

2.02 GAS-TIGHT TANK

A. The tank shall be submersible and able to withstand up to 10 feet of water over the base.

B. The tank shall be of welded construction and shall be made of 7-gauge mild steel or Type 304L stainless steel, as specified in Section 4.0.

C. A means of lifting the tank shall be provided.

2.03 VIEWING WINDOWS

A. Each load-interrupter switch shall be provided with a large viewing window at least 6 inches by 12 inches to allow visual verification of the switch-blade position (closed, open, and grounded) while shining a flashlight on the blades.

B. Each fault interrupter shall be provided with a large viewing window at least 6 inches by 12 inches to allow visual verification of the disconnect-blade position (closed, open, and grounded) while shining a flashlight on the blades.

©COPYRIGHT 2012 CH2M HILL

C. Viewing windows shall be located on the opposite side of the gear from the bushings and bushing wells so that operating personnel shall not be required to perform any routine operations in close proximity to high-voltage elbows and cables.

D. A cover shall be provided for each viewing window to prevent operating personnel from viewing the flash which may occur during switching operations.

2.04 HIGH-VOLTAGE BUS

A. Bus and interconnections shall withstand the stresses associated with short-circuit currents up through the maximum rating of the switchgear.

B. Before installation of aluminum bus, all electrical contact surfaces shall first be pre-pared by machine-abrading to remove any oxide film. Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.

2.05 PROVISIONS FOR GROUNDING

A. One ground-connection pad shall be provided on the gas-tight tank of the switchgear.

B. The ground-connection pad shall be constructed of stainless steel and welded to the gas-tight tank, and shall have a short-circuit rating equal to that of the switchgear.

C. When an enclosure is provided, no less than one enclosure ground pad shall be provided.

D. One ground-connection pad per way shall be provided.

2.06 CONNECTIONS

A. For gear rated 12.5 kA short circuit, load-interrupter switches shall be equipped with 600-ampere bushings, and fault interrupters shall be equipped with 200-ampere bushing wells.

B. Bushings and bushing wells shall be located on one side of the gear to reduce the required operating clearance.

2.07 BUSHINGS AND BUSHING WELLS

A. Bushings and bushing wells shall conform to ANSI/IEEE Standard 386.

B. Bushings and bushing wells shall include a semiconductive coating.

©COPYRIGHT 2012 CH2M HILL

C. Bushings and bushing wells shall be mounted in such a way that the semiconductive coating is solidly grounded to the gas-tight tank.

PART 3 BASIC COMPONENTS

3.01 LOAD-INTERRUPTER SWITCHES

A. The three-phase, group-operated load-interrupter switches shall have a three-time and ten-time duty-cycle fault-closing rating as specified under "Ratings." This rating defines the ability to close the switch the designated number of times against a three-phase fault with asymmetrical (peak) current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Certified test abstracts establishing such ratings shall be furnished upon request.

B. The switch shall be provided with an integral ground position that is readily visible through the viewing window to eliminate the need for cable handling and exposure to high voltage to ground the equipment.

C. The ground position shall have a three-time and ten-time duty-cycle fault-closing rating.

D. The switch shall be provided with an open position that is readily visible through the viewing window to eliminate the need for cable handling and exposure to high voltage to establish a visible gap.

E. The open gaps of the switch shall be sized to allow cable testing through a feed thru bushing or the back of the elbow.

3.02 FAULT INTERRUPTERS

A. Fault interrupters shall have a three-time and ten-time duty-cycle fault-closing and fault interrupting rating as specified under "Ratings." This rating defines the fault interrupter's ability to close the designated number of times against a three-phase fault with asymmetrical (peak) current in at least one phase equal to the rated value and clear the resulting fault current, with the interrupter remaining operable and able to carry and interrupt rated current. Certified test abstracts establishing such ratings shall be furnished upon request.

B. The fault interrupter shall be provided with a disconnect with an integral ground position that is readily visible through the viewing window to eliminate the need for cable handling and exposure to high voltage to ground the equipment.

C. The ground position shall have a three-time and ten-time duty-cycle fault-closing rating.

©COPYRIGHT 2012 CH2M HILL

D. The disconnect shall be provided with an open position that is readily visible through the viewing window, eliminating the need for cable handling and exposure to high volt-age to establish a visible gap.

E. The fault interrupter, including its three-position disconnect, shall be a single integrated design so that operation between the closed and open positions or the open and grounded positions is accomplished with a single, intuitive movement.

F. The open gaps of the disconnect shall be sized to allow cable testing through a feedthru bushing or the back of the elbow.

G. An internal indicator shall be provided for each fault interrupter to show when it is in the tripped condition. The indicator shall be clearly visible through the viewing window.

3.03 OPERATING MECHANISMS

A. Load-interrupter switches and fault interrupters shall be operated by means of a quick-make, quick-break mechanism.

B. The manual handle shall charge the operating mechanism for closing, opening, and grounding of the switches and fault interrupters.

C. A single, integrated operating mechanism shall fully operate each fault interrupter or load interrupter switch in a continuous movement, so that additional operations are not required to establish open or grounded positions.

D. Operating mechanisms shall be equipped with an operation selector to prevent inadvertent operation from the closed position directly to the grounded position, or from the grounded position directly to the closed position. The operation selector shall require physical movement to the proper position to permit the next operation.

E. Operating shafts shall be padlockable in any position to prevent operation.

F. The operation selector shall be padlockable to prevent operation to the grounded position.

G. The operating mechanism shall indicate switch position which shall be clearly visible from the normal operating position.

3.04 OVERCURRENT CONTROL

A. A microprocessor-based overcurrent control shall be provided to initiate fault interruption.

B. Pilot and indicating lights shall be LED technology.

©COPYRIGHT 2012 CH2M HILL

C. For dry-vault-mounted style and pad-mounted style switchgear, the control shall be mounted in a watertight enclosure. For UnderCover style and wet-vault-mounted style switchgear, the control shall be mounted in a submersible enclosure. The control shall be removable in the field without taking the gear out of service.

D. Control settings shall be field-programmable using a personal computer connected via a data port to the control. The data port shall be accessible from the exterior of the enclosure. Neither external power nor energization of the gear shall be required to set or alter control settings.

E. Power and sensing for the control shall be supplied by integral current transformers.

F. The minimum total clearing time (from initiation of the fault to total clearing) for fault interruption shall be 40 milliseconds (2.4 cycles) at 60 hertz or 44 milliseconds (2.2 cycles) at 50 hertz.

G. The control shall feature time-current characteristic (TCC) curves including standard E speed, K-speed, coordinating-speed tap, coordinating-speed main, and relay curves per IEEE C37.112-1996. Coordinating-speed tap curves shall optimize coordination with load-side weak-link/backup current-limiting fuse combinations, and coordinating-speed main curves shall optimize coordination with tap-interrupter curves and upstream feeder breakers.

H. The standard E-speed curve shall have phase-overcurrent settings ranging from 25E through 400E. The standard K-speed curve shall have phase-overcurrent settings ranging from 25K through 200K. The coordinating-speed tap curve shall have phase-overcurrent and independent ground-overcurrent settings ranging from 50 amperes through 400 amperes. The coordinating-speed main curve shall have phase-overcurrent settings ranging from 100 amperes through 800 amperes and independent ground-overcurrent settings ranging from 100 amperes through 400 amperes.

I. Time-current characteristic curves shall conform to the following IEEE C37.112-1996 IEEE Standard Inverse-Time Characteristic Equations for Overcurrent Relays: U.S. Moderately Inverse Curve U1, U.S. Inverse Curve U2, U.S. Very Inverse Curve U3, U.S. Extremely Inverse Curve U4, U.S. Short-Time Inverse Curve U5, I.E.C. Class A Curve (Standard Inverse) C1, I.E.C. Class B Curve (Very Inverse) C2, I.E.C. Class C Curve (Extremely Inverse) C3, I.E.C. Long-Time Inverse Curve C4, and I.E.C. Short-Time Inverse Curve C5.

©COPYRIGHT 2012 CH2M HILL

J. The control shall have field-adjustable instantaneous-trip settings (0.2 kA through 6 kA) and definite-time delay settings (32 ms through 96 ms for coordinating-speed tap and 64 ms through 128 ms for coordinating-speed main), to allow tailoring of the coordinating-speed tap and coordinating-speed main curves to the application.

K. Event records shall be easily extractable from the control using a personal computer connected to the data port.

3.05 OPTIONAL VOLTAGE INDICATION

A. Voltage Indication:

1. Voltage indication shall be provided for each load-interrupter switch and fault interrupter by means of capacitive taps on the bushings, eliminating the need for cable handling and exposure to high voltage to test the cables for voltage prior to grounding. This feature shall include a flashing liquid-crystal display to indicate the presence of voltage for each phase, and a solar panel to supply power for testing of the complete voltage-indication circuit.
2. The voltage-indication feature shall be mounted on the covers for the viewing windows, on the opposite side of the gear from the bushings and bushing wells, so that operating personnel shall not be required to perform any routine operations in close proximity to high-voltage elbows and cables.

PART 4 SWITCHGEAR STYLE

4.01 PAD-MOUNTED STYLE

A. To guard against corrosion due to extremely harsh environmental conditions, the gas-tight tank shall be made of Type 304L stainless steel.

B. For gear rated 12.5 kA short circuit, the switchgear shall conform to or exceed the requirements of applicable portions of IEC 298, Appendix AA covering arc resistance, through 12.5 kA for 15 cycles.

C. Enclosure:

1. The switchgear shall be provided with a pad-mounted enclosure suitable for installation of the gear on a concrete pad.
2. The pad-mounted enclosure shall be separable from the switchgear to allow clear access to the bushings and bushing wells for cable termination.

©COPYRIGHT 2012 CH2M HILL

3. The enclosure shall be provided with removable front and back panels, and hinged lift-up roof sections for access to the operating and termination compartments. Each roof section shall have a retainer to hold it in the open position.
4. Lift-up roof sections shall overlap the panels and shall have provisions for pad-locking that incorporate a means to protect the padlock shackle from tampering.
5. The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.
6. Panel openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between panels and panel openings to guard against water entry.
7. For bushings rated 600 amperes continuous, the termination compartment shall be of an adequate depth to accommodate encapsulated surge arresters mounted on 600-ampere elbows having 200-ampere interfaces.
8. For bushing wells rated 200 amperes continuous, the termination compartment shall be of an adequate depth to accommodate 200-ampere elbows mounted on feedthru inserts.
9. An instruction manual holder shall be provided.
10. Non-removable lifting tabs shall be provided.
11. To guard against corrosion due to extremely harsh environmental conditions, the entire exterior of the enclosure shall be fabricated from Type 304 stainless steel.
12. Enclosure shall be low profile style.

D. Enclosure Finish

1. All exterior welded seams shall be filled and sanded smooth for neat appearance.
2. To remove oils and dirt, to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond, and to retard underfilm propagation of corrosion, all surfaces shall undergo a thorough pretreatment process comprised of a fully automated system of cleaning, rinsing, phosphatizing, sealing, drying, and cooling, before any protective coatings are applied. By utilizing an automated pretreatment process, the enclosure shall receive a highly consistent thorough treatment, eliminating fluctuations in reaction time, reaction temperature, and chemical concentrations.

©COPYRIGHT 2012 CH2M HILL

3. After pretreatment, protective coatings shall be applied that shall help resist corrosion and protect the steel enclosure. To establish the capability to resist corrosion and protect the enclosure, representative test specimens coated by the manufacturer's finishing system shall satisfactorily pass the following tests:
   a. 4000 hours of exposure to salt-spray testing per ASTM B 117 with:
      1) Underfilm corrosion not to extend more than 1/32 in. from the scribe, as evaluated per ASTM D 1645, Procedure A, Method 2 (scraping); and
      2) Loss of adhesion from bare metal not to extend more than 1/8 in. from the scribe.
   b. 1000 hours of humidity testing per ASTM D 4585 using the Cleveland Condensing Type Humidity Cabinet, with no blistering as evaluated per ASTM D 714.
   c. 500 hours of accelerated weathering testing per ASTM G 53 using lamp UVB-313, with no chalking as evaluated per ASTM D 659, and no more than 10% reduction of gloss as evaluated per ASTM D 523.
   d. Crosshatch-adhesion testing per ASTM D 3359 Method B, with no loss of finish.
   e. 160-inch-pound impact, followed by adhesion testing per ASTM D 2794, with no chipping or cracking.
   f. 3000 cycles of abrasion testing per ASTM 4060, with no penetration to the substrate. Certified test abstracts substantiating the above capabilities shall be furnished upon request.
4. The finish shall be inspected for scuffs and scratches. Blemishes shall be touched up by hand to restore the protective integrity of the finish.
5. The finish shall be olive green, Munsell 7GY3.29/1.5.

PART 5 LABELING

5.01 HAZARD-ALERTING SIGNS

A. The exterior of the pad-mounted enclosure (if furnished) shall be provided with "Warning-Keep Out-Hazardous Voltage Inside-Can Shock, Burn, or Cause Death" signs.

B. Each unit of switchgear shall be provided with a "Danger-Hazardous Voltage-Failure to Follow These Instructions Will Likely Cause Shock, Burns, or Death" sign. The text shall further indicate that operating personnel must know and obey the employer's work rules, know the hazards involved, and use proper protective equipment and tools to work on this equipment.

C. Each unit of switchgear shall be provided with a "Danger-Keep Away-Hazardous Voltage-Will Shock, Burn, or Cause Death" sign.

©COPYRIGHT 2012 CH2M HILL

5.02 NAMEPLATES, RATINGS LABELS, AND CONNECTION DIAGRAMS

A. Each unit of switchgear shall be provided with a nameplate indicating the manufacturer's name, catalog number, model number, date of manufacture, and serial number.

B. Each unit of switchgear shall be provided with a ratings label indicating the following: voltage rating; main bus continuous current rating; short-circuit rating; fault-interrupter ratings including interrupting and duty-cycle fault-closing; and load-interrupter switch ratings including duty-cycle fault-closing and short-time.

PART 6 ACCESSORIES

6.01 A USB CABLE KIT SHALL BE PROVIDED FOR CONNECTING AN OVERCURRENT CONTROL TO A USER-FURNISHED PERSONAL COMPUTER.

END OF SECTION

©COPYRIGHT 2012 CH2M HILL

SECTION 26 05 01
ELECTRICAL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway Transportation Officials (AASHTO).
2. ASTM International (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. A240/A240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
   c. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   d. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   e. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
3. Electronic Industries Association (EIA/TIA): 569, Commercial Building Standard for Telecommunications Pathways and Spaces.
4. Federal Specifications (FS):
   a. W-C-596, Connector, Electrical, Power, General Specification for.
   b. W-S-896, Switch, Toggle (Toggle and Lock), Flush Mounted (General Specification).
5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   b. PC62.41.1, Draft Guide on the Surge Environment in Low-Voltage (1,000 V and less) AC Power Circuits.
   c. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   d. 114, Standard Test Procedures for Single-Phase Induction Motors.
6. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
7. National Electrical Contractor’s Association, Inc. (NECA): 1, Standard Practices for Good Workmanship in Electrical Contracting.

©COPYRIGHT 2012 CH2M HILL

8. National Electrical Manufacturers Association (NEMA):
   a. C80.1, Rigid Steel Conduit-Zinc Coated.
   b. C80.3, Electrical Metallic Tubing-Zinc Coated.
   c. C80.6, Intermediate Metal Conduit-Zinc Coated (IMC).
   d. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   e. CC1, Electrical Power Connectors for Substations.
   f. ICS 1, Industrial Control and Systems: General Requirements.
   g. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated Not More Than 2000 Volts AC or 750 Volts DC.
   h. ICS 2.3, Industrial Control and Systems: Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers.
   i. MG 1, Motors and Generators.
   j. PB 1, Panelboards.
   k. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   l. ST 20, Dry Type Transformers for General Applications.
   m. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
   n. TC 3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.
   o. WC 55, Instrumentation Cables and Thermocouple Wire.
   p. WC 70, Standard for Non-Shielded Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy.
   q. WC 71, Standard for Non-Shielded Cables Rated 2001-5000 Volts for use in the Distribution of Electrical Energy.
   r. WC 74, 5-46 KV Shielded Power Cable for use in the Transmission and Distribution of Electric Energy.
   s. WD 1, General Color Requirements for Wiring Devices.
9. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
10. Underwriters Laboratories, Inc. (UL):
   a. 1, Flexible Metal Conduit.
   b. 6, Electrical Rigid Metal Conduit—Steel.
   c. 13, Power-Limited Circuit Cables.
   d. 44, Thermoset Insulated Wires and Cables.
   e. 62, Flexible Cord and Fixture Wire.
   f. 67, Panelboards.
   g. 98, Enclosed and Dead-Front Switches.
   h. 198C, High Interrupting Capacity Fuses, Current Limiting Types.
   i. 198E, Class R Fuses.
   j. 360, Liquid-Tight Flexible Steel Conduit.
   k. 486A, Wire Connectors and Soldering Lugs for Use with Copper Conductors.

©COPYRIGHT 2012 CH2M HILL

l. 486C, Splicing Wire Connectors.
m. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
n. 508, Industrial Control Equipment.
o. 510, Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
p. 514B, Fittings for Cable and Conduit.
q. 651, Schedule 40 and 80 PVC Conduit.
r. 674, Electric Motors And Generators for use in Division 1 Hazardous (Classified) Locations.
s. 797, Electrical Metallic Tubing.
t. 854, Service-Entrance Cables.
u. 870, Wireways, Auxiliary Gutters, and Associated Fittings.
v. 943, Ground-Fault Circuit Interrupters.
w. 1059, Terminal Blocks.
x. 1242, Intermediate Metal Conduit.
y. 1277, Electrical Power and Control Tray Cables with Optional Optical-Fibre Members.
z. 1449, Transient Voltage Surge Suppressors.
aa. 1561, Dry-Type General Purpose and Power Transformers.
bb. 2111, Overheating Protection for Motors.

1.02 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. MCOV: Maximum Allowable Continuous Operating Voltage.

C. MOV: Metal Oxide Varistor.

D. SASD: Silicon Avalanche Suppressor Diode.

E. SVR: Surge Voltage Rating.

F. TVSS: Transient Voltage Surge Suppressor.

1.03 SUBMITTALS

A. Action Submittals:

1. Boxes and device plates.
2. Junction and pullboxes.
3. Precast handholes.
4. Wiring devices.

©COPYRIGHT 2012 CH2M HILL

5. Panelboards and mini-power centers.
6. Circuit breakers and switches.
7. Control devices, terminal blocks, and relays.
8. Support and framing channels.
9. TVSS equipment.
10. Conduit, fittings, and accessories.
11. Wireways.
12. Conductors, cable, and accessories.
13. Grounding materials.
14. Local Control Panels: Arrangement drawings, schematic and wiring diagrams, bill of materials, nameplate schedule, manufacturer information on components.
15. Luminaires.

B. Informational Submittals:

1. Factory test reports.
2. Field test reports.
3. Signed permits indicating Work is acceptable to regulatory authorities having jurisdiction.
4. Operation and Maintenance Data:
   a. Provide for all equipment, as well as each device having features that can require adjustment, configuration, or maintenance.
   b. Minimum information shall include manufacturer's preprinted instruction manual, one copy of the approved submittal information for the item, tabulation of any settings, and copies of any test reports.

1.04 APPROVAL BY AUTHORITY HAVING JURISDICTION

A. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.

B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark or label.

PART 2 PRODUCTS

2.01 GENERAL

A. Products shall comply with all applicable provisions of NFPA 70.

©COPYRIGHT 2012 CH2M HILL

B. Like Items of Equipment: End products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.

C. Equipment and Devices Installed Outdoors or in Unheated Enclosures: Capable of continuous operation within ambient temperature range of 40 degrees F to 100 degrees F.

D. Hazardous Areas: Products shall be acceptable to the regulatory authority having jurisdiction for the class, division, and group of hazardous area indicated.

2.02 SERVICE ENTRANCE EQUIPMENT AND METERING

A. Equipment, installation arrangement, and scope of work shall be provided in accordance with requirements of the local electric utility.

2.03 OUTLET AND DEVICE BOXES

A. Cast Metal:

1. Box: Cast ferrous metal.
2. Cover: Gasketed, weatherproof, and cast ferrous metal with stainless steel screws.
3. Hubs: Threaded.
4. Lugs: Cast Mounting.
5. Manufacturers and Products, Nonhazardous Locations:
   a. Crouse-Hinds; Type FS or FD.
   b. Appleton; Type FS or FD.
6. Manufacturers and Products, Hazardous Locations:
   a. Crouse-Hinds; Type GUA or EAJ.
   b. Appleton; Type GR.

2.04 JUNCTION AND PULL BOXES

A. Outlet Boxes Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.

B. Conduit Bodies Used as Junction Boxes: As specified under Article Conduit and Fittings.

C. Large Cast Metal Box:

1. NEMA 250, Type 4.
2. Box: Cast ferrous metal, electrogalvanized finished, with drilled and

©COPYRIGHT 2012 CH2M HILL

tapped conduit entrances and exterior mounting lugs.
3. Cover: Hinged with clamps.
4. Gasket: Neoprene.
5. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
6. Manufacturers and Products, Surface Mounted Nonhinged Type:
   a. Crouse-Hinds; Series W.
   b. O-Z/Gedney; Series Y.
7. Manufacturer and Product, Surface Mounted, Hinged Type: O-Z/Gedney; Series YW.
8. Manufacturers and Products, Recessed Type:
   a. Crouse-Hinds; Type WJBF.
   b. O-Z/Gedney; Series YR.

D. Large Cast Metal Box, Hazardous Locations:

1. NEMA 250, Type 7 or 9 as required for Class, Division, and Group involved.
2. Box: Cast ferrous metal, electro-galvanize finished, or copper-free aluminum with drilled and tapped conduit entrances.
3. Cover: Hinged with screws.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers and Products:
   a. Crouse-Hinds; Type EJB.
   b. Appleton; Type EJB.

E. Large Stainless Steel Box:

1. NEMA 250, Type 4X.
2. Box: 14-gauge, ASTM A240, Type 316 stainless steel with white enamel painted interior mounting panel.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers:
   a. Hoffman Engineering Co.
   b. Robroy Industries.

F. Concrete Box, Nontraffic Areas:

1. Box: Reinforced, cast concrete with extension.
2. Cover: Steel diamond plate with locking bolts.
3. Cover Marking: ELECTRICAL, or as shown.
4. Size: As shown.
5. Manufacturer and Product: Utility Vault Co.; Series 36-1017PB, with cover DP.

©COPYRIGHT 2012 CH2M HILL

2.05 PRECAST HANDHOLES

A. Construction: Precast concrete.

B. Loading: AASHTO H-10 or H-20, as noted below, in accordance with ASTM C857.

C. Drainage:

1. Slope floors toward drain points leaving no pockets or other nondraining areas.
2. Provide drainage outlet at low point of floor.

D. Raceway Entrances: Provide knockout panels on all four sides.

E. Handhole Frames and Covers:

1. Material: Steel, hot-dipped galvanized.
2. Cover Type: Solid, bolt-on or hinged, of checkered design, as noted below.
3. Cover Loading: As noted below.
4. Cover Designation: Lettering minimum 2 inches in height, as shown.

F. Hardware: Steel, hot-dip galvanized.

G. Furnish knockout for ground rod in each handhole.

H. Manufacturer and Models: Utility Vault Company.

1. Small: H-10 incidental traffic loading; Model 3030-B with 3030-DP cover.
2. Large: H-20 off-street traffic loading; Model 444-LA with 44-332P cover.

2.06 WIRING DEVICES

A. Switches:

1. NEMA WD 1 and FS W-S-896.
2. Industrial grade, totally enclosed, ac type, with quiet tumbler switches and screw terminals.
3. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
4. Rating: 20 amps, 120/277 volts.

©COPYRIGHT 2012 CH2M HILL

5. Color: Brown.
6. Automatic grounding clip and integral grounding terminal on mounting strap.
7. Manufacturers and Products:
   a. Leviton; 1221 Series.
   b. Bryant; 4901 Series.
   c. Hubbell; 1221 Series.

B. Receptacle, Single and Duplex:

1. NEMA WD 1 and FS W-C-596.
2. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for 10 AWG.
3. High strength, thermoplastic base color.
4. Color: Brown.
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
7. One-piece mounting strap with integral ground contact (rivetless construction).
8. Manufacturers and Products:
   a. Arrow Hart; 5262 Series.
   b. Leviton; 5262/5362 Series.
   c. Bryant; 5262/5362 Series.
   d. Hubbell; 5262/5362 Series.

C. Receptacle, Ground Fault Circuit Interrupter:

1. Duplex, listed Class A to UL Standard 943, tripping at 5 mA.
2. Color: Brown.
3. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
4. Size: For 2-inch by 4-inch outlet boxes.
5. Standard Model: NEMA WD 1, with 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails or screw terminals and provisions for testing.
6. Feed-Through Model: NEMA WD 1, with 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails or feed-through screw terminals and provisions for testing.
7. Impact resistant nylon face.
8. Manufacturers:
   a. Bryant.
   b. Hubbell.
   c. Leviton.

©COPYRIGHT 2012 CH2M HILL

D. Receptacle, Special-Purpose:

1. Rating and number of poles as shown or as required for anticipated purpose.
2. One matching plug with cord-grip features for each special-purpose receptacle.

E. Receptacle, Explosion-Proof:

1. UL listed.
2. Dead front, interlocked, circuit breaking.
3. Electrical Ratings: 20 amps, 125 volts.
4. Hazardous Area Ratings: NEMA 7BCD, 9FG.
5. Provide matching plug with each receptacle.
6. Manufacturers and Products:
   a. Crouse-Hinds; Ark Guard 2, Series ENR.
   b. Appleton; U-Line.
   c. Killark; Series UGR/UGP.

2.07 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Metal:

1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
2. Finish: ASTM A167, Type 302/304, satin.
3. Mounting Screw: Oval-head, finish matched to plate.

C. Cast Metal:

1. Material: Copper-free aluminum, with gaskets.
2. Screw: Oval-head stainless steel.

D. Engraved:

1. Character Height: 3/16 inch.
2. Filler: White.

E. Weatherproof:

1. For Receptacles, Damp Locations:
   a. Gasketed, cast-aluminum, with individual cap over each receptacle opening.

©COPYRIGHT 2012 CH2M HILL

b. Mounting Screw and Cap Spring: Stainless steel.
c. Manufacturers and Products:
1) Crouse-Hinds; Type WLRD-1.
2) Appleton; Type FSK-WRD.

2. For Receptacles, Wet Locations:
a. Impact-resistant, nonmetallic, single-gang, horizontal-mounting, providing, while in-use, NEMA 3R rating.
b. Stainless steel mounting and hinge hardware.
c. Lockable, paintable.
d. Color: Gray.
e. Manufacturers:
1) Carlon.
2) Leviton.

3. For Switches:
a. Gasketed, cast-metal or cast-aluminum, incorporating external operator for internal switch.
b. Mounting Screw: Stainless steel.
c. Manufacturers and Products:
1) Crouse-Hinds; DS-181 or DS-185.
2) Appleton; FSK-1VTS or FSK-1VS.

2.08 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. NEMA PB 1, NFPA 70, and UL 67.

B. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

C. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.

D. Rating: Applicable to a system with available short-circuit current of 22,000 amperes rms symmetrical at 208Y/120 or 120/240 volts.

E. Cabinet:

1. NEMA 250, Type 3R.
2. Material: Code-gauge, hot-dip galvanized sheet steel with reinforced steel frame.
3. Wiring Gutter: Minimum 4-inch square; both sides, top and bottom.
4. Front: Fastened with adjustable clamps.
a. Trim Size: As required by mounting.
b. Finish: Manufacturer’s standard.
5. Interior:
a. Factory assembled; complete with circuit breakers.

©COPYRIGHT 2012 CH2M HILL

b. Spaces: Cover openings with easily removable metal cover.
6. Door Hinges: Concealed.
7. Locking Device:
a. Flush type.
b. Doors Over 30 Inches in Height: Multipoint.
c. Identical keylocks, with two milled keys each lock.
8. Circuit Directory: Metal frame with transparent plastic face and enclosed card on interior of door.

F. Bus Bar:

1. Material: Copper full sized throughout length.
2. Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.
3. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
4. Lugs and Connection Points:
a. Suitable for either copper or aluminum conductors.
b. Solderless main lugs for main, neutral, and ground bus bars.
c. Subfeed or through-feed lugs as shown.

G. Circuit Breakers:

1. UL 489.
2. Thermal-magnetic, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.
3. Type: Bolt-on circuit breakers in all panelboards.
4. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
5. Do not use tandem or dual circuit breakers in normal single-pole spaces.
6. Ground Fault Circuit Interrupter (GFCI): UL Class A GFCI, 5 mA trip, and 22,000 amps interrupting capacity circuit breakers.
7. Ground Fault Equipment Protector (GFEP): 30 mA trip, 10,000 amps interrupting capacity circuit breaker, and UL listed for equipment ground fault protection.

H. Manufacturers:

1. General Electric Co.
2. Square D Co.

2.09 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

A. UL 489 listed for use at location of installation.

©COPYRIGHT 2012 CH2M HILL

B. Minimum Interrupt Rating: 22,000 amps rms symmetrical at 208 volts.

C. Thermal-magnetic, quick-make, quick-break, indicating type showing ON/OFF and TRIPPED indicating positions of operating handle.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Locking: Provisions for padlocking handle.

F. Enclosure: As specified under Execution.

G. Interlock: Enclosure and switch shall interlock to prevent opening cover with breaker in the ON position.

H. Manufacturers:

1. General Electric Co.
2. Square D Co.

2.10 FUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. UL 98 listed for use and location of installation.

B. NEMA KS 1 and UL 98 Listed for application to system with available short-circuit current of 22,000 amps rms symmetrical.

C. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Fuse mountings shall reject Class H fuses and accept only current-limiting fuses specified.

F. Enclosure: As specified under Execution.

G. Interlock: Enclosure and switch to prevent opening cover with switch in ON position.

H. Manufacturers:

1. General Electric Co.
2. Square D Co.

©COPYRIGHT 2012 CH2M HILL

2.11 NONFUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

C. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Enclosure: As specified under Execution.

E. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

F. Manufacturers:

1. General Electric Co.
2. Square D Co.

2.12 PUSHBUTTONS, INDICATING LIGHTS, AND SELECTOR SWITCHES

A. Type: Heavy-duty, oiltight. Provide contact arrangements, colors, inscriptions, and functions as shown.

B. Contact Rating: NEMA ICS 2, Type A600.

C. Unless otherwise shown, provide the following features:

1. Selector Switch Operating Lever: Standard.
2. Indicating Lights: Push-to-test, transformer-type.
3. Pushbutton Color:
   a. ON or START: Black.
   b. OFF or STOP: Red.
4. Pushbuttons and selector switches lockable in OFF position where indicated.

D. Legend Plate:

1. Material: Aluminum.
2. Engraving: Indicating specific function, or as shown.
3. Letter Height: 7/64 inch.

E. Manufacturers and Products:

©COPYRIGHT 2012 CH2M HILL

1. General Electric Co.; Type CR 104P.
2. Square D Co.; Type T.

2.13 TERMINAL BLOCKS

A. Type: UL 1059. Compression screw clamp, with current bar providing direct contact with wire and yoke, with individual rail mounted terminals. Marking system shall permit use of preprinted or field-marked tags.

B. Yokes and Clamping Screws: Zinc-plated, hardened steel.

C. Rating: 600V ac.

D. Manufacturers:

1. Weidmuller, Inc.
2. Ideal.

2.14 MAGNETIC CONTROL RELAYS

A. NEMA ICS 2, Class A600 (600 volts, 10 amperes continuous, 7,200VA make, 720VA break), machine tool type with field convertible contacts.

B. Manufacturer and Model: General Electric; Type CR120B.

2.15 PHASE MONITOR RELAY

A. Voltage and phase monitor relay shall drop out on low voltage, voltage unbalance, loss of phase, or phase reversal.

B. Contacts: Single-pole, double-throw, 10 amperes, 120/240V ac. Where additional contacts are shown or required, provide magnetic control relays.

C. Adjustable trip and time delay settings.

D. Transient Protection: 1,000V ac.

E. Mounting: Multipin plug-in socket base.

F. Manufacturer and Product: Automatic Timing and Controls; SLD Series.

1. Square D.

2.16 SUPPORT AND FRAMING CHANNELS

A. Carbon Steel Framing Channel:

©COPYRIGHT 2012 CH2M HILL

1. Material: Rolled, mild strip steel, 12 gauge, ASTM A1011/A1011M, Grade 33.
2. Finish: Hot-dip galvanized after fabrication.

B. Stainless Steel Framing Channel: Rolled, ASTM A167, Type 316 stainless steel, 12-gauge.

C. Manufacturers:

1. B-Line Systems, Inc.
2. Unistrut Corp.

2.17 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment: Adhesive.

C. Color: Black, engraved to a white core, or as shown.

D. Engraving:

1. Devices and Equipment: Name or tag shown, or as required.
2. Panelboards:
   a. Designation.
   b. Service voltage.
   c. Phases.
3. Minimum Requirement: Label metering and power distribution equipment, local control panels, junction boxes, motor controls, and transformers.

E. Letter Height:

1. Pushbuttons, Selector Switches, and Other Devices: 1/8 inch.
2. Equipment and Panelboards: 1/4 inch.

2.18 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) EQUIPMENT

A. General:

1. Units shall be suitable for the service voltage and configuration (phases and wires) shown.
2. Protection Modes:
   d. Normal, differential, and common.
   e. Bipolar or bi-directional.

©COPYRIGHT 2012 CH2M HILL

3. Ratings: Short-circuit current rating shall equal or exceed that of protected distribution equipment. Surge Voltage Rating (SVR) shall not exceed those specified under UL 1449 for the associated nominal system voltage. Maximum Allowable Continuous Operating Voltage (MCOV) shall be at least 115 percent of the nominal system voltage.
4. Unit shall be UL-listed.
5. Provide status indicators for unit ON-LINE and unit operation NORMAL.
6. Provide common alarm contact output.
7. Provide fusible disconnect switch (integral with TVSS unit, where available) where not shown connected via branch circuit device of protected distribution equipment.
8. Minimum Enclosure Rating: NEMA 250, Type 2. Provide Type 4/4X for outdoor or wet locations.

B. Type 1 TVSS:

1. Requirements: High surge current device designed for location/exposure Category C3, per IEEE C62.41. Provide surge current rating per phase as shown. Unit shall utilize symmetrically balanced Metal Oxide Varistor (MOV) technology.
2. Manufacturer and Product: Transtector; Model Aegis SP.

2.19 CONDUIT AND FITTINGS

A. Rigid Galvanized Steel Conduit (RGS):

1. Meet requirements of NEMA C80.1 and UL 6.
2. Material: Hot-dip galvanized, with chromated protective layer.

B. PVC Schedule 40 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed, or direct sunlight exposure, and 90 degrees C insulated conductors.

C. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel, with an extruded PVC jacket.

D. Flexible Coupling, Hazardous Locations:

1. Approved for use in the atmosphere involved.

©COPYRIGHT 2012 CH2M HILL

2. Rating: Watertight and UL listed for use in Class I, Division 1 and Division 2 areas.
3. Outer bronze braid and an insulating liner.
4. Conductivity equal to a similar length of rigid metal conduit.
5. Manufacturers and Products:
   a. Crouse-Hinds; Type ECGJH or ECLK.
   b. Appleton; EXGJH or EXLK.

E. Fittings:

1. Provide bushings, grounding bushings, conduit hubs, conduit bodies, couplings, unions, conduit sealing fittings, drain seals, drain/breather fittings, expansion fittings, and cable sealing fittings, as applicable.
2. Rigid Galvanized Steel and Intermediate Metal Conduit:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, galvanized.
3. PVC Conduit:
   a. Meet requirements of NEMA TC 3.
   b. Type: PVC, slip-on.
4. Flexible Metal, Liquid-Tight Conduit:
   a. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
   b. Insulated throat and sealing O-rings.
5. Flexible Coupling, Hazardous Locations:
   a. Approved for use in the atmosphere involved.
   b. Rating: Watertight and UL listed for use in Class I, Division 1 and Division 2 areas.
   c. Outer bronze braid and an insulating liner.
   d. Conductivity equal to a similar length of rigid metal conduit.
   e. Manufacturers and Products:
      1) Crouse-Hinds; Type ECGJH or ECLK.
      2) Appleton; EXGJH or EXLK.

2.20 METAL WIREWAYS

A. Meet requirements of UL 870.

B. Type: Steel-enclosed, with removable, hinged cover.

C. Rating: Outdoor raintight.

D. Finish: Gray, baked enamel.

E. Manufacturers:

©COPYRIGHT 2012 CH2M HILL

1. Circle AW.
2. Hoffman.

2.21 CONDUIT ACCESSORIES

A. Duct Bank Spacers:

1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
2. Suitable for all types of conduit.
3. Manufacturers:
   a. Underground Device, Inc.
   b. Carlon.

B. Identification Devices:

1. Raceway Tags:
   a. Material: Permanent, [nonferrous metal] [nylon] [polyethylene].
   b. Shape: Round.
   c. Raceway Designation: Pressure stamped, embossed, or engraved.
   d. Tags relying on adhesives or taped-on markers not permitted.
2. Warning Tape:
   a. Material: Polyethylene, 4-mil gauge with detectable strip.
   b. Color: Red.
   c. Width: Minimum 6 inches.
   d. Designation: Warning on tape that electric circuit is located below tape.
   e. Identifying Letters: Minimum 1-inch high permanent black lettering imprinted continuously over entire length.

C. Raceway Band:

1. Slip-on Type:
   a. Provide heat-shrinkable, black, medium-wall polyolefin tubing with factory-applied adhesive/sealant. Select product size based upon raceway outside diameter.
   b. Manufacturer and Product: 3M; Type IMCSN, medium wall cable sleeve.
2. Wrap-around Type:
   a. Provide 4-inch width, 20-mil thickness, nonprinted black PVC corrosion protection tape with primer.
   b. Manufacturer and Product: 3M; Type Scotchrap 51 with Scotchrap Pipe Primer.

©COPYRIGHT 2012 CH2M HILL

2.22 CONDUCTORS AND CABLES

A. Conductors 600 Volts and Below:

1. Conform to applicable requirements of NEMA WC 71, WC 72, and WC 74.
2. Conductor Type:
   a. 120- and 277-Volt Lighting, 10 AWG and Smaller: Solid copper.
   b. 120-Volt Receptacle Circuits, 10 AWG and Smaller: Solid copper.
   c. All Other Circuits: Stranded copper.
3. Insulation: Type THHN/THWN
4. Flexible Cords and Cables:
   a. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
   b. Conform to physical and minimum thickness requirements of NEMA WC 70.

B. 600-Volt Rated Cable:

1. General:
   a. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
   b. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
   c. Suitable for installation in open air, in cable trays, or conduit.
   d. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
   e. Overall Outer Jacket: [PVC, flame-retardant, sunlight- and oil-resistant.
2. Type TSP, 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.
   a. Outer Jacket: 45 mils nominal thickness.
   b. Individual Pair Shield: 1.35 mils, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
   c. Dimension: 0.31-inch nominal outside diameter.
   d. Conductors:
      1) Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.

©COPYRIGHT 2012 CH2M HILL

2) 20 AWG, seven-strand tinned copper drain wire.
3) Insulation: 15 mils nominal PVC.
4) Jacket: 4 mils nominal nylon.
5) Color Code: Pair conductors black and red.

e. Manufacturers: Okonite Co.

C. Accessories:

1. Tape:
   a. General Purpose, Flame Retardant: 7 mils, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
   b. Flame Retardant, Cold and Weather Resistant: 8.5 mils, vinyl plastic, Scotch Brand 88.
   c. Arc and Fireproofing:
      1) 30 mils, elastomer.
      2) Manufacturers and Products:
         a) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
         b) Plymount; Plyarc 53, with Plyglas 77 glass cloth tapebinder.
2. Identification Devices:
   a. Sleeve-type, permanent, PVC, yellow or white, with legible machine-printed black markings.
   b. Manufacturer and Products: Raychem; Type D-SCE or ZH-SCE.
3. Connectors and Terminations:
   a. Nylon, Self-Insulated Crimp Connectors:
      1) Manufacturers and Products:
         a) Thomas & Betts; Sta-Kon.
         b) Burndy; Insulug.
         c) ILSCO.
4. Self-Insulated, Freespring Wire Connector (Wire Nuts):
   a. Plated steel, square wire springs.
   b. UL Standard 486C.
   c. Manufacturers and Products:
      1) Thomas & Betts.
      2) Ideal; Twister.
5. Cable Lugs:
   a. In accordance with NEMA CC 1.
   b. Rated 600 volts of same material as conductor metal.
   c. Uninsulated Crimp Connectors and Terminators:
      1) Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
      2) Manufacturers and Products:

©COPYRIGHT 2012 CH2M HILL

a) Thomas & Betts; Color-Keyed.
b) Burndy; Hydent.
c) ILSCO.

d. Uninsulated, Bolted, Two-Way Connectors and Terminators:
1) Manufacturers and Products:
a) Thomas & Betts; Locktite.
b) Burndy; Quiklug.
c) ILSCO.

6. Cable Ties:
a. Nylon, adjustable, self-locking, and reusable.
b. Manufacturer and Product: Thomas & Betts; TY-RAP.

7. Heat Shrinkable Insulation:
a. Thermally stabilized, crosslinked polyolefin.
b. Manufacturer and Product: Thomas & Betts; SHRINK-KON.

D. Conductors Above 600 Volts

1. EPR Insulated Cable:
a. Extrusion: Single-pass, triple-tandem, of conductor screen, insulation, and insulation screen.
b. Type: 15 kV, shielded, UL 1072, Type MV-105.
c. Conductors: Copper, concentric lay Class B round stranded in accordance with ASTM B3, ASTM B8, and ASTM B496.
d. Strand Fill: Waterproof strand compound enclosing conductors.
e. Conductor Screen: Extruded, semiconducting ethylene-propylene rubber in accordance with NEMA WC 71 and AEIC CS 8.
f. Insulation: 133 percent insulation level, ethylene-propylene rubber (EPR) containing no polyethylene, in accordance with NEMA WC 71, and AEIC CS 8.
g. Insulation Thickness: 220-mil, 15 kV, nominal.
h. Insulation Screen: Thermosetting, semiconducting ethylene-propylene rubber (EPR), extruded directly over insulation in accordance with NEMA WC 74 and AEIC CS 8.
i. Metallic Shield: Uncoated, 5-mil, copper shielding tape, helically applied with 12-1/2 percent minimum overlap.
j. Jacket: Extruded polyvinyl chloride (PVC) compound applied in accordance with NEMA WC 71 or NEMA WC 74.
k. Operating Temperature: 105 degrees C continuous normal operations, 130 degrees C emergency operating conditions, and 250 degrees C short-circuit conditions.
l. Manufacturers:
1) Okonite Co.
2) Pirelli Wire and Cable.

©COPYRIGHT 2012 CH2M HILL

3) General Cable.
4) Southwire Co.
5) Kerite

E. Accessories for Conductors Above 600 Volts

1. Molded Splice Kits:
   a. Components necessary to provide insulation, metallic shielding and grounding systems, and overall jacket.
   b. Capable of making splices with a current rating equal to, or greater than cable ampacity, conforming to IEEE 404.
   c. Class 15 kV, with compression connector, EPDM molded semiconductive insert, peroxide-cured EPDM insulation, and EPDM molded semiconductive outer shield.
   d. Premolded splice shall be rejacketed with a heat shrinkable adhesive-lined sleeve to provide a waterproof seal.
   e. Manufacturers:
      1) Elastimold.
      2) Cooper Industries.
2. Heat Shrinkable Splice Kits:
   a. Components necessary to provide insulation, metallic shielding and grounding systems, and overall jacket.
   b. Capable of making splices with a current rating equal to, or greater than, cable ampacity, conforming to IEEE 404.
   c. Class 15 kV, with compression connector, splice insulating and conducting sleeves, stress-relief materials, shielding braid and mesh, and abrasion-resistant heat shrinkable adhesive-lined rejacketing sleeve to provide a waterproof seal.
   d. Manufacturers:
      1) Raychem.
      2) 3M Co.
3. Termination Kits:
   a. Capable of terminating 15 kV, single-conductor, polymeric-insulated shielded cables plus a shield ground clamp.
   b. Capable of producing a termination with a current rating equal to, or greater than, cable ampacity meeting Class 1 requirements of IEEE 48.
   c. Capable of accommodating cable shielding or construction without need for special adapters or accessories.
   d. Manufacturers:
      1) Raychem.
      2) 3M Co.
4. Bus Connection Insulation
   a. Heat shrinkable tubing, tape, and sheets of flexible cross-linked

©COPYRIGHT 2012 CH2M HILL

polymeric material formulated for high dielectric strength.
b. Tape and sheet products to have coating to prevent adhesion to metal surfaces.
c. Insulating materials to be removable and reusable.
d. Manufacturer: Raychem.

5. Elbow Connector Systems:
   a. Molded, peroxide-cured, EPDM-insulated, Class 15 kV, 95 kV BIL, 200A, 10,000A rms load-break and 600A, 40,000 rms nonload-break elbows as shown, having copper current-carrying parts in accordance with IEEE 386.
   b. Protective Caps: Class 15 kV, 95 kV BIL, 200 and 600 amperes, with molded EPDM insulated body.
   c. Insulated Standoff Bushings: Class 15 kV, 95kV BIL, 200 and 600 amperes, complete with EPDM rubber body, stainless steel eyebolt with brass pressure foot, and stainless steel base bracket.
   d. Bushing Inserts: Class 15 kV, 95 kV BIL, 200A, load-break 600A, nonload-break with EPDM rubber body and all-copper, current-carrying parts.
   e. Manufacturers:
      1) Cooper Industries.
      2) Elastimold.
6. Cable Lugs:
   a. In accordance with NEMA CC1.
   b. Rated 15 kV of same material as conductor metal.
   c. Manufacturers and Products, Uninsulated Compression Connectors and Terminators:
      1) Burndy; Hydent.
      2) Thomas & Betts; Color-Keyed.
      3) ILSCO.
   d. Manufacturers and Products, Uninsulated, Bolted, Two-Way Connectors and Terminators:
      1) Thomas & Betts; Locktite.
      2) ILSCO.

2.23 GROUNDING

A. Ground Rods: Provide copper-clad with minimum diameter of 5/8-inch, and length of 10 feet.

B. Ground Conductors: As specified in Article Conductors and Cable.

C. Connectors:

1. Exothermic Weld Type:

©COPYRIGHT 2012 CH2M HILL

a. Outdoor Weld: Suitable for exposure to elements or direct burial.
b. Indoor Weld: Utilize low-smoke, low-emission process.
c. Manufacturers:
1) Erico Products, Inc.; Cadweld and Cadweld Exolon.
2) Thermoweld.

2. Compression Type:
a. Compress-deforming type; wrought copper extrusion material.
b. Single indentation for conductors 6 AWG and smaller.
c. Double indentation with extended barrel for conductors 4 AWG and larger.
d. Single barrels prefilled with oxide-inhibiting and antiseizing compound.
e. Manufacturers:
1) Burndy Corp.
2) Thomas and Betts Co.
3) ILSCO.

3. Mechanical Type:
a. Split-bolt, saddle, or cone screw type; copper alloy material.
b. Manufacturers:
1) Burndy Corp.
2) Thomas and Betts Co.

2.24 LUMINAIRES AND ACCESSORIES

A. Specific requirements relating to fixture type and lamp type are provided on Drawings.

B. Poles:

1. Rating (With Luminaire): 150 mph steady winds, without incurred damage.
2. Material: Fiberglass (FRP) 37’ Tapered, Direct Embed.
3. Manufacturers:
a. Alliance Composites, Inc.
b. Valmont.

2.25 EQUIPMENT LABELING

A. Label all new equipment. Match existing equipment labeling system. Owner shall approve new labeling before installation.

©COPYRIGHT 2012 CH2M HILL

PART 3 EXECUTION

3.01 GENERAL

A. Install materials and equipment in accordance with manufacturer's instructions and recommendations.

B. Work shall comply with all applicable provisions of NECA 1.

C. Install materials and equipment in hazardous areas in a manner acceptable to regulatory authority having jurisdiction for the class, division, and group of hazardous areas shown.

D. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

3.02 PROTECTION FOLLOWING INSTALLATION

A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation.

B. Cap conduit runs during construction with manufactured seals.

C. Close openings in boxes or equipment during construction.

D. Energize space heaters furnished with equipment.

3.03 SERVICE ENTRANCE EQUIPMENT AND METERING

A. Unless otherwise specified or shown, schedule and coordinate work of serving utility as required to provide electric service to the Work.

3.04 OUTLET AND DEVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.

B. Install plumb and level.

C. Support boxes independently of conduit by attachment to building structure or structural member.

D. Box Type (Steel Raceway System):

1. Outdoor Locations: Cast metal.

©COPYRIGHT 2012 CH2M HILL

2. Cast-in-Place Concrete Slabs: Sheet steel.

E. Box Type, Corrosive Locations (PVC-Coated rigid Galvanized Steel Raceway System): PVC-coated cast metal with matching cover.

3.05 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Use conduit bodies as junction and pull boxes where no splices are required and their use is allowed by applicable codes.

F. Installed boxes shall be accessible.

G. Do not install on finished surfaces.

H. Install plumb and level.

I. Support boxes independently of conduit by attachment to building structure or structural member.

J. At or Below Grade:

1. Install boxes for belowgrade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
3. Obtain Owner’s written acceptance prior to installation in paved areas, roadways, or walkways.
4. Use boxes and covers suitable to support anticipated weights.

K. Mounting Hardware:

1. Outdoor or Noncorrosive Indoor Wet Areas: Stainless steel.
2. Corrosive Areas: Stainless steel.

©COPYRIGHT 2012 CH2M HILL

L. Location/Type:

1. Indoor and Outdoor, Wet: NEMA 250, Type 4.
2. Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X, stainless steel.
3. Indoor and Outdoor, Hazardous: NEMA 250, Type 7, where indicated.
4. Underground Conduit: Concrete.
5. Corrosive: NEMA 250, Type 4X, stainless steel.
6. Outdoor, Where Indicated Weatherproof (WP): NEMA 250, Type 3R.
7. Industrial Use in Areas Not Otherwise Classified: NEMA 250, Type 12, unless otherwise shown.

M. Install Drain/breather fittings in NEMA 250, Type 4 and Type 4X enclosures.

3.06 PRECAST HANDHOLES

A. Excavate, shore, brace, backfill, and final grade in accordance with Section 31 23 16, Excavation, and Section 31 23 23.15, Trench Backfill.

B. Do not install until final raceway grading has been determined.

C. Install such that raceways enter at nearly right angles and as near as possible to one end of wall, unless otherwise shown.

3.07 WIRING DEVICES

A. Switches:

1. Mounting Height: See Article Outlet and Device Boxes.
2. Install with switch operation in vertical position.
3. Install single-pole, two-way switches such that toggle is in up position when switch is on.

B. Receptacles:

1. Install with grounding slot down, except where horizontal mounting is shown, in which case install with neutral slot down.
2. Ground receptacles to boxes with grounding wire only.
3. Weatherproof Receptacles:
   a. Install in cast metal box.
   b. Install such that hinge for protective cover is above receptacle opening.
4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for “downstream” conventional receptacles.

©COPYRIGHT 2012 CH2M HILL

5. Special-Purpose Receptacles: Install in accordance with manufacturer's instructions.

3.08 DEVICE PLATES

A. Securely fasten to wiring device; ensure a tight fit to box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box, unless plates have no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Engrave with designated titles.

F. Types (Unless Otherwise Shown):

1. Outdoor: Weatherproof.

3.09 PANELBOARDS AND MINI-POWER CENTERS

A. Install securely, plumb, in-line and square with rack.

B. Provide typewritten circuit directory for each panelboard.

C. Cabinet Location/Type:

1. Wet or Outdoor: NEMA 250, Type 3R, Outdoor.
2. Industrial Use in Areas Not Otherwise Classified: NEMA 250, Type 12, unless otherwise shown.

3.10 CIRCUIT BREAKERS AND SWITCHES

A. Location and Enclosure Type:

1. Hazardous Gas: NEMA 250, Type 7.
2. Wet or Outdoor: NEMA 250, Type 4.
3. Corrosive: NEMA 250, Type 4X.
4. Wet and Corrosive: NEMA 250, Type 4X.
5. Where Denoted WP: NEMA 250, Type 3R.

©COPYRIGHT 2012 CH2M HILL

3.11 TERMINAL BLOCKS

A. Install for termination of control circuits entering or leaving equipment and local control panels.

3.12 SUPPORT AND FRAMING CHANNELS

A. Install where required for mounting and supporting electrical equipment and raceway systems.

B. Channel Type:

1. Outdoor, Corrosive Locations: Type 316 stainless steel.

C. Paint carbon steel channel cut ends prior to installation with zinc-rich primer.

3.13 NAMEPLATES

A. Provide identifying nameplate on all equipment.

3.14 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) EQUIPMENT

A. Install in accordance with manufacturer’s instructions, including lead length, overcurrent protection, and grounding.

3.15 CONDUIT AND FITTINGS

A. General:

1. Crushed or deformed raceways not permitted.
2. Maintain raceway entirely free of obstructions and moisture.
3. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.
4. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.
5. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.
6. Group raceways installed in same area.
7. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.
8. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.
9. Install watertight fittings in outdoor, underground, or wet locations.
10. Paint threads and cut ends, before assembly of fittings, galvanized conduit, installed in exposed or damp locations with zinc-rich paint or

©COPYRIGHT 2012 CH2M HILL

liquid galvanizing compound.

11. Metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.
12. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

B. Installation in Cast-in-Place Structural Concrete:

1. Minimum cover 2 inches, including all fittings.
2. Conduit placement shall not require changes in reinforcing steel location or configuration.
3. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.
4. Conduit larger than 1 inch shall not be embedded in concrete slabs, walls, foundations, columns or beams, unless approved by Engineer.
5. Slabs and Walls:
   a. Trade size of conduit not to exceed one-fourth of the slab or wall thickness.
   b. Install within middle two-fourths of slab or wall.
   c. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
   d. Separate conduit 2 inches and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
   e. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1 inch.
   f. Separate conduit by a minimum six times the outside dimension of expansion and deflection fittings at expansion joints.
   g. Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.
6. Columns and Beams:
   a. Trade size of conduit not to exceed one-fourth of beam thickness.
   b. Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

C. Conduit Application:

1. Diameter:
   a. Exterior Minimum: 3/4 inch.
2. Outdoor, Exposed: Rigid galvanized steel.
3. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors:
   a. Rigid galvanized steel.
   b. PVC Schedule 40.
4. Direct Earth Burial: PVC Schedule 40.
5. Under Slabs-On-Grade: PVC Schedule 40.

©COPYRIGHT 2012 CH2M HILL

6. Corrosive Areas: PVC Schedule 40.
7. Classified Areas: Rigid galvanized steel.

D. Connections:

1. General: Flexible metal, liquid-tight conduit.
2. Hazardous Areas: Flexible coupling suitable for Class I, Division 1 and 2 areas.
3. Wet or Corrosive Areas: Flexible metal liquid-tight.
4. Length: 18 inches minimum, 60 inches maximum, sufficient to allow movement or adjustment of equipment.
5. Outdoor areas, process areas exposed to moisture, and areas required to be oiltight and dust-tight: Flexible metal, liquid-tight conduit.
6. Transition From Underground or Concrete Embedded to Exposed: Rigid galvanized steel conduit.
7. Under Equipment Mounting Pads: Rigid galvanized steel conduit.
8. Exterior Light Pole Foundations: Rigid galvanized steel PVC Schedule 40 conduit.

E. Penetrations:

1. Make at right angles, unless otherwise shown.
2. Notching or penetration of structural members, including footings and beams, not permitted.
3. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack.
   a. Corrosive-Sensitive Areas:
      1) Seal conduit entering equipment panelboards and field panels containing electronic equipment.
      2) Seal penetration with Type 5 sealant, as specified in Section 07 92 00, Joint Sealants.
   b. Existing manhole (Underground): Core drill wall and install watertight entrance seal device, or saw cut wall and grout seal opening.
   c. Handholes:
      1) Metallic Raceways: Provide insulated grounding bushings.
      2) Nonmetallic Raceways: Provide bell ends flush with wall.

F. Support:

1. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 8 feet. Do not support from piping, pipe supports, or other raceways.

©COPYRIGHT 2012 CH2M HILL

2. Application/Type of Conduit Strap:
   a. Steel Conduit: Zinc-coated steel, pregalvanized steel, or malleable iron.
   b. Nonmetallic Conduit: Nonmetallic or PVC-coated metal.

G. Bends:

1. Install concealed raceways with a minimum of bends in the shortest practical distance.
2. Install with symmetrical bends or cast metal fittings.
3. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.
4. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.
5. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run and raceways are same size.
6. PVC Conduit:
   a. Bends 30 Degrees and Larger: Provide factory-made elbows.
   b. 90-Degree Bends: Provide rigid steel elbows, PVC coated where direct buried from underground to above ground.
   c. Use manufacturer’s recommended method for forming smaller bends.
7. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

H. Expansion and Deflection Fittings: Provide on all raceways at structural expansion joints and in long tangential runs.

I. PVC Conduit:

1. Solvent Welding:
   a. Provide manufacturer recommended solvent; apply to all joints.
   b. Install such that joint is watertight.
2. Adapters:
   a. PVC to Metallic Fittings: PVC terminal type.
   b. PVC to Rigid Metal Conduit or IMC: PVC female adapter.
3. Belled-End Conduit: Bevel the unbelled end of the joint prior to joining.

J. Termination at Enclosures:

1. Cast Metal Enclosure: Provide manufacturer’s premolded insulating sleeve inside metallic conduit terminating in threaded hubs.

©COPYRIGHT 2012 CH2M HILL

2. Nonmetallic, Cabinets, and Enclosures: Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
3. Sheet Metal Boxes, Cabinets, and Enclosures:
   a. Rigid Galvanized Conduit:
      1) Provide one lock nut each on inside and outside of enclosure.
      2) Install grounding bushing.
      3) Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
      4) Install insulated bushing on ends of conduit where grounding is not required.
      5) Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
      6) Utilize sealing locknuts or threaded hubs on outside of NEMA 3R and NEMA 12 enclosures.
      7) Terminate conduits with threaded conduit hubs at NEMA 4 and 4X boxes and enclosures.
   b. Flexible Metal Conduit: Provide two-screw type, insulated, malleable iron connectors.
   c. PVC Schedule 40 Conduit: Provide PVC terminal adapter with locknut.
4. Free-Standing Enclosures:
   a. Terminate metal conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.
   b. Terminate PVC conduit entering bottom with bell end fittings.

K. Underground Raceways:

1. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.
2. Cover: Maintain minimum 2-foot cover above conduit, unless otherwise shown.
3. Make routing changes as necessary to avoid obstructions or conflicts.
4. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.
5. Union type fittings not permitted.
6. Spacers:
   a. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench.
   b. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.
7. Support conduit so as to prevent bending or displacement during backfilling.

©COPYRIGHT 2012 CH2M HILL

8. Installation with Other Piping Systems:
   a. Crossings: Maintain minimum 12-inch vertical separation.
   b. Parallel Runs: Maintain minimum 12-inch separation.
   c. Installation over valves or couplings not permitted.

L. Empty Raceways:

1. Provide permanent, removable cap over each end.
2. Provide PVC plug with pull tab for underground raceways with end bells.
3. Provide nylon pull cord.
4. Identify, as specified in Article Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

M. Identification Devices:

1. Raceway Tags:
   a. Identify origin and destination.
   b. Install at each terminus, near midpoint, and at minimum intervals of every 50 feet of exposed raceway.
   c. Provide nylon strap for attachment.
2. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of runs.

N. Raceway Band:

1. Install wherever metallic conduit emerges from concrete slabs. Not required with PVC-coated RGS conduit. Center band at slab surface and install according to manufacturer's instructions.
   a. Slip-on Type: Clean conduit surface at installation location. Cut tubing to 4-inch minimum lengths and slip onto raceway prior to slab placement and termination of conduit. Heat-shrink onto conduit.
   b. Wrap-around Type: Use where slip-on access to conduit is not possible. Clean conduit surface at installation location. Apply primer. Apply wraps to provide two layers of tape. Neatly finish tape end to prevent unraveling.

3.16 METAL WIREWAYS

A. Install in accordance with manufacturer's instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

©COPYRIGHT 2012 CH2M HILL

3.17 CONDUCTORS AND CABLES

A. Conductor storage, handling, and installation shall be in accordance with manufacturer's recommendations.

B. Do not exceed manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

C. Conduit system shall be complete prior to drawing conductors. Lubricate prior to pulling into conduit. Lubrication type shall be as approved by conductor manufacturer.

D. Terminate all conductors and cables, unless otherwise shown.

E. Do not splice conductors, unless specifically indicated or approved by Engineer.

F. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 12 inches.

G. Wiring within Equipment and Local Control Panels: Remove surplus wire, dress, bundle, and secure.

H. Power Conductor Color Coding:

1. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.
2. 8 AWG and Smaller: Provide colored conductors.
3. Colors:
   a. Neutral Wire: White.
   b. Live Wires, 120/240-Volt, Single-Phase System: Black, red.
   c. Live Wires, 120/208-Volt, Three-Phase System: Black, red, or blue.
   d. Live Wires, 277/480-Volt, Three-Phase System: Brown, orange, or yellow.
   e. Ground Wire: Green.

©COPYRIGHT 2012 CH2M HILL

I. Circuit Identification:

1. Circuits Appearing in Circuit Schedules: Identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.
2. Circuits Not Appearing in Circuit Schedules: Assign circuit name based on device or equipment at load end of circuit. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.
3. Method: Identify with sleeves. Taped-on markers or tags relying on adhesives not permitted.
4. 15kV Class circuit tags shall be engraved white on black plastic tags similar to existing method.

J. Connections and Terminations:

1. Install wire nuts only on solid conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control circuit conductors.
3. Tape insulate all uninsulated connections.
4. Install crimp connectors and compression lugs with tools approved by connector manufacturer.

3.18 GROUNDING

A. Grounding shall be in compliance with NFPA 70 and as shown.

B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

A. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

B. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

C. Equipment Grounding Conductors: Provide in all conduits containing power conductors and control circuits above 50 volts.

D. Ground Rods: Install full length with conductor connection at upper end. Install one ground rod in each handhole.

©COPYRIGHT 2012 CH2M HILL

3.19 LUMINAIRES AND ACCESSORIES

A. Install in accordance with manufacturer's recommendations.

B. Install plumb and level at mounting heights shown.

C. Provide proper hangers, supports, pendants, and canopies as necessary for complete installation.

3.20 FIELD QUALITY CONTROL

A. General:

1. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.
2. Test instrument calibration shall be in accordance with NETA ATS.
3. Perform inspection and electrical tests after equipment has been installed.
4. Perform tests with apparatus de-energized whenever feasible.
5. Inspection and electrical tests on energized equipment are to be:
   a. Scheduled with Owner prior to de-energization.
   b. Minimized to avoid extended period of interruption to the operating plant equipment.

B. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer's tolerances.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70.

C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

D. Adjust mechanisms and moving parts for free mechanical movement.

E. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

F. Verify nameplate data for conformance to Contract Documents.

G. Realign equipment not properly aligned and correct unlevelness.

©COPYRIGHT 2012 CH2M HILL

H. Properly anchor electrical equipment found to be inadequately anchored.

I. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

J. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

K. Provide proper lubrication of applicable moving parts.

L. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

M. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by Engineer, door and panel sections having damaged surfaces.
5. Replace missing or damaged hardware.

N. Provide certified test report(s) documenting the successful completion of specified testing. Include field test measurement data.

O. Test the following equipment and materials:

1. Conductors: Insulation resistance, No. 4 and larger only.
2. Panelboards, switches, and circuit breakers.
3. Grounding electrodes.

P. Controls:

1. Test control and signal wiring for proper termination and function.
2. Test local control panels and other control devices for proper terminations, configuration and settings, and functions.
3. Demonstrate control, monitoring, and indication functions in presence of Owner and Engineer.

Q. Balance electrical load between phases on panelboards and mini-power centers after installation.

©COPYRIGHT 2012 CH2M HILL

R. Voltage Testing:

1. When installation is complete and facility is in operation, check voltage at point of termination of electric utility supply system to Project.
2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
3. If unbalance exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded conditions more than plus or minus 4 percent of nominal, make written request to electric utility to correct condition.
4. If corrections are not made, obtain written statement from a responsible electric utility official that voltage variations and/or unbalance are within their normal standards.

END OF SECTION

©COPYRIGHT 2012 CH2M HILL

Page Intentionally Left Blank

©COPYRIGHT 2012 CH2M HILL

SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. D877, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
   b. D923, Standard Practice for Sampling Electrical Insulating Liquids.
   c. D924, Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
   d. D971, Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
   e. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
   f. D1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
   g. D1500, Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
   h. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
   i. D1533, Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
   j. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.
   b. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminators Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5kV through 500kV.
   c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
   d. 95, Recommended Practice for Insulation Testing of AC Electric Machinery (2300V and Above) with High Direct Voltage.

©COPYRIGHT 2013 CH2M HILL

e. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
f. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems.
g. 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
h. C2, National Electrical Safety Code.
i. C37.20.1, Standard for Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.
j. C37.20.2, Standard for Metal-Clad Switchgear.
k. C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear.
l. C37.23, Standard for Metal-Enclosed Bus.
m. C62.33, Standard Test Specifications for Varistor Surge-Protective Devices.

3. Insulated Cable Engineers Association (ICEA):
   a. S-93-639, 5-46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electric Energy.
   b. S-94-649, Concentric Neutral Cables Rated 5 through 46 kV.
   c. S-97-682, Standard for Utility Shielded Power Cables Rated 5 through 46 kV.
4. National Electrical Manufacturers Association (NEMA):
   a. AB 4, Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
   b. PB 2, Deadfront Distribution Switchboards.
   c. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
5. InterNational Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70B, Recommended Practice for Electrical Equipment Maintenance.
   c. 70E, Standard for Electrical Safety in the Workplace.
   d. 101, Life Safety Code.
7. National Institute for Certification in Engineering Technologies (NICET).
8. Occupational Safety and Health Administration (OSHA): CFR 29, Part 1910, Occupational Safety and Health Standards.

©COPYRIGHT 2013 CH2M HILL

1.02 SUBMITTALS

A. Informational Submittals:

1. Submit 30 days prior to performing inspections or tests:
   a. Schedule for performing inspection and tests.
   b. List of references to be used for each test.
   c. Sample copy of equipment and materials inspection form(s).
   d. Sample copy of individual device test form.
   e. Sample copy of individual system test form.
2. Energization Plan: Prior to initial energization of electrical distribution equipment; include the following:
   a. Owner's representative sign-off form for complete and accurate arc flash labeling and proper protective device settings for equipment to be energized.
   b. Staged sequence of initial energization of electrical equipment.
   c. Lock-Out-Tag-Out plan for each stage of the progressive energization.
   d. Barricading, signage, and communication plan notifying personnel of newly energized equipment.
3. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test:

1.03 QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.
3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years' testing experience on similar projects.
5. Technicians certified by NICET or NETA.
6. Assistants and apprentices assigned to Project at ratio not to exceed two certified to one noncertified assistant or apprentice.
7. Registered Professional Engineer to provide comprehensive Project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA CFR 29, Part 1910.7 criteria for accreditation of testing laboratories or a full member company of NETA.

©COPYRIGHT 2013 CH2M HILL

B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.

C. Test instrument calibration shall be in accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment listed herein has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment shall be:

1. Scheduled with Owner prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

D. Notify Owner at least 48 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Tests and inspections shall establish:

1. Electrical equipment is operational within industry and manufacturer's tolerances and standards.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.

B. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

C. Set, test, and calibrate fault interrupter overcurrent control, circuit breakers, fuses phase monitoring relay and other applicable devices.

D. Adjust mechanisms and moving parts of equipment for free mechanical movement.

©COPYRIGHT 2013 CH2M HILL

E. Adjust and set electromechanical electronic relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

F. Verify nameplate data for conformance to Contract Documents and approved Submittals.

G. Realign equipment not properly aligned and correct unlevelness.

H. Properly anchor electrical equipment found to be inadequately anchored.

I. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screw driver to manufacturer's recommendations, or as otherwise specified in NETA ATS.

J. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

K. Provide proper lubrication of applicable moving parts.

L. Inform Engineer of working clearances not in accordance with NFPA 70.

M. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

N. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by Engineer door and panel sections having dented surfaces.
5. Repair or replace, as determined by Engineer poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
   a. Provide matching paint and touch up scratches and mars.
   b. If required because of extensive damage, as determined by Engineer, refinish entire assembly.

©COPYRIGHT 2013 CH2M HILL

O. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved Submittals.

P. Replace transformer insulating oil not in compliance with ASTM D923.

3.02 CHECKOUT AND STARTUP

A. Voltage Field Test:

1. Check voltage at point of termination of power company supply system to Project when installation is essentially complete and is in operation.
2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
3. Record supply voltage (all three phases simultaneously on same graph) for 24 hours during normal working day.
   a. Submit Voltage Field Test Report within 5 days of test.
4. Unbalance Corrections:
   a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.
   b. Obtain written certification from responsible power company official that voltage variations and unbalance are within their normal standards if corrections are not made.

B. Equipment Line Current Tests:

1. Check line current in each phase for each new piece of equipment.
2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
3. If phase current for a piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

3.03 SF6 PAD MOUNTED SWITCHGEAR ASSEMBLIES

A. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer’s recommendations. Visual and Mechanical Inspection:

1. Insulator damage and contaminated surfaces.
2. Proper operation of indicating devices.
3. Check nameplates for proper identification of:
   a. Equipment title and tag number with latest one-line diagram.
   b. Fault interrupter microprocessor.

©COPYRIGHT 2013 CH2M HILL

4. Verify load and fault interrupter ratings, sizes, and types conform to those specified.
5. Check operation and sequencing of electrical and mechanical interlock systems by:
   a. Closure attempt for locked open devices.
   b. Opening attempt for locked closed devices.
   c. Key exchange to operate devices in OFF-NORMAL positions.
6. Verify performance of each control device and feature.
7. Exercise active components.

3.04 PANELBOARDS

A. Visual and Mechanical Inspection: Include the following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
3. Check panelboard mounting, area clearances, and alignment and fit of components.
4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
5. Perform visual and mechanical inspection for overcurrent protective devices.

B. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   b. Each phase of each bus section.
   c. Phase-to-phase and phase-to-ground for 1 minute.
   d. With breakers open.
   e. With breakers closed.
   f. Control wiring except that connected to solid state components.
   g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Ground continuity test ground bus to system ground.

©COPYRIGHT 2013 CH2M HILL

3.05 LIQUID FILLED TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Effective core and equipment grounding.
7. Removal of shipping brackets, fixtures, or bracing.
8. Tank leaks and proper liquid level.
9. Integrity and contamination of bus insulation system.
10. Verify tap-changer is set at correct ratio for rated voltage under normal operating conditions.
11. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. Test Duration: 10 minutes with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
   c. Results temperature corrected in accordance with NETA ATS, Table 100.14.
   d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   e. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.
3. Sample insulating oil in accordance with ASTM D923 and have laboratory test for:
   a. Dielectric breakdown voltage in accordance with ASTM D877 or ASTM D1816.
   b. Acid neutralization number in accordance with ASTM D974.
   c. Interfacial tension in accordance with ASTM D971.
   d. Color in accordance with ASTM D1500.
   e. Visual condition in accordance with ASTM D1524.
   f. Specific gravity in accordance with ASTM D1298.

©COPYRIGHT 2013 CH2M HILL

g. Water content, in parts per million, in accordance with ASTM D1533.
h. Dielectric fluid test results in accordance with NETA ATS, Table 100.4.
i. Power factor at 25 degrees C and at 100 degrees, in accordance with ASTM D924.
j. Maximum power factor, corrected to 20 degrees C, in accordance with manufacturer's specifications.

3.06 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed power cable No. 6 and larger for:
   a. Physical damage.
   b. Proper connections in accordance with single-line diagram.
   c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
   d. Color coding conformance with specification.
   e. Proper circuit identification.
2. Mechanical Connections For:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables For:
   a. Proper shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.
4. Control Cables For:
   a. Proper termination.
   b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 6 and Larger:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.
   b. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
   c. Evaluate ohmic values by comparison with conductors of same length and type.
   d. Investigate values less than 50 megohms.

©COPYRIGHT 2013 CH2M HILL

2. Continuity test by ohmmeter method to ensure proper cable connections.

C. Low-voltage cable tests may be performed by installer in lieu of independent testing firm.

3.07 MEDIUM-VOLTAGE CABLES, 15 KV MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed cable for:
   a. Physical damage plus jacket and insulation condition.
   b. Proper connections in accordance with single-line diagram or approved Submittals.
   c. Proper shield grounding.
   d. Proper cable support.
   e. Proper cable termination.
   f. Cable bends not in conformance with manufacturer's minimum allowable bending radius.
   g. Proper arc and fireproofing in common cable areas.
   h. Proper circuit and phase identification.
2. Mechanical Connections:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturers.
3. Conductors Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 5,000-volt megohmmeter for 8 kV and 15 kV conductors.
   b. Test each cable individually with remaining cables and shields grounded.
   c. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
   d. Evaluate ohmic values by comparison with conductors of same length and type.
   e. Investigate values less than 50 megohms.
2. Shield Continuity Tests:
   a. By ohmmeter method on each section of conductor.
   b. Investigate values in excess of 10 ohms per 1,000 feet of conductors.

©COPYRIGHT 2013 CH2M HILL

3. Acceptance Tests:
   a. In accordance with IEEE 400, ICEA S-93-639, NEMA WC 74, ICEA S-94-649, and ICEA S-97-682 for insulated conductors.
   b. Each conductor section tested with:
      1) Splices and terminations in place but disconnected from equipment.
      2) Remaining conductors and shields grounded in accordance with IEEE 400.
   c. Apply maximum test voltage per NETA ATS, Table 100.6, based on method (DC, AC, PD or VLF) used.
   d. Measure only leakage current associated with conductor.
   e. Utilize guard ring or field reduction sphere to suppress corona at disconnected terminations.
   f. Maximum test voltage shall not exceed limits for terminators specified in IEEE 48, IEEE 386, or manufacturer's specifications.
   g. Apply test voltage in a minimum of five equal increments until maximum acceptable test voltage is reached.
      1) Increments not to exceed ac voltage rating of conductor.
      2) Record dc leakage current at each step after a constant stabilization time consistent with system charging current.
   h. Raise conductor to specified maximum test voltage and hold for 15 minutes or as specified by conductor manufacturer. Record leakage current at 30 seconds and 1 minute, and at 1-minute intervals, thereafter.
   i. Immediately following test, ground conductor for adequate time period to drain insulation stored charge.
   j. Test results evaluated on a pass/fail basis.
4. New Conductors Spliced to Existing Conductors:
   a. Prior to performing splices, high potential dc test new conductor sections.
   b. After splicing new conductors to existing conductors, disconnect existing conductors and perform the following tests:
      1) Shield continuity test.
      2) Insulation resistance test.
      3) Obtain Owner's permission to perform high potentional test on existing cable. High potential test with test voltage not to exceed 60 percent of applied acceptance dc test voltage.

3.08 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.
2. Proper operation of switch operating handle.
3. Adequate mechanical support for each fuse.
4. Proper contact-to-contact tightness between fuse clip and fuse.

©COPYRIGHT 2013 CH2M HILL

5. Cable connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Proper phase barrier material and installation.
7. Verify fuse sizes and types correspond to one-line diagram or approved Submittals.
8. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
   c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each switch blade and fuse holder.
   b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.09 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 70 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.
3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Operate breaker to verify smooth operation.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

©COPYRIGHT 2013 CH2M HILL

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480-volt and 600-volt circuit breakers **[and 500-volt dc megohmmeter for 240-volt circuit breakers]**.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. Test values to comply with NETA ATS, Table 100.1.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.
   c. Ground fault pickup and delay.
   d. Instantaneous pickup by run-up or pulse method.
   e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   f. Trip times shall be within limits established by NEMA AB 4, Table 5-3. Alternatively, use NETA ATS, Table 100.7.
   g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4. Alternatively, use NETA ATS, Table 100.8.

3.10 FAULT INTERRUPTER OVERCURRENT CONTROL RELAYS

A. Perform inspection and testing in accordance with NETA PATS, industry standards and Manufacturer's recommendation.

B. Verify overcurrent setting is in accordance with drawings.

3.11 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in panelboard and switchgear assemblies for proper connection and tightness.
2. Ground bus connections in panelboard and switchgear assemblies for proper termination and tightness.

©COPYRIGHT 2013 CH2M HILL

3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:

1. Fall-of-Potential Test:
   a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
   b. Main ground electrode system resistance to ground to be no greater than 5 ohm(s).
2. Two-Point Direct Method Test:
   a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
   b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.
3. Neutral Bus Isolation:
   a. Test each neutral bus individually with neutral bonding jumper removed at service entrance or separately derived system.
   b. Evaluate ohmic values by measuring resistance between ground bus and neutral bus.
   c. Investigate values less than 50 megohms.

3.12 LOW VOLTAGE SURGE ARRESTORS

A. Visual and Mechanical Inspection:

1. Adequate clearances between arrestors and enclosures.
2. Ground connections to ground electrode.

3.13 ELECTRICAL TESTS:

1. Varistor Type Arrestors:
   a. Clamping voltage test.
   b. Rated RMS voltage test.
   c. Rated dc voltage test.
   d. Varistor arrestor test values in accordance with IEEE C62.33, Section 4.4 and Section 4.9.

©COPYRIGHT 2013 CH2M HILL

3.14 MEDIUM-VOLTAGE SURGE ARRESTORS AND SURGE CAPACITORS

A. Visual Inspection:

1. Ground connections to ground bus.
2. Shortest practical jumper connections to line.

B. Electrical Tests:

1. Grounding electrode resistance test in accordance with IEEE 81, Section 8.2.1.5 using three-point fall-of-potential method.
2. Insulation power factor.
3. Insulation resistance.
4. RF noise test using Stoddart noise test set with applied voltage of 1.18 times maximum continuous operating voltage.
5. Insulation power factor leakage current, watts loss, and insulation resistance test in accordance with manufacturer's test values. RIV value not to exceed 10 microvolts above background noise.
6. Leakage current and watts loss tests.

END OF SECTION

©COPYRIGHT 2013 CH2M HILL

SECTION 26 12 02
OIL-FILLED PAD MOUNTED TRANSFORMERS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM): D3487, Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
   b. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
   c. C57.12.22, Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2,500 kVA and Smaller.
   d. C57.12.26, Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High Voltage Connectors.
   e. C57.12.28, Switchgear and Transformers—Pad-Mounted Equipment, Enclosure Integrity.
   f. C57.12.90, Standard Test Code for Liquid Immersed Distribution, Power, and Regulating Transformers.
   g. C57.106, Guide for Acceptance and Maintenance of Insulating Oil in Equipment.
   h. C62.11, Metal-Oxide Surge Arrestors for Alternating-Current Power Circuits (>1 kV).
3. National Electrical Manufacturers Association (NEMA):
   a. TR 1, Transformers, Regulators, Reactors.
   b. TP 1, Guide for Determining Energy Efficiency for Distribution Transformers.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories Inc. (UL).

1.02 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Dimensional drawings.
3. Transformer nameplate data.

©COPYRIGHT 2013 CH2M HILL

B. Informational Submittals:

1. Operation and Maintenance Data.
2. Factory test reports certified.

1.03 QUALITY ASSURANCE

A. Design, test, and assemble in accordance with applicable standards of NEMA TR 1, IEEE C57.12.00, IEEE C57.12.22, IEEE C57.12.26, and IEEE C57.12.90.

1.04 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage and deliver prior to 90 percent Project completion the following spare parts, special tools, and materials:

1. One quart of paint to match color and quality of equipment final shop finish.
2. Two spare fuse links for each replaceable fuse size.
3. Pentahead socket for 1/2-inch socket drive.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Square D Co.

B. General Electric.

C. Cooper Power System.

2.02 GENERAL

A. Integral Unit: Compartmental type unit consisting of transformer, oil-filled tank, and high and low voltage terminating compartments, assembled on a common structural base.

B. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter.

2.03 TRANSFORMER

A. kVA Rating: 75.

B. Primary Voltage: 13.8 kV line-to-line, three-phase, 60-Hz.

C. Secondary Voltage: 208/120 voltz, three-phase, four-wire, 60 Hz.

©COPYRIGHT 2013 CH2M HILL

D. BIL Rating:

1. 95 BIL for 15 kV insulation class transformers.
2. 30 BIL for secondary.

E. Temperature Rise: 65 degrees C above 30 degrees average ambient with maximum ambient not to exceed 40 degrees C.

F. Impedance: 1.35 percent minimum for transformers rated 150 kVA and less.

G. Efficiency: Meet or exceed values in Table 4-1 of NEMA TP 1.

H. Dielectric Coolant: Fully biodegradable, nontoxic, and nonbio-accumulating fluid, qualifying as “less flammable” per NEC 450.23; Factory Mutual Approved or UL Classified.

I. Primary Taps:

1. Full capacity, two 2-1/2 percent below and two 2-1/2 percent above, rated voltage.
2. Externally operated no-load tap changer.
3. Provisions for locking handle in any position.

J. Coil Conductors: Copper windings.

K. Sound Level: In accordance with manufacturer’s standards.

2.04 ENCLOSURE

A. In accordance with IEEE C57.12.28 requirements.

B. Welded carbon steel transformer tank, with cooling panels when required, and lifting eyes.

C. 12-gauge sheet steel terminal compartment enclosure having no exposed screws, bolts, or other fasteners that are externally removable.

D. Color: Provide green finish as approved by Owner.

2.05 TERMINAL COMPARTMENTS

A. General: IEEE C57.12.28, enclosed high and low voltage compartments side by side, separated by steel barrier, bolted to transformer tank.

1. Doors:
   a. Individual, full-height, air-filled.
   b. Low voltage door with three-point latching mechanism, vault type handle, and single padlocking provision.

©COPYRIGHT 2013 CH2M HILL

c. High voltage door fastenings inaccessible until low voltage door has been opened.
d. Door Bolts: Penta-head type.
e. Lift-off, stainless steel hinges and door stops.
f. Removable front sill to facilitate rolling or skidding over conduit stubs.
g. Recessed lock pocket, with steel door release bolt adjacent to secondary compartment door handle.

B. High Voltage Compartment:

1. Deadfront in accordance with IEEE C57.12.26 type construction.
2. Protective fuses.
3. High voltage bushings.
4. Transformer grounding pad.
5. Surge arrestors without barriers.
6. Radial feed, two position sectionalizing load-break switch.

C. Low Voltage Compartment:

1. Livefront in accordance with IEEE C57.12.26 type construction.
2. Low voltage bushings.
3. Grounding pad.
4. Stainless steel equipment nameplate.
5. Liquid level gauge.
6. 1-inch upper filter press and filling plug.
7. Drain valve with sampling device.
8. Dial type thermometer.
9. Pressure relief valve.
10. Pressure relief device, self-resealing with indicator.
11. Pressure-vacuum gauge.
12. Nameplate.

2.06 BUSHINGS

A. High Voltage:

1. Deadfront Termination:
   a. Universal bushing well rated at 15 kV in accordance with IEEE 386.
   b. Bushings externally clamped and front removable.
   c. Rated for 200 amperes continuous, 95 kV BIL.
   d. Standoff brackets located adjacent to bushings.

©COPYRIGHT 2013 CH2M HILL

B. Low Voltage:

1. Molded epoxy bushing clamped to tank with 8 hole spade type terminals.
2. Rated 150 percent of continuous full-load current, 30 BIL, 600 volts.
3. Internally connected neutral extending to neutral bushing.

2.07 HIGH VOLTAGE SWITCHING

A. Internal, oil-immersed, gang-operated load-break, manually operated switches.

B. Hot stick operated handle located in high voltage compartment.

C. Capable of operating at full-load current.

D. Feed Switch: Two-position, ON/OFF radial.

2.08 HIGH VOLTAGE PROTECTION

A. Bayonet-Type, Oil-Immersed Expulsion Fuses:

1. Accessible through primary compartment.
2. Externally replaceable with hot stick.
3. Fault sensing with interrupting capacity of 1,800 amperes rms asymmetrical.

2.09 SURGE ARRESTORS

A. Metal-Oxide, Varistor Type:

1. Insulated body, elbow type, 9 kV in accordance with IEEE C62.11.
2. Installed in high voltage compartment.
3. Connected to transformer high voltage terminals.

2.10 TANK GROUNDING PADS

A. High and Low Voltage Compartments:

1. Connected together with bare No. 2/0 stranded copper conductors.
2. Wye-wye high and low voltage neutrals internally connected with link and brought out to insulated low voltage bushing externally grounded to tank.
3. Low voltage neutral connected to externally mounted insulating bushing in low voltage compartment and grounded to tank with removable strap.

©COPYRIGHT 2013 CH2M HILL

2.11 TAP CHANGER WARNING SIGN

A. Red laminated plastic, engraved to white core.

B. Engrave to read: DO NOT OPERATE WHEN TRANSFORMER ENERGIZED.

C. Mount above tap changer handle.

2.12 FACTORY TESTS

A. Production tests in accordance with IEEE C57.12.90 and IEEE C57.12.00, Section 8 and Table 16.

B. Dielectric test in accordance with IEEE C57.12.26.

PART 3 EXECUTION

3.01 GENERAL

A. Secure to mounting pads with anchor bolts.

B. Install plumb and longitudinally in alignment with pad or adjacent building wall.

C. Ground neutrals and enclosures in accordance with applicable codes.

3.02 ADJUSTMENTS

A. Adjust voltage taps to obtain rated output voltage under normal operating load conditions.

END OF SECTION

©COPYRIGHT 2013 CH2M HILL

SECTION 31 05 13
SOILS FOR EARTHWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preparation of subgrade for pavement.

B. Excavation for Mechanical/Electrical Work and Site Utilities: Excavation and backfill required in conjunction with underground mechanical and electrical utilities, buried mechanical and electrical appurtenances, and site utilities.

1.02 QUALITY ASSURANCE

A. Codes and Standards: Perform earthwork and site grading in compliance with applicable requirements of governing authorities having jurisdiction.

B. Testing and Inspection Service: Employ, at Contractor's expense, an independent testing and inspection laboratory acceptable to Engineer to perform survey for satisfactory soil materials, including sampling and testing of soil materials and to provide field testing facilities for quality control testing during earthwork and site grading operations. A Certified Soils Lab and Engineer shall be retained by the Contractor to direct and monitor all backfilling and compaction procedures, as well as furnish a final certification (by Registered Engineer) letter to the Engineer that all backfill has been properly placed and compacted. This includes all compaction to finished grade, as well as all asphalt paving and stabilized subgrade work.

C. Tests for Proposed Soil Materials: Test soil materials proposed for use in work and promptly submit test result reports.

D. Provide one optimum moisture-maximum density curve for each type of soil encountered in subgrade and fills. Determine maximum densities in accordance with ASTM D1557 (AASHTO T180). Testing service shall determine suitability of materials to be used as fill.

1.03 SUBMITTALS

A. Test Reports: Submit copies of following reports directly to Engineer. All test reports must be signed by a licensed Professional Engineer.

1. Field density test reports.
2. One optimum moisture-maximum density curve for each type of soil encountered.

©COPYRIGHT 2012 CH2M HILL

3. Other tests and materials certificates as required.

1.04 JOB CONDITIONS

A. Site Information: Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn therefrom by Contractor. Data are made available for convenience of Contractor. Additional test borings and other exploratory operations may be made by Contractor at no cost to Owner.

B. Existing Utilities: Locate existing underground utilities in areas of work before starting earthwork operations. Where utilities to remain in place, provide adequate means of protection during earthwork operations.

1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner, and public and private utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
2. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided. Provide minimum of 72-hour notice of proposed interruption to Engineer.
3. Demolish and completely remove from site underground utilities indicated to be removed. Coordinate with local utility companies for shut-off of services if lines are active.

C. Use of Explosives: Use of explosives is not permitted.

D. Temporary Protection: Barricade open excavations made as part of earthwork operations and post with warning lights. Operate warning lights as recommended by authorities having jurisdiction. Protect new and existing structures, utilities, pavements, and other facilities from damages caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

PART 2 PRODUCTS

2.01 DEFINITIONS

A. Satisfactory soil materials are defined as those complying with ASTM D 2487 soil classification groups GW, GP, GM, SM, SW and SP.

©COPYRIGHT 2012 CH2M HILL

B. Unsatisfactory soil materials are defined as those complying with ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH and PT.

C. Satisfactory soil materials are defined as those complying with the American Association of State Highway and Transportation Officials (AASHTO) Designation M145, soil classification Groups A-1, A-2-4, A-2-5, and A-3.

D. Unsatisfactory soil materials are defined as those described in AASHTO M145 for soil classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7; also, peat and other highly organic soils.

E. Cohesionless Soil Materials: Include gravels, sand-gravel mixtures, sands and gravelly-sands.

F. Cohesive Soil Materials: Include clayey and silty gravels, sand-clay mixtures, gravel-silt mixtures, clayey and silty sands, sand-silt mixtures, clays, silts, and very fine sands.

2.02 SOIL MATERIALS

A. Backfill and Fill Materials: Use satisfactory soil materials for backfill and fill, free of rock or gravel larger than 2 inches in any dimension, debris, waste, vegetable, and other deleterious matter and complying with the above definitions. See Article 3.03.A.

B. Pavement Subbase Material: Properly graded mixture of natural or crushed gravel, crushed stone, crushed slag, natural or processed sand that will readily compact to required density.

1. Use material complying with AASHTO M147, Grade A, unless otherwise indicated.

PART 3 EXECUTION

3.01 EXCAVATION

A. General: Excavation consists of removal and disposal of materials encountered when establishing required grade elevations.

B. Excavation is Unclassified, and includes excavation to subgrade elevations indicated, regardless of character of materials and obstructions encountered.

©COPYRIGHT 2012 CH2M HILL

C. Excavation Classifications: The following classifications of excavation will be made when rock excavation is encountered in the Work:

1. Earth excavation includes excavation of pavements and other obstructions visible on ground surface; underground structures, utilities and other items indicated to be demolished and removed; together with earth and other materials encountered that are not classified as rock or unauthorized excavation.
2. Rock excavation in trenches and pits includes removal and disposal of materials and obstructions encountered which cannot be excavated with a 1.0 cubic yard (heaped) capacity, 42-inch wide bucket on track-mounted power excavator equivalent to Caterpillar Model 215, rated at not less than 90 HP flywheel power and 30,000 pound drawbar pull. Trenches in excess of 10 feet-0 inch in width and pits in excess of 30 feet-0 inch in either length or width are classified as open excavation.
3. Rock excavation in open excavations includes removal and disposal of materials and obstructions encountered which cannot be dislodged and excavated with modern track-mounted heavy-duty excavating equipment without drilling, blasting or ripping. Rock excavation equipment is defined as Caterpillar Model No. 973 or No. 977K, or equivalent track-mounted loader, rated at not less than 170 HP flywheel power and developing 40,000 pound break-out force (measured in accordance with SAE J732C).
4. Typical of materials classified as rock are boulders 1/2 cubic yard or more in volume, solid rock, rock in ledges, and rock-hard cementitious aggregate deposits.
5. Intermittent drilling that may be performed to increase production and is not necessary to permit excavation of material encountered will be classified as earth excavation.

D. Unauthorized excavation consists of removal of materials beyond indicated elevations or side dimensions without the specific direction of Engineer. Replace unauthorized excavation by backfilling and compacting as specified for authorized excavations of same classification, unless otherwise directed by Engineer. Cost of unauthorized excavation and remedial backfill shall be borne by Contractor.

E. Dewatering - Use of dewatering is not permitted, ***except as approved and permitted by the FDEP Permit (see Section 01440, with attached Permit)***. Where dewatering would be required at drainage structures bases below water table, the Contractor shall provide a minimum of 12 inches of limerock base below bottom of structure.

©COPYRIGHT 2012 CH2M HILL

F. Material Storage: Stockpile excavated materials classified as satisfactory soil material where directed, until required for fill. Place stockpiled fill materials away from edges of excavation; grade, and shape stockpiles for proper drainage.

G. Excavation for Pavements: Cut surface under pavements to comply with cross-sections, elevations and grades as shown.

H. Excavation for Trenches: Dig trenches to uniform width required for particular item to be installed, sufficiently wide to provide working room.

1. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations.
2. Where rock is encountered, carry excavation 6 inches below required elevation and backfill with a 6-inch layer of crushed stone or gravel prior to installing pipe.
3. For pipes or conduit 5 inches or less in nominal size, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
4. For pipes or conduit 6 inches or larger in nominal size, tanks and other mechanical/electrical work indicated to receive subbase, excavate to subbase depth indicated, or, if not otherwise indicated, to 6 inches below bottom of work to be supported.
5. Except as otherwise indicated, excavate for exterior water-bearing piping (water, steam, condensate, drainage) so top of piping is not less than 3 feet-6 inches below finished grade.
6. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.
7. For piping or conduit less than 2 feet-6 inches below surface of roadways, provide 4-inch thick concrete base slab support. After installation and testing of piping or conduit, provide minimum 4-inch thick encasement (sides and top) of concrete prior to backfilling or placement of roadway subbase.
8. Do not backfill trenches until tests and inspections have been made and backfilling is authorized by Engineer. Use care in backfilling to avoid damage or displacement of pipe systems.

I. Closing Abandoned Underground Utilities: Close open ends of abandoned underground utilities indicated to remain with sufficiently strong closure to withstand pressures which may result after closing.

1. Close open ends of metallic conduit and pipe with threaded galvanized metal caps or plastic plugs, or other suitable method for type of material and size of pipe. Do not use wood plugs.
2. Close open ends of concrete and masonry utilities with not less than 8 inches thick brick masonry bulkheads, constructed to fill opening.

©COPYRIGHT 2012 CH2M HILL

3. Lay brick in mortar, forming a full bed with ends and side joints in one operation and with maximum 3/8 inch wide joints. Protect fresh masonry from rapid drying and maintain protection until mortar has set.

J. See Article 3.08 for surplus material disposal locations.

3.02 COMPACTION

A. General: Control all soil compaction during construction to provide 98 percent AASHTO T-180 of density specified for each area classification.

B. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or to layer of soil material. Apply water in such manner as to prevent free water from appearing on surface during or subsequent to compaction operations.

C. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

1. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing, until moisture content is reduced to satisfactory value.

3.03 BACKFILL AND FILL

A. General: In excavations, use satisfactory excavated or borrow material that has been sampled, tested and approved by soil testing agency. Obtain materials from an off-site (off Port property) location. Place in layers to required subgrade elevations indicated.

1. Under walks and pavements, use subbase material, or excavated or borrow material, or combination of both.
2. Under piping and conduit, provide subbase material where indicated under piping or conduit; shape to fit bottom 90 degree of cylinder.
3. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Flow, strip, or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

©COPYRIGHT 2012 CH2M HILL

B. Break-up the ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and specified percentage of relative density. After site clearance, the footprint of any proposed structures and pavement areas shall be compacted with a self-propelled roller (Dynapac CA-15 or equivalent) until the subsoils achieve 98 percent of maximum dry density (ASTM D1557) to a depth of at least 12 inches below the stripped grade prior to adding backfill. The soil densification should encompass the entire footprint of the structures or the entire paved area, plus a 10 foot wide perimeter that extends beyond the maximum lines of the superstructures.

C. Placement and Compaction: Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches loose depth for material compacted by hand-operated equipment.

D. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content of soil material. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

E. Backfill excavations as promptly as work permits, but not until completion of inspection, testing, approval, and recording location of underground utilities, as required.

3.04 GRADING

A. General: Uniformly grade areas within limits of site grading under this section, including adjacent transition areas. Smooth finished surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Degree of finish required will be that ordinarily obtainable from either blade-grader or scraper operations.

C. Pavements: Shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than 1/2 inch above or below required subgrade elevation, compacted as specified, and graded to prevent ponding of water after rains. Include such operations as plowing, discing, and any moisture or aerating required to provide optimum moisture content for compaction. Fill low areas resulting from removal of unsatisfactory soil materials, obstructions, and other deleterious materials, using satisfactory soil material. Shape in line, grade, and cross-section as indicated.

©COPYRIGHT 2012 CH2M HILL

3.05 PAVEMENT SUBBASE COURSE

A. General: Subbase course consists of placing subbase course material, in layers of specified thickness, over subgrade surface to support a pavement base course.

B. Placing: Place subbase course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placement operations.

1. When compacted subbase course is shown to be 6 inches thick or less, place material in single layer. When shown to be more than 6 inches thick, place subbase material in equal layers, except no single layer more than 6 inches or less than 3 inches in thickness when compacted.

3.06 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction: Contractor shall provide independent testing service to inspect and approve subgrades and fill layers before further construction work is performed thereon.

1. Perform field density tests in accordance with ANSI/ASTM D1556 (sand cone method), ANSI/ASTM D 2167 (rubber balloon method) or ASTM 2922 and ASTM 3017 (Nuclear Testing Method) as applicable.
2. Make at least one field density test of subgrade for every 1,500 square feet of paved area, but in no case less than 3 tests.
3. In each compacted fill layer, make one field density test for every 1,500 square feet of overlaying paved area, but in no case less than 3 tests.

B. If, based on reports of testing service and inspection, subgrade or fills which have been placed are below specified density, additional compaction and testing will be required until satisfactory results are obtained. Results of density tests of soil-in-place will be considered satisfactory if average of any 4 consecutive density tests which may be selected are in each instance equal to or greater than specified density, and if not more than 1 density test out of 5 has a value more than 2 percent below required density.

3.07 MAINTENANCE

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

©COPYRIGHT 2012 CH2M HILL

C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

3.08 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Removal from Owner's Property: Remove waste materials, including unsatisfactory excavated material, asphalt, trash and debris, and legally dispose off the Owner's property.

B. Disposal on Owner’s Property: All excavated materials classified as satisfactory soils and unused material from the final product of this project shall **NOT** be disposed off the Port’s property. These excess materials including but are not limited to excavated old base material, old sub-base material and material classified as satisfactory soils, and items not meeting Article 3.08, paragraph A, and material classified as satisfactory soils shall be transported by the Cargo Area Site Package Contractor to a Port placement area, as indicated on G-001 of the Drawings. Contractor shall uniformly spread material throughout the placement area using Best Management Practices. Placement area will be shared with other contractors. Cargo Area Site Package Contractor shall be responsible for maintaining, clearing and managing this area throughout the duration of the Project. Stockpiles created will be source pits for use as fill on other construction projects.

END OF SECTION

©COPYRIGHT 2012 CH2M HILL

Page Intentionally Left Blank

©COPYRIGHT 2012 CH2M HILL

SECTION 31 23 23
EARTHWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preparation of subgrade (Base and Subbase) for pavement.

B. Excavation for Mechanical/Electrical Work and Site Utilities: Excavation and backfill required in conjunction with underground mechanical and electrical utilities buried mechanical and electrical appurtenances, and site utilities.

1.02 QUALITY ASSURANCE

A. Codes and Standards: Perform earthwork and site grading in compliance with applicable requirements of governing authorities having jurisdiction.

B. Testing and Inspection Service: Employ, at Contractor's expense, an independent testing and inspection laboratory acceptable to Engineer to perform survey for satisfactory soil materials, including sampling and testing of soil materials and to provide field testing facilities for quality control testing during earthwork and site grading operations. A Certified Soils Lab and Engineer shall be retained by the Contractor to direct and monitor all backfilling and compaction procedures, as well as furnish a final certification (by Registered Engineer) letter to the Engineer that all backfill has been properly placed and compacted. This includes all compaction to finished grade, as well as all asphalt paving and stabilized subgrade work.

C. Tests for Proposed Soil Materials: Test soil materials proposed for use in work and promptly submit test result reports.

D. Provide one optimum moisture-maximum density curve for each type of soil encountered in subgrade and fills. Determine maximum densities in accordance with ASTM D1557 (AASHTO T180). Testing service shall determine suitability of materials to be used as fill.

1.03 SUBMITTALS

A. Test Reports: Submit copies of following reports directly to Engineer. All test reports must be signed by a licensed Professional Engineer.

1. Field density test reports.

©COPYRIGHT 2012 CH2M HILL

2. One optimum moisture-maximum density curve for each type of soil encountered.
3. Other tests and materials certificates as required.

1.04 JOB CONDITIONS

A. Site Information: Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn therefrom by Contractor. Data are made available for convenience of Contractor. Additional test borings and other exploratory operations may be made by Contractor at no cost to Owner.

B. Existing Utilities: Locate existing underground utilities in areas of work before starting earthwork operations. Where utilities to remain in place, provide adequate means of protection during earthwork operations.

1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner, and public and private utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
2. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided. Provide minimum of 72-hour notice of proposed interruption to Engineer.
3. Demolish and completely remove from site underground utilities indicated to be removed. Coordinate with local utility companies for shut-off of services if lines are active.

C. Use of Explosives: Use of explosives is not permitted.

D. Temporary Protection: Barricade open excavations made as part of earthwork operations and post with warning lights. Operate warning lights as recommended by authorities having jurisdiction. Protect new and existing structures, utilities, pavements, and other facilities from damages caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

©COPYRIGHT 2012 CH2M HILL

PART 2 PRODUCTS

2.01 DEFINITIONS

A. Satisfactory soil materials are defined as those complying with ASTM D 2487 soil classification groups GW, GP, GM, SM, SW and SP.

B. Unsatisfactory soil materials are defined as those complying with ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH and PT.

C. Satisfactory soil materials are defined as those complying with the American Association of State Highway and Transportation Officials (AASHTO) Designation M145, soil classification Groups A-1, A-2-4, A-2-5, and A-3.

D. Unsatisfactory soil materials are defined as those described in AASHTO M145 for soil classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7; also, peat and other highly organic soils.

E. Cohesionless Soil Materials: Include gravels, sand-gravel mixtures, sands and gravelly-sands.

F. Cohesive Soil Materials: Include clayey and silty gravels, sand-clay mixtures, gravel-silt mixtures, clayey and silty sands, sand-silt mixtures, clays, silts, and very fine sands.

2.02 SOIL MATERIALS

A. Backfill and Fill Materials: Use satisfactory soil materials for backfill and fill, free of rock or gravel larger than 2 inches in any dimension, debris, waste, vegetable, and other deleterious matter and complying with the above definitions. See Article 3.03.A.

B. Pavement Subbase Material: Properly graded mixture of natural or crushed gravel, crushed stone, crushed slag, natural or processed sand that will readily compact to required density. Use material complying with AASHTO M147, Grade A, unless otherwise indicated.

C. Base Course Aggregate: FDOT Reclaimed Portland Cement Concrete Pavement crushed and processed per FDOT Section 901-5 or FDOT Limerock Material For Base Course and Stabilized Base per FDOT Sections 200 and 911. Provide material which meets FDOT Section 204 for graded aggregate base material for gradation and have an LBR value of not less than 100.

©COPYRIGHT 2012 CH2M HILL

PART 3 EXECUTION

3.01 EXCAVATION

A. General: Excavation consists of removal and disposal of materials encountered when establishing required grade elevations.

B. Excavation is Unclassified, and includes excavation to subgrade elevations indicated, regardless of character of materials and obstructions encountered.

C. Excavation Classifications: The following classifications of excavation will be made when rock excavation is encountered in the Work:

1. Earth excavation includes excavation of pavements and other obstructions visible on ground surface; underground structures, utilities and other items indicated to be demolished and removed; together with earth and other materials encountered that are not classified as rock or unauthorized excavation.
2. Rock excavation in trenches and pits includes removal and disposal of materials and obstructions encountered which cannot be excavated with a 1.0 cubic yard (heaped) capacity, 42 inches wide bucket on track-mounted power excavator equivalent to Caterpillar Model 215, rated at not less than 90 HP flywheel power and 30,000 pound drawbar pull. Trenches in excess of 10 feet-0 inch in width and pits in excess of 30 feet-0 inch in either length or width are classified as open excavation.
3. Rock excavation in open excavations includes removal and disposal of materials and obstructions encountered which cannot be dislodged and excavated with modern track-mounted heavy-duty excavating equipment without drilling, blasting or ripping. Rock excavation equipment is defined as Caterpillar Model No. 973 or No. 977K, or equivalent track-mounted loader, rated at not less than 170 HP flywheel power and developing 40,000 lb. break-out force (measured in accordance with SAE J732C).
4. Typical of materials classified as rock are boulders 1/2 cubic yard or more in volume, solid rock, rock in ledges, and rock-hard cementitious aggregate deposits.
5. Intermittent drilling that may be performed to increase production and is not necessary to permit excavation of material encountered will be classified as earth excavation.

©COPYRIGHT 2012 CH2M HILL

D. Unauthorized excavation consists of removal of materials beyond indicated elevations or side dimensions without the specific direction of Engineer. Replace unauthorized excavation by backfilling and compacting as specified for authorized excavations of same classification, unless otherwise directed by Engineer. Cost of unauthorized excavation and remedial backfill shall be borne by Contractor.

E. Dewatering: Use of dewatering is not permitted, where dewatering would be required at drainage structures bases below water table, the Contractor shall provide a minimum of 12 inches of limerock base below bottom of structure.

F. Material Storage: Stockpile excavated materials classified as satisfactory soil material where directed, until required for fill. Place stockpiled fill materials away from edges of excavation; grade, and shape stockpiles for proper drainage.

G. Excavation for Pavements: Cut surface under pavements to comply with cross-sections, elevations and grades as shown.

H. Excavation for Trenches: Dig trenches to uniform width required for particular item to be installed, sufficiently wide to provide working room.

1. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations.
2. Where rock is encountered, carry excavation 6 inches below required elevation and backfill with a 6-inch layer of crushed stone or gravel prior to installing pipe.
3. For pipes or conduit 5 inches or less in nominal size, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
4. For pipes or conduit 6 inches or larger in nominal size, tanks and other mechanical/electrical work indicated to receive subbase, excavate to subbase depth indicated, or, if not otherwise indicated, to 6 inches below bottom of work to be supported.
5. Except as otherwise indicated, excavate for exterior water-bearing piping (water, steam, condensate, drainage) so top of piping is not less than 3 feet.-6 inches below finished grade.
6. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.
7. For piping or conduit less than 2 feet-6 inches below surface of roadways, provide 4 in. thick concrete base slab support. After installation and testing of piping or conduit, provide minimum 4-inch thick encasement (sides and top) of concrete prior to backfilling or placement of roadway subbase.

©COPYRIGHT 2012 CH2M HILL

8. Do not backfill trenches until tests and inspections have been made and backfilling is authorized by Engineer. Use care in backfilling to avoid damage or displacement of pipe systems.

I. Closing Abandoned Underground Utilities: Close open ends of abandoned underground utilities indicated to remain with sufficiently strong closure to withstand pressures which may result after closing.

1. Close open ends of metallic conduit and pipe with threaded galvanized metal caps or plastic plugs, or other suitable method for type of material and size of pipe. Do not use wood plugs.
2. Close open ends of concrete and masonry utilities with not less than 8 in thick brick masonry bulkheads, constructed to fill opening.
3. Lay brick in mortar, forming a full bed with ends and side joints in one operation and with maximum 3/8-inch wide joints. Protect fresh masonry from rapid drying and maintain protection until mortar has set.

J. See Article 3.08 for surplus material disposal locations.

3.02 COMPACTION

A. General: Control all soil compaction during construction to provide 98 percent AASHTO T-180 of density specified for each area classification.

B. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or to layer of soil material. Apply water in such manner as to prevent free water from appearing on surface during or subsequent to compaction operations.

C. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

1. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing, until moisture content is reduced to satisfactory value.

©COPYRIGHT 2012 CH2M HILL

3.03 BACKFILL AND FILL

A. General: In excavations, use satisfactory excavated or borrow material that has been sampled, tested and approved by soil testing agency. Obtain materials from an off-site (off Port/Campus property) location. Place in layers to required subgrade elevations indicated.

1. Under walks and pavements, use subbase material, or excavated or borrow material, or combination of both.
2. Under piping and conduit, provide subbase material where indicated under piping or conduit; shape to fit bottom 90 degree of cylinder.
3. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Flow, strip, or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

B. Break-up the ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and specified percentage of relative density. After site clearance, the footprint of any proposed structures and pavement areas shall be compacted with a self-propelled roller (Dynapac CA-15 or equivalent) until the subsoils achieve 98 percent of maximum dry density (ASTM D1557) to a depth of at least 12 inches below the stripped grade prior to adding backfill. The soil densification should encompass the entire footprint of the structures or the entire paved area, plus a 10 foot wide perimeter that extends beyond the maximum lines of the superstructures.

C. Placement and Compaction: Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches loose depth for material compacted by hand-operated equipment.

D. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content of soil material. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

E. Backfill excavations as promptly as work permits, but not until completion of inspection, testing, approval, and recording location of underground utilities, as required.

©COPYRIGHT 2012 CH2M HILL

3.04 GRADING

A. General: Uniformly grade areas within limits of site grading under this section, including adjacent transition areas. Smooth finished surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Degree of finish required will be that ordinarily obtainable from either blade-grader or scraper operations.

C. Pavements: Shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than 1/2-inch above or below required subgrade elevation, compacted as specified, and graded to prevent ponding of water after rains. Include such operations as plowing, discing, and any moisture or aerating required to provide optimum moisture content for compaction. Fill low areas resulting from removal of unsatisfactory soil materials, obstructions, and other deleterious materials, using satisfactory soil material. Shape in line, grade, and cross-section as indicated.

3.05 PAVEMENT SUBBASE COURSE

A. General: Subbase course consists of placing subbase and base course material, in layers of specified thickness, over subgrade surface to support a pavement base course.

B. Placing: Place Base course material on prepared and proof rolled subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase and base material during placement operations.

1. When compacted subbase and base course is shown to be 6 inches thick or less, place material in single layer. When shown to be more than 6 inches thick, place subbase material in equal layers, except no single layer more than 6 in. or less than 3 inches in thickness when compacted.

C. See Section 32 12 16, Asphaltic Concrete Paving - 3.01 for additional surface preparation requirements for asphalt paved/surfaces.

©COPYRIGHT 2012 CH2M HILL

3.06 FIELD QUALITY CONTROL

A. Quality Control Testing during Construction: Contractor shall provide independent testing service to inspect and approve subgrades (subbase and base) and fill layers before further construction work is performed thereon.

1. Perform field density tests in accordance with ANSI/ASTM D1556 (sand cone method), ANSI/ASTM D 2167 (rubber balloon method) or ASTM 2922 and ASTM 3017 (Nuclear Testing Method) as applicable. (This includes proof rolled insitu material).
2. Make at least one field density test of subgrade for every 1,500 square foot of paved area, but in no case less than 3 tests.
3. In each compacted fill layer, make one field density test for every 1,500 square foot of overlaying paved area, but in no case less than 3 tests.

B. If, based on reports of testing service and inspection, subgrade or fills which have been placed are below specified density, additional compaction and testing will be required until satisfactory results are obtained. Results of density tests of soil-in-place will be considered satisfactory if averages of any 4 consecutive density tests which may be selected are in each instance equal to or greater than specified density, and if not more than 1 density test out of 5 has a value more than 2 percent below required density.

3.07 MAINTENANCE

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

3.08 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Removal from Owner's Property: Remove all waste materials, including satisfactory and unsatisfactory excavated material, asphalt, trash and debris, and legally dispose off the Owner's property.

END OF SECTION

©COPYRIGHT 2012 CH2M HILL

Page Intentionally Left Blank

©COPYRIGHT 2012 CH2M HILL

SECTION 32 12 16
ASPHALTIC CONCRETE PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Asphalt concrete paving for trench work and patching.

1.02 SUBMITTALS

A. Material Certificates: Provide copies of materials certificates signed by material producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements and is furnished from an FDOT approved source or plant.

B. Job-Mix Designs: For each job mix proposed for the Work, include technical data and tested physical and performance properties.

1.03 QUALITY ASSURANCE

A. Codes and Standards: Comply with State highway or transportation department standard specifications, latest edition, and with local governing regulations if more stringent than herein specified.

1.04 SITE CONDITIONS

A. Weather Limitations:

1. Apply prime and tack coats when ambient temperature is above 50 degree F, and when temperature has not been below 35 degree F for 12 hours immediately prior to application. Do not apply when base is wet or contains an excess of moisture.
2. Construct asphalt concrete surface course when atmospheric temperature is above 40 degree F, and when base is dry. Base course may be placed when air temperature is above 30 degree F and rising.

B. Grade Control: Establish and maintain required lines and elevations.

©COPYRIGHT 2012 CH2M HILL

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Use locally available materials and gradations which exhibit a satisfactory record of previous installations.

B. Surface Course Aggregate: Crushed stone, crushed gravel, crushed slag, and sharp-edged natural sand.

C. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material complying with AASHTO M 17 (ASTM D242).

D. Asphalt Cement: AASHTO M 226 (ASTM D3381) for viscosity graded material and AASHTO M 20 (ASTM D946) for penetration graded material.

E. Prime Coat: Cut-back asphalt type; AASHTO M 82 (ASTM D2027) MC-30, MC-70 or MC-250.

F. Tack Coat: Emulsified asphalt; AASHTO M 140 (ASTM D977) or M 208 (D2397); SS-1, SS-1h, CSS-1 or CSS-1h, diluted with one part water to one part emulsified asphalt.

G. Herbicide Treatment:

1. Characteristics: Commercial chemical for weed control, registered by Environmental Protection Agency. Provide granular, liquid, or wettable powder form.
2. Source Manufacturers:
   a. Ciba-Geigy Corp.
   b. Dow Chemical U.S.A.
   c. E.I. DuPont De Nemours & Co., Inc.
   d. U.S. Borax and Chemical Corp.

2.02 ASPHALT-AGGREGATE MIXTURE

A. Provide FDOT Type S-3 plant-mixed, hot-laid asphalt-aggregate mixture and as recommended by local paving authorities to suit project conditions. Provide FDOT Type S-3 for use as a leveling course where indicated. Provide mixtures only from FDOT approved plants.

©COPYRIGHT 2012 CH2M HILL

PART 3 EXECUTION

3.01 SURFACE PREPARATION

A. Remove loose material from compacted subbase surface immediately before applying herbicide treatment or prime coat.

B. Proof roll prepared subbase surface to check for unstable areas and areas requiring additional compaction prior to placing base material.

C. Sub-Base and Base Course Material preparation shall be per Section 31 23 23, Earthwork.

D. Do not begin paving work until deficient subbase and base areas have been corrected and are ready to receive paving and until a letter of certification from testing lab is received by the Engineer

E. Herbicide Treatment: Apply chemical weed control agent in strict compliance with manufacturer's recommended dosages and application instructions. Apply to compacted, dry subbase prior to application of prime coat.

F. Install base course aggregate in accordance with FDOT Section 204 or, at Contractors option, install limerock base course in accordance with FDOT Section 200.

G. Prime Coat: FDOT Section 300. Apply at rate of 0.20 to 0.50 gal. per square yard, over compacted subgrade. Apply material to penetrate and seal, but not flood, surface. Cure and dry as long as necessary to attain penetration and evaporation of volatile.

H. Tack Coat: FDOT Section 300. Apply to contact surfaces of previously constructed asphalt or portland cement concrete and surfaces abutting or projecting into asphalt concrete pavement. Distribute at rate of 0.05 to 0.15 gal. per square yard of surface.

I. Allow to dry until at proper condition to receive paving.

J. Exercise care in applying bituminous materials to avoid smearing of adjoining concrete surfaces. Remove and clean damaged surfaces.

©COPYRIGHT 2012 CH2M HILL

3.02 PLACING MIX

A. Place asphalt concrete mixture on prepared surface in accordance with FDOT Section 330, spread and strike-off. Spread mixture at minimum temperature of 225 degree F. Place inaccessible and small areas by hand. Place each course to required grade, cross section, and compacted thickness.

B. Place paving in strips not less than 10 feet wide. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete base course for a section before placing surface course.

C. Make joints between old and new pavements, and between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density and smoothness as other sections of asphalt concrete course. Clean contact surfaces and apply tack coat.

3.03 ROLLING

A. Begin rolling when mixture will bear roller weight without excessive displacement. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.

B. Breakdown Rolling: Accomplish initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling with hot material.

C. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.

D. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

E. Remove and replace paving areas mixed with foreign materials and defective areas. Cut-out such areas and fill with fresh, hot asphalt concrete. Compact by rolling to maximum surface density and smoothness.

F. After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened for 72 hours or otherwise directed by Engineer of Record.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

©COPYRIGHT 2012 CH2M HILL

3.04 FIELD QUALITY CONTROL

A. Contractor shall test completed asphalt concrete courses for compliance with requirements for thickness and surface smoothness. Repair or remove and replace unacceptable paving as directed by Engineer.

B. Contractor shall test completed compacted thickness tolerances:

1. Surface Course: 1/4 inch, plus or minus.
2. Total compacted thickness shall not to be less than minimum thickness indicated.

C. Surface Smoothness Tolerances: Contractor shall check finished surface of each asphalt concrete course for smoothness tolerance of 3/16 inches in 10 foot straightedge applied parallel with, and at right angles to centerline of paved area.

D. In-Place Density: Contractor shall take samples of uncompacted paving mixtures and compacted pavement shall be taken by testing agency according to ASTM D979.

1. Contractor shall determine reference maximum theoretical density by averaging results from 4 samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D2041, and compacted according to job-mix specifications.
2. Contractor shall determine in-place density of compacted pavement by testing core samples according to ASTM D1188 or ASTM D2726.
   a. Take one core sample for every 1,000 square yard or less of installed pavement, but in no case fewer than 3 cores per 50 feet of trench.
   b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D2950 and correlated with ASTM D1188 or ASTM D2726.

END OF SECTION

©COPYRIGHT 2012 CH2M HILL

Page Intentionally Left Blank

©COPYRIGHT 2012 CH2M HILL

SECTION 32 31 13
CHAIN-LINK FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aluminum chain-link fabric.

B. Galvanized steel framework.

C. Barbed wire.

1.02 SUBMITTALS

A. Product Data: Material descriptions, construction details, dimensions of individual components and profiles, and finishes for the following:

1. Fence and gate posts, rails, and fittings.
2. Chain-link fabric, reinforcements, and attachments.
3. Gates and hardware.
4. Barbed wire.
5. Vinyl coating and privacy slats.

B. Shop Drawings: Show locations of fence, each gate, posts, and tension wires and details of extension arms, gate slide, hardware, and accessories. Indicate materials, dimensions, sizes, weights, and finishes of components. Include plans, elevations, sections, gate slide and other required installation and operational clearances, and details of post anchorage and attachment and bracing.

1.03 QUALITY ASSURANCE

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

B. Source Limitations for Chain-Link Fences and Gates: Obtain each grade, finish, type, and variety of component for chain-link fences and gates from one source with resources to provide chain-link fences and gates of consistent quality in appearance and physical properties.

1.04 PROJECT CONDITIONS

A. Division 1 Section "Construction Facilities and Temporary Controls" for temporary utilities.

©COPYRIGHT 2012 CH2M HILL

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

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

PART 2 PRODUCTS

2.01 CHAIN-LINK FENCE FABRIC (ALL PVC COATED)

A. Chain-Link Fence Fabric: ASTM RR-F-191/3D Class 1, Grade B or ASTM A491, with vinyl coating. Wire Size: 2-inch mesh, 0.192-inch diameter. Vinyl coating shall meet SS-40 PVC Heavy 10 mil coating criteria, per ASTM F668, Class 2, in Black color.

B. Selvage: Twisted at top selvage and knuckled at bottom.

C. Wire to have 75,000 psi tensile strength.

D. Aluminum Privacy Slats – made to fit 2-inch mesh with 9-gauge. Slats shall be installed diagonally (45 degrees) and provide a minimum of 80 percent privacy coverage. Color: Black to match framework.

2.02 INDUSTRIAL FENCE FRAMING (ALL PVC COATED)

A. Round Steel Pipe: Standard weight, Schedule 40, galvanized steel pipe complying with ASTM F1083. Comply with ASTM F1043, Material Design Group IA, external and internal coating Type A, consisting of not less than 1.8-oz./sq. ft. zinc; and the following strength and stiffness requirements:

1. Brace Rails: 1.560 in., 2.27 lb./ft.
2. Line Posts, End, Corner and Pull Posts: 4.00 in., 8.65 lb./ft; SS-40 PVC Heavy 10 mil coating criteria per ASTM F1043.7.3 in color to match fabric.
3. Gate Posts: 6.00 in., 10.00 lb./ft.

B. Vinyl Coat for Pipe: Meets Federal Specification RR-F-191/3D, Class 1, Grade B.

©COPYRIGHT 2012 CH2M HILL

2.03 TENSION WIRE / PIPE BRACING (ALL PVC COATED)

A. General: Provide horizontal tension wire and pipe bracing as required for stability, as shown.

B. Location: Extended along top of barbed wire arms and top of fence fabric for supporting barbed tape.

C. Location: Continuously extended along bottom of fence fabric.

D. Aluminum Wire: 0.192-inch-diameter tension wire, mill finished, complying with ASTM B211, alloy 6061-T94 with 50,000-psi minimum tensile strength. Coated with vinyl/PVC coating to match framework.

2.04 FITTINGS (ALL PVC COATED)

A. General: Provide fittings for a complete fence installation, including special fittings for corners. Comply with ASTM F626. Coated with vinyl/PVC to match framework.

B. Brace Ends: Hot-dip galvanized pressed steel or hot-dip galvanized cast iron. Provide rail ends or other means for attaching rails securely to each gate, corner, pull, and end post. Coated with vinyl/PVC to match framework.

C. Tension and Brace Bands: Mill-finished per Section 2.02.

D. Tension Bars: Mill-finished aluminum, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post. Coated with vinyl/PVC to match framework.

E. According to CLFMI, truss rod may be eliminated from compression brace in any line of steel fence with round or C-section line post that has a continuous center rail. Diagonal truss rod assemblies are positioned at a 45- to 50-degree angle running from brace rail, usually at midpoint of line post to bottom of terminal post.

F. Truss Rod Assemblies: Hot-dip galvanized steel rod and turnbuckle or other means of adjustment.

G. Barbed Wire Arms: Hot-dip galvanized pressed steel or hot-dip galvanized cast iron. Provide Type I, single slanted arm, according to ASTM F626, with clips, slots, or other means for attaching strands of barbed wire, integral with post cap; one for each post, unless otherwise indicated. Provide line posts with arms designed with opening to accommodate tension wire. Provide corner arms at fence corner posts, unless extended posts are indicated.

©COPYRIGHT 2012 CH2M HILL

H. Tie Wires, Clips, and Fasteners: Provide the following types according to ASTM F626:

1. Standard Round Wire Ties: Aluminum: ASTM B211; alloy 1350-H19; 0.192-inch-diameter, mill-finished wire.

I. Round Wire Hog Rings: Aluminum for attaching chain-link fabric to horizontal tension wires.

J. Pipe Sleeves: For posts set into concrete, provide preset hot-dip galvanized steel pipe sleeves complying with ASTM A53, not less than 6 inches long with inside dimensions not less than 1/2 inch more than outside dimension of post, and flat steel plate forming bottom closure.

2.05 INDUSTRIAL SWING GATES (ALL PVC COATED)

A. General: Comply with ASTM F900 for swing gate types.

1. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F1043 and ASTM F1083 for materials and protective coatings.
2. Metal Pipe and Tubing: Aluminum. Comply with ASTM B429 and ASTM F1043 for materials and protective coatings.

B. Frames and Bracing: Fabricate members from round, galvanized steel tubing with outside dimension and weight according to ASTM F900 and the following and PVC coated to match framework:

1. Gate Fabric Height: 2 inches less than adjacent fence height.
2. Leaf Width: As indicated.
3. Frame Members: Tubular steel – 1.90 inches round.

C. Frame Corner Construction: Welded.

D. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame 12 inches, as required to attach barbed wire assemblies.

E. Hardware: Latches permitting operation from both sides of gate, hinges, center gate stops and keepers for each gate leaf more than 5 feet wide. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate. The gate shall have stainless steel, adjustable, self-closing gate hinges to assure that the gate closes upon passage of personnel. The gate manufacturer shall attach the hinges to the gate frame and gate post as recommended by the hinge manufacturer.

F. The gate shall only open toward the outside of the compound and have positive stops attached to the gate to prevent operating inward.

©COPYRIGHT 2012 CH2M HILL

2.06 BARBED WIRE

A. Aluminum Barbed Wire: Mill-finished aluminum wire, ASTM B211 for the following alloys. Comply with ASTM A585, Type I, for 2-strand, 0.099-inch-diameter line wire with 0.080-inch-diameter, 4-point barbs spaced not more than 5 inches o.c.

1. Line Wire: Manufacturer's standard alloy.
2. Barb Wire: Alloy 5000-H38 or alloy 6061-T94.

2.07 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

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

PART 3 EXECUTION

3.01 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.02 INSTALLATION, GENERAL

A. General: Install chain-link fencing to comply with ASTM F567 and more stringent requirements specified.

B. Post Excavation: Drill-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed or compacted soil.

C. Post Setting: Hand-excavate holes for post foundations in firm, undisturbed or compacted soil. Set posts in concrete footings. Protect portion of posts aboveground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Using mechanical devices to set line posts per ASTM F567 is not permitted. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during placement and finishing operations until concrete is sufficiently cured. Extend concrete 2 inches above grade, smooth.

©COPYRIGHT 2012 CH2M HILL

3.03 CHAIN-LINK FENCE INSTALLATION

A. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

B. Line Posts: Space line posts uniformly at 10 feet o.c.

C. Post Bracing Assemblies: Install according to ASTM F567, maintaining plumb position and alignment of fencing. Install braces at end and gate posts and at both sides of corner and pull posts. Locate horizontal braces at midheight of fabric on fences with top rail and at two-thirds fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

D. Tension Wire: Install according to ASTM F567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch-diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric.

1. Top Tension Wire: Install tension wire through post cap loops.
2. Bottom Tension Wire: Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same gage and type of wire.

E. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 2 inches between finish grade or surface and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

F. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.

G. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing. Maximum Spacing: Tie fabric to line posts 12 inches o.c. and to braces 24 inches o.c.

H. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

I. Barbed Wire: Install barbed wire uniformly spaced angled toward security side of fence. Pull wire taut and install securely to extension arms and secure to end post or terminal arms.

©COPYRIGHT 2012 CH2M HILL

3.04 GATE INSTALLATION

A. General: Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.05 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware**,** gate operators, and other moving parts.

END OF SECTION

©COPYRIGHT 2012 CH2M HILL

Page Intentionally Left Blank

©COPYRIGHT 2012 CH2M HILL