TECHNICAL SPECIFICATIONS

Springfield Plant Emergency Generator

JEA
Jacksonville, FL

100% Submittal
March 2019

Prepared By:
Jacobs Engineering Group Inc.
200 W. Forsyth Street, Suite 1520
Jacksonville, FL 32202
(904) 636-5432
COA # 2822

JEA
TECHNICAL SPECIFICATIONS
FOR
SPRINGFIELD PLANT EMERGENCY GENERATOR

General/Process
01 57 13
31 20 00

Stephen V. Manis, P.E.
Florida Registered P.E. No. 43342
Construction & Engineering
Services Consultants, Inc.
9432 Baymeadows Road, Suite 100
Jacksonville, FL 32256
(904) 652-1186
COA # 27598

JEA
TECHNICAL SPECIFICATIONS
FOR
SPRINGFIELD PLANT EMERGENCY GENERATOR

Structural
01 88 15
03 30 10
05 05 19

Clement W. Anson, P.E.
Florida Registered P.E. No. 75167
Jacobs Engineering Group Inc.
200 W. Forsyth St., Suite 1520
Jacksonville, FL 32202
(904) 636-5432
COA # 2822

JEA
TECHNICAL SPECIFICATIONS
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Electrical
Division 23
Division 26

Adam S. Levine, P.E.
Florida Registered P.E. No. 77010
Sims Wilkerson Cartier Engineering, Inc.
12124 High Tech Avenue, Suite 200
Orlando, FL 32817
(407) 380-0400
COA # 6106

SECTION 00 01 00

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SECTION 01 57 13

TEMPORARY EROSION AND SEDIMENTATION CONTROL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall design, provide, maintain and remove temporary erosion and sedimentation controls as necessary.

B. Temporary erosion controls may include, but are not limited to, mulching, netting, and watering, on site surfaces and spoil and borrow are surfaces and providing interceptor ditches at ends of berms and at those locations which will ensure that erosion during construction will be either eliminated or maintained within acceptable limits as established by JEA.

C. Temporary sedimentation controls include, but are not limited to, silt dams, traps, barriers and appurtenances at the foot of sloped surfaces which will ensure that sedimentation pollution will be either eliminated or maintained within acceptable limits as established by JEA.

D. CONTRACTOR shall provide effective temporary erosion and sediment control measures during construction or until final controls become effective.

1.2 SUBMITTALS

A. Submit schedule for temporary erosion and sedimentation control.

PART 2 -- PRODUCTS

2.1 EROSION CONTROL

A. Seeding and mulching, fertilization and watering shall be in accordance with Section 570-1 through 570-3 of the FDOT Specifications.

B. Netting: Fabricated of material acceptable to JEA or Engineer.

2.2 SEDIMENTATION CONTROL

A. Bales: Synthetic type.

B. Netting: Fabricated of material acceptable to JEA or Engineer.

C. Filter Stone: Crushed stone conforming to FDOT Specifications.

PART 3 -- EXECUTION

3.1 EROSION CONTROL

A. Seeding shall be in accordance with Section 570-4 through 570-5 of the FDOT Specifications. The CONTRACTOR shall insure that all seeded areas have sustained growth prior to acceptance.

B. Mulching shall be in accordance with Section 570-4.6 of the FDOT Specifications.

C. Minimum procedures for mulching and netting are:
   1. Apply mulch loosely to a thickness of between 0.75 inches and 1.5 inches.
   2. Apply netting over mulched areas on sloped surfaces.

3.2 SEDIMENTATION CONTROL

A. Install and maintain silt dams, traps and barriers as shown on the approved schedule. Hay bales which deteriorate and filter stone which is lodged shall be replaced as required.

3.3 PERFORMANCE

A. Should any of the temporary erosion and sediment control measures employed by the CONTRACTOR fail to produce results which comply with the requirements of JEA, CONTRACTOR shall immediately take whatever steps are necessary to correct the deficiency at his own expense.

END OF SECTION 01 57 13

SECTION 01 88 15

ANCHORAGE AND BRACING

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers requirements for anchorage and bracing of equipment, distribution systems, and other nonstructural components required in accordance with the Florida Building Code Sixth Edition (2017), for wind, gravity, soil, and operational loads.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American Institute of Steel Construction (AISC) 360, Specification for Structural Steel Buildings.
   2. American Society of Civil Engineers (ASCE): ASCE 7, Minimum Design Loads for Buildings and Other Structures.
   3. International Code Council (ICC): International Building Code (IBC).
   4. Florida Building Code Sixth Edition (2017).

1.3 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.

1.4 DESIGN AND PERFORMANCE REQUIREMENTS

A. General:
   1. Anchorage and bracing systems shall be designed by a qualified professional engineer registered in the State of Florida.
   2. Design anchorage into concrete including embedment in accordance with ACI 318-14; Chapter 17 and Project Specifications.
      a. Unless otherwise noted, design for cracked concrete condition.
   3. Design anchorage and bracing of architectural, mechanical, and electrical components and systems in accordance with this section, unless a design is specifically provided within Contract Documents or where exempted hereinafter.
   4. Design attachments, braces, and anchors for equipment, components, and distribution systems to structure for gravity, wind, and operational loading.
   5. Anchor and brace piping and ductwork, whether exempt or not exempt for this section, so that lateral or vertical displacement does not result in damage or failure to essential architectural, mechanical, or electrical equipment.
   6. Provide supplementary framing where required to transfer anchorage and bracing loads to structure.
   7. Adjust equipment pad sizes or provide additional anchorage confinement reinforcing to provide required anchorage capacities.

B. Design Loads:
   1. Gravity: Design anchorage and bracing for self-weight and superimposed loads on components and equipment.
   2. Wind: Design anchorage and bracing for wind criteria provided on General Structural Notes on Drawings for wind-exposed mechanical and electrical equipment.
   3. Operational:
      a. For loading supplied by equipment manufacturer for FBC required load cases.
      b. Loads may include equipment vibration, torque, thermal effects, effects of internal contents other load-inducing conditions.
      c. Locate braces to minimize vibration to or movement of structure.
      d. For vibrating loads, use anchors meeting requirements of Section 05 05 19, Post-Installed Anchors, for anchors with designated capacities for vibratory loading per manufacturer's ICC-ES report.

1.5 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings:
      a. List of architectural, mechanical, and electrical equipment requiring Contractor-designed anchorage and bracing, unless specifically exempted.
      b. Submittal will be rejected if proposed anchorage method would create excessive stress to supporting member. Revise anchorages and strengthen structural support to eliminate overstressed condition.

B. Informational Submittals:
   1. Anchorage and Bracing Calculations: For attachments, braces, and anchorages, include FBC and Project-specific criteria as noted on General Structural Notes on Drawings, in addition to manufacturer's specific criteria used for design; sealed by an engineer registered in the State of Florida.
   2. Manufacturer's hardware installation requirements.

C. Deferred Submittals:
   1. Submit deferred Action Submittals such as Shop Drawings with supporting deferred informational submittals such as calculations no less than 4 weeks in advance of installation of component, equipment or distribution system to be anchored to structure.

PART 2 - PRODUCTS

2.1 GENERAL

A. Design and construct attachments and supports transferring loads to structure of materials and products suitable for application and in accordance with design criteria shown on Drawings and nationally recognized standards.

B. Provide anchor bolts for anchorage of equipment to concrete. Provide anchor bolts of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.

PART 3 - EXECUTION

3.1 GENERAL

A. Make attachments, bracing, and anchorage in such a manner that component lateral force is transferred to lateral force resisting system of structure through a complete load path.

B. Provide snubbers in each horizontal direction and vertical restraints for components mounted on vibration isolation systems where required to resist overturning.

C. Provide piping anchorage that maintains design flexibility and expansion capabilities at flexible connections and expansion joints.

3.2 INSTALLATION

A. Do not install components or their anchorages or restraints prior to review and acceptance by Engineer and AHJ.

END OF SECTION 01 88 15

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SECTION 03 30 10

STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 GENERAL

A. Work shall conform to requirements of ACI 301, Specifications for Structural Concrete, unless otherwise specified.

1.2 REFERENCES

A. In accordance with ACI 301 and the following:
   1. American Concrete Institute (ACI):
      a. 301, Specifications for Structural Concrete.
      b. 305.1, Specification for Hot Weather Concreting.
      c. 306.1, Specification for Cold Weather Concreting.
      d. 308.1, Specification for Curing Concrete.
      e. SP-66, Detailing Manual.
      f. ASTM International (ASTM):
      g. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
      h. Concrete Reinforcing Steel Institute (CRSI):
      i. Manual of Standard Practice. Placing Reinforcing Bars.
      j. ANSI/CRSI – RB 4.1, CRSI Standard for Supports for Reinforcement Used in Concrete.
   2. National Ready Mixed Concrete Association (NRMCA).

1.3 DEFINITIONS

A. Cold Weather: When ambient temperature is below 40 degrees F or is approaching 40 degrees F and falling.

B. Defective Area: Surface defects that include honeycomb, rock pockets, indentations, and surface voids greater than 3/16-inch deep, surface voids greater than 3/4 inch in diameter, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances and include but are not limited to fins, form pop-outs, and other projections. At exposed concrete, defective areas also include texture irregularities, stains, and other color variations that cannot be removed by cleaning.

C. Exposed Concrete: Concrete surface that can be seen inside or outside of structure regardless of whether concrete is above water, dry at all times, or can be seen when structure is drained.

D. Hot Weather: As defined in ACI 305.1.

E. New Concrete: Concrete less than 60 days old.

F. Top Bars: Horizontal bars placed such that 12 inches of fresh concrete is cast below in single placement.

1.4 SUBMITTALS

A. Action Submittals:
1. Shop Drawings:
a. Formwork and Formwork Accessories: Unless otherwise specified, conform to requirements of ACI 301.
b. Reinforcing steel prepared in accordance with CRSI Manual of Standard Practice and ACI SP-66 Detailing Manual:
1) Bending lists.
2) Placing drawings.
2. Mix Design:
a. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
b. Documentation of average strength for proposed mix design in accordance with ACI 301.
c. Test Reports:
1) Cement: Chemical analysis report.
2) Supplementary Cementitious Materials: Chemical analysis report and report of other specified test analyses.
3) Aggregates:
a) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.
b) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.
c) All of the following:
(1) Manufacturer's Certificate of Compliance that each admixture does not intentionally add chlorides and/or that the chloride content of each admixture does not exceed trace amounts.
(2) Verification that potable water is used in the concrete mix or test data documenting the chloride content of the water.
(3) Letter from the concrete supplier stating that fine and coarse aggregates are from sources that are not known to be susceptible to chlorides in the aggregates.
4) Alkali Aggregate Reactivity: Where required, in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.
a) Product Data:
(1) Admixtures: Manufacturer's product data sheets for each admixture used in proposed mix designs.
3. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details shall include, but not be limited to, the following:
a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement, other metallic embeds, and forms prior to placement.
b. Documentation of embeds that must be at a temperature above freezing prior to placement of concrete.
c. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
d. Methods for temperature protection during placement.
e. Types of covering, insulation, housing, or heating to be provided.
f. Curing methods to be used during and following protection period.
g. Use of strength accelerating admixtures.
h. Methods for verification of in-place strength.
i. Procedures for measuring and recording concrete temperatures.

j. Procedures for preventing drying during dry, windy conditions.

4. Detailed plan for hot-weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan shall include, but not be limited to, the following:
   a. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
   b. Use of retarding admixture.
   c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
   d. Types of shading and wind protection to be provided.
   e. Curing methods, including use of evaporation retardant.
   f. Procedures for measuring and recording concrete temperatures.
   g. Procedures for preventing drying during dry, windy conditions.
5. Concrete repair techniques.

B. Informational Submittals:
1. Preinstallation Conference minutes.
2. Manufacturer's application instructions for bonding agent and bond breaker.
3. Statement of Qualification:
   a. Batch Plant: Certification as specified herein.
   b. Mix designer.
   c. Installer.
   d. Testing agency.
4. Concrete Delivery Tickets:
   a. For each batch of concrete before unloading at Site.
   b. In accordance with ASTM C94/C94M, including Requirement 14.2.1. through Requirement 14.2.10.
   c. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.

1.5 QUALITY ASSURANCE

A. Qualifications:
1. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities.
2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level. Requirement may be waived if individual is Contractor's Licensed Design Engineer.
3. Flatwork Finisher: Unless otherwise permitted, at least one person on finishing crew shall be certified as an ACI Flatwork Finisher, or equivalent.
4. Testing Agency: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
   a. 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.

B. Preinstallation Conference:
1. Required Meeting Attendees:
   a. Contractor, including pumping, placing and finishing, and curing subcontractors.
   b. Ready-mix producer.
   c. Admixture representative.

d. Testing and sampling personnel.
e. Steel Reinforcement Installer
f. Engineer or Engineer's designee.

2. Schedule and conduct prior to incorporation of respective products into Project. Notify Engineer of location and time.
3. Agenda shall include:
   a. Admixture types, dosage, performance, and redosing at Site.
   b. Mix designs, test of mixes, and Submittals.
   c. Placement methods, techniques, equipment, consolidation, and form pressures.
   d. Slump and placement time to maintain slump.
   e. Finish, curing, and water retention.
   f. Steel reinforcement details.
   g. Protection procedures for weather conditions.
   h. Other specified requirements requiring coordination.
4. Conference minutes.

PART 2 - PRODUCTS

2.1 FORMWORK

A. Form Materials:
   1. For exposed areas, use hard plastic finished plywood, overlaid waterproof particle board, or steel in new and undamaged condition, of sufficient strength and surface smoothness to produce specified finish.
   2. For unexposed areas, use new shiplap or plywood.

B. Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.

2.2 CONCRETE

A. Materials:
   1. Cementitious Materials:
      a. Cement:
         1) Portland Cement: Unless otherwise specified, conform to requirements of ASTM C150/C150M.
         2) Furnish from one source.
      b. Supplementary Cementitious Materials (SCM):
         1) Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618, except as modified herein:
            a) ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
   2. Aggregates: Unless otherwise permitted, furnish from one source for each aggregate type used in a mix design.
      a. Aggregates:
         1) In accordance with ASTM C33/C33M, except as modified herein.
            a) Class Designation: 4M unless otherwise specified.
            b) Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
            c) Alkali Silica Reactivity: See Article Concrete Mix Design.
               (1) Fine Aggregates:
                  (a) Clean, sharp, natural sand.

(b) ASTM C33/C33M.
(c) Limit deleterious substances in accordance with ASTM C33/C33M, Table 2 and as follows:
(d) Limit material finer than 75-μm (No. 200) sieve to 3 percent mass of total sample.
(e) Limit coal and lignite to 0.5 percent.

2) Coarse Aggregate:
a) Natural gravels, combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
b) Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.

3. Admixtures:
a. Characteristics:
1) Compatible with other constituents in mix.
2) Contain at most, only trace amount chlorides in solution.
3) Furnish type of admixture as recommended by manufacturer for anticipated temperature ranges.
b. Air-Entraining Admixture: ASTM C260/C260M.
c. Water-Reducing Admixture: ASTM C494/C494M, Type A or Type D.
d. Retarding Admixture: ASTM C 494/C 494M, Type B.
e. Accelerating Admixture: ASTM C 494/C 494M, Type C.
f. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F or Type G.
g. Plasticizing Admixture: ASTM C1017/C1017M, Type I or Type II.
h. Do not use calcium chloride as an admixture.
4. Water and Ice: Mixing water shall be potable water.

B. Concrete Mix Design:
1. General:
a. See Supplement at the end of this section for mix design requirements for class of concrete used on Project.
b. Prepare design mixture for strength of concrete, selecting and proportioning ingredients in accordance with requirements of ACI 301, unless otherwise specified.
c. Selection of constituent materials and products in mix design are optional, unless specified otherwise.
d. Use water-reducing admixture or high-range, water-reducing admixture, or plasticizing admixture to achieve fresh properties that facilitate handling, placing, and consolidating of concrete, and specified hardened properties.
e. Desired fresh properties of concrete shall be determined by Contractor and coordinated with concrete producer. Fresh properties of concrete shall remain stable to satisfaction of Contractor, for duration of placement and consolidation, and shall remain in conformance with requirements of Contract Documents.
2. Potential Alkali-Aggregate Reactivity of Concrete:
a. Do not use aggregates known to be susceptible to alkali-carbonate reaction (ACR).
3. Proportions:
a. Design mix to meet aesthetic, durability, and strength requirements.
b. Where fly ash is included in mix, minimum fly ash content shall be a minimum of 15 percent and maximum of 25 % of weight of total cementitious materials.
4. Slump:

a. Contractor shall select a target slump at the point of delivery of concrete mixtures for each application.
b. Selected target slump shall not exceed 9 inches.
c. Concrete shall show no signs of visible segregation.
d. The target slump value shall be enforced for the duration of Project.
e. Determine slump by ASTM C143/C143M.
f. Slump tolerances shall meet the requirements of ACI 117.
g. Design mixes that include a high-range, water-reducing or a plasticizing admixture shall have a minimum slump of 2 inches prior to addition of admixture. Unless otherwise permitted, slump shall be 8 inches maximum at point of delivery, for concrete with a high-range, water-reducing admixture.
h. Slump tolerance shall meet requirements of ACI 117.

C. Concrete Mixing:
1. General: In accordance with ACI 301, except as modified herein.
2. Truck Mixers:
a. For every truck, test slump, of samples taken per ASTM C94/C94M, Paragraph 12.5.1.
b. Where specified slump is more than 4 inches, and if slump tests differ by more than 2 inches, discontinue use of truck mixer, unless causing condition is corrected and satisfactory performance is verified by additional slump tests.

2.3 REINFORCING STEEL

A. Deformed Steel Reinforcing Bars: ASTM A615/A615M, Grade 60. Welding of reinforcing bars is not permitted.

B. Fabrication: Follow CRSI Manual of Standard Practice.

2.4 ANCILLARY MATERIALS

A. Bonding Agent:
1. Unless otherwise specified, in accordance with the following:
a. ASTM C881/C881M, Type V.
b. Two-component, moisture-insensitive, 100 percent solids epoxy.

B. Bond Breaker:
1. Nonstaining type, providing positive bond prevention.

C. Reinforcing Steel Accessories:
1. Precast Concrete Bar Supports: In compliance with ANSI/CRSI – RB 4.1 Cementitious (Precast) Reinforcement Supports.
a. Precast concrete bar supports shall have equal or greater strength than the surrounding concrete.
b. Precast concrete bar supports shall be four square inches minimum, in plan.

D. Tie Wire:
1. Black, soft-annealed 16-gauge wire.
2. Nylon-coated, epoxy-coated, or plastic-coated wire.

E. Premolded Joint Filler:
1. Bituminous Type: ASTM D994/D994M or ASTM D1751.

2. Sponge Rubber: Neoprene, closed-cell, expanded; ASTM D1056, Type 2C5, with compression deflection, 25 percent deflection (limits), 119 kPa to 168 kPa (17 psi to 24 psi) minimum.

F. Curing Compound:
1. Water-based, high-solids content, nonyellowing, curing compound meeting requirements of ASTM C1315 Type I, Class A.
2. Manufacturers and Products:
a. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.
b. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.
c. Vexcon Chemical, Inc., Philadelphia, PA; Starseal 1315.
d. Dayton Superior; Safe Cure and Seal 1315 EF.

G. Evaporation Retardant:
1. Optional: Fluorescent fugitive dye color tint that disappears completely upon drying.
2. Manufacturers and Products:
a. BASF Construction Chemicals, Shakopee, MN; MasterKure ER 50.
b. Euclid Chemical Co., Cleveland, OH; Eucobar.

H. Nonshrink Grout:
1. Nonmetallic, nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
b. Temperatures of 40 degrees F, 80 degrees F, and 100 degrees F.
5. Pass fluid grout through flow cone with continuous flow 1 hour after mixing.
6. Minimum Strength of Fluid Grout:
a. 3,500 psi at 1 day.
b. 4,500 psi at 3 days.
c. 7,500 psi at 28 days.
7. Maintain fluid consistency when mixed in 1 yard to 9 yard loads in ready-mix truck.
8. Manufacturers and Products:
a. BASF Building Systems, Inc., Shakopee, MN; MasterFlow 928.
b. Five Star Products Inc., Fairfield, CT; Five Star Fluid Grout 100.
c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.
d. Dayton Superior Corp., Miamisburg, OH; Sure Grip High Performance Grout.

I. Repair Material:
1. Contain only trace amounts of chlorides and other chemicals that can potentially cause steel to oxidize.
2. Where repairs of exposed concrete are required, prepare mockup using proposed repair materials and methods, for confirmation of appearance compatibility prior to use.
3. Obtain Manufacturer’s Certificate of Compliance that products selected are appropriate for specific applications.
4. Repair mortar shall be Site mixed.
5. Prepare concrete substrate and mix, place, and cure repair material in accordance with manufacturer’s written recommendations.
6. Manufacturers and Products:
a. BASF Building Systems Inc., Shakopee, MN; MasterEmaco S Series products.
b. Sika Chemical Corp., Lyndhurst, NJ; SikaTop Series.

PART 3 - EXECUTION

3.1 FORMWORK

A. Form Construction:
1. Construct forms and provide smooth-form finish.
2. Form 3/4-inch bevels at concrete edges, unless otherwise shown.
3. Make joints tight to prevent escape of mortar and to avoid formation of fins.
4. Brace as required to prevent distortion during concrete placement.

B. Form Removal:
1. Nonsupporting forms (walls and similar parts of Work) may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:
   a. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
   b. Curing and protection operations are maintained.
2. Remove forms with care to prevent scarring and damaging the surface.
3. Prior to form removal, provide thermal protection for concrete being placed under the requirements of cold weather concreting.

3.2 PLACING REINFORCING STEEL

A. Unless otherwise specified, in accordance with ACI 301.

B. Accessories:
1. Bar Supports in Contact with Ground: Provide precast concrete block supports.
   a. Do not use brick, broken concrete masonry units, spalls, rocks, construction debris, or similar material for supporting reinforcing steel.
2. Bar Supports in Contact with Forms: All plastic or stainless steel bar supports.
3. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports, and location of reinforcement remains within tolerance throughout work.

C. Splices and Laps:
1. Lap Splice Reinforcing: Refer to Structural General Notes on Drawings for additional information.
2. Tie splices with 18-gauge annealed wire as specified in CRSI Standard.

3.3 CONCRETE PLACEMENT INTO FORMWORK

A. Inspection: Notify Engineer at least 1 work day in advance before starting to place concrete.

B. Placement into Formwork:
1. Reinforcement: Secure in position before placing concrete.
2. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 1.5 feet deep, except for slabs that shall be placed full depth. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.
3. Placement frequency shall be such that lift lines will not be visible in exposed concrete finishes.
4. Use placement devices (such as, chutes, pouring spouts, and pumps) as required to prevent segregation.

5. Vertical Free Fall Drop to Final Placement: 3 feet maximum.

C. Conveyor Belts and Chutes:
1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system for concrete to pass without becoming segregated.
2. Do not use chutes longer than 50 feet.
3. Wipe clean with device that does not allow mortar to adhere to belt.
4. Cover conveyor belts and chutes.

D. Retempering: Not permitted for concrete where cement has partially hydrated.

E. Pumping of Concrete:
1. Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to ensure completion of concrete placement without cold joints in case of primary placing equipment breakdown.
2. Minimum Pump Hose (Conduit) Diameter: 4 inches.
3. Replace pumping equipment and hoses (conduits) that are not functioning properly.

F. Retempering: Not permitted for concrete where cement has partially hydrated.

3.4 CONSOLIDATION AND VISUAL OBSERVATION

A. Provide at least one standby vibrator in operable condition at placement site prior to placing concrete.

3.5 COLD WEATHER PLACEMENT

A. Unless otherwise permitted, shall be in accordance with requirements of ACI 301, ACI 306.1, and as follows:
1. Cold weather requirements shall apply when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling.
2. Do not place concrete over frozen earth or against surfaces with frost or ice present. Frozen earth shall be thawed to acceptance of Engineer.
3. Unless otherwise permitted, do not place concrete in contact with surfaces less than 35 degrees F; requirement is applicable to all surfaces including reinforcement and other embedded items.
4. Provide supplemental external heat as needed when other means of thermal protection are unable to maintain minimum surface temperature of concrete as specified in ACI 306.1.
5. Maintain minimum surface temperature of concrete as specified in ACI 306.1 for no less than 3 days during cold weather conditions.
6. Protect concrete from freezing until end of curing period and until concrete has attained a compressive strength of 3,500 psi or design compressive strength if less than 3,500 psi.

B. External Heating Units: Do not exhaust heater flue gases directly into enclosed area as it causes concrete carbonation as a result of concentrated carbon dioxide.

C. Cure as specified.

3.6 HOT WEATHER PLACEMENT

A. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 301, ACI 305.1, and as follows:
   1. Maintain concrete temperature below 95 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
   2. Internal concrete temperature in structure shall not exceed 158 degrees F, and maximum temperature differential between center of section and external surfaces of concrete shall not exceed 35 degrees F.
   3. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
   4. Cure as specified.

3.7 CONCRETE BONDING

A. Construction Joints at Existing Concrete:
   1. Thoroughly clean and roughen existing concrete surfaces to roughness profile of 1/4 inch.
   2. Saturate surface with water for 24 hours prior to placing new concrete.

3.8 PREMOLDED JOINT FILLER INSTALLATION

A. Sufficient in width to completely fill joint space where shown.

B. Drive nails approximately 1 foot 6 inches on center through filler, prior to installing, to provide anchorage embedment into concrete during concrete placement.

C. Secure premolded joint filler in forms before concrete is placed.

3.9 FINISHING FORMED SURFACES

A. Provide surface finish 2.0 (SF-2.0) in accordance with ACI 301 and as herein specified.

B. Prepare substrate and mix, place, and cure repair material per manufacturer’s written recommendations.

C. Repair defective areas of concrete.
   1. Cut edges perpendicular to surface at least 1/2 inch deep. Do not feather edges. Soak area with water for 24 hours.
   2. Patch with specified repair material.
   3. Repair concrete surfaces using specified materials. Select system, submit for review, and obtain approval from Engineer prior to use.
   4. Develop repair techniques with material manufacturer on surface that will not be visible in final construction prior to starting actual repair work and show how finish color will blend with adjacent surfaces. Obtain approval from Engineer.
   5. Obtain quantities of repair material and manufacturer’s detailed instructions for use to provide repair with finish to match adjacent surface or apply sufficient repair material adjacent to repair to blend finish appearance.
   6. Repair of concrete shall provide structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Engineer.

3.10 FINISHING UNFORMED SURFACES

A. General:
   1. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
   2. Do not use “jitterbugs” or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
   3. Do not dust surfaces with dry materials nor add water to surfaces.
   4. Cure concrete as specified.

B. Slab Tolerances:
   1. Exposed Slab Surfaces: Comprise of flat planes as required within tolerances specified.
   2. Slab Finish Tolerances and Slope Tolerances: Crowns on floor surface not too high as to prevent 10-foot straightedge from resting on end blocks, nor low spots that allow block of twice the tolerance in thickness to pass under supported 10-foot straightedge.
   3. Steel gauge block 5/16 inch thick.
   4. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown. Where thickness tolerance will not affect slope, drainage, or slab elevation, thickness tolerance may exceed 1/2 inch plus.
   5. Provide light broom finish unless specified otherwise.
   6. Finish exposed edges with steel edging tool.

3.11 EXPOSED METAL OBJECTS

A. Remove metal objects not intended to be exposed in as-built condition of structure including wire, nails, and bolts, by chipping back concrete to depth of 1 inch and then cutting or removing metal object.

B. Repair area of chipped-out concrete as specified for defective areas.

3.12 PROTECTION AND CURING

A. Protect and cure concrete in accordance with requirements of ACI 301, ACI 308.1, and as follows:
   1. Protect fresh concrete from direct rays of sunlight, drying winds, and wash by rain.
   2. Cure formed surfaces with curing compound applied in accordance with manufacturer’s written instructions as soon as forms are removed and finishing is completed.
   3. Remove and replace concrete damaged by freezing.
   4. Repair areas damaged by construction, using specified repair materials and approved repair methods.

3.13 NONSHRINK GROUT

A. General: Mix, place, and cure nonshrink grout in accordance with grout manufacturer’s written instructions.

3.14 BACKFILL AGAINST STRUCTURES

A. Do not backfill against until concrete has obtained specified 28-day compressive strength.

B. Unless otherwise permitted, place backfill simultaneously on both sides of structure, where such fill is required, to prevent differential pressures.

3.15 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. General:
   1. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hours and for additional time as may be required before transporting to test lab.
   2. Unless otherwise specified, sample concrete for testing for making test specimens, from point of delivery.
   3. When concrete is pumped, sample and test air content at point of delivery and at point of placement.
   4. Evaluation will be in accordance with ACI 301 and Specifications.
   5. Test specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
   6. Frequency of testing may be changed at discretion of Engineer.
   7. Pumped Concrete: Take concrete samples for slump, ASTM C143/C143M, and test specimens, ASTM C31/C31M and ASTM C39/C39M, at placement (discharge) end of line.
   8. If measured air content at delivery is greater than specified limit, check test of air content will be performed immediately on a new sample from delivery unit. If check test fails, concrete has failed to meet requirements of Contract Documents. If measured air content is less than lower specified limit, adjustments will be permitted in accordance with ASTM C94/C94M, unless otherwise specified. If check test of adjusted mixture fails, concrete has failed to meet requirements of Contract Documents. Concrete that has failed to meet requirements of Contract Documents shall be rejected.

B. Concrete Strength Test:
   1. Unless otherwise specified, one specimen at age of 7 days for information, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance.
   2. If result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing by 7 additional days.
   3. Provide a minimum of one spare test specimen per sample. Test spare cylinder as directed by Engineer.

C. Cold Weather Placement Tests:
   1. During cold weather concreting, cast cylinders for field curing as follows. Use method that will produce greater number of specimens:
      a. Six extra test cylinders from last 100 cubic yards of concrete.
      b. Minimum three specimens for each 2 hours of placing time or for each 100 cubic yards.
   2. These specimens shall be in addition to those cast for lab testing.
   3. Protect test cylinders from weather until they can be placed under same protection provided for concrete of structure that they represent.
   4. Keep field test cylinders in same protective environment as parts of structure they represent to determine if specified strength has been obtained.
   5. Test cylinders in accordance with applicable sections of ASTM C31/C31M and ASTM C39/C39M.
   6. Use test results to determine specified strength gain prior to falsework removal.

D. Slab Finish Tolerances and Slope Tolerances:
   1. Support 10-foot-long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
   2. Compliance with designated limits in four of five consecutive measurements is satisfactory, unless defective conditions are observed.

3.16 SUPPLEMENTS

A. Requirements of concrete mix designs following "End of Section," are a part of this Specification and supplement requirements of Part 1 through Part 3 of this section:
   1. Concrete Mix Design, Class 4500F1S0W0C0.

END OF SECTION 03 30 10

SUPPLEMENT 03 30 10

PART 4 Concrete Mix Design, Class 4500F1S0W0C0

A. Mix Locations: Where specified in Contract Documents.

B. Exposure Categories and Classifications: F1S0W0C0.

C. Mix Properties:
1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.45.
2. Minimum concrete compressive strength (f'c) shall be 4,500 psi at 28 days.
a. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	**Air Content (%)***
3/8	6.0
1/2	5.5
3/4	5.0
1	4.5
1-1/2	4.5
2§	4.0
3§	3.5

‡See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.

*Tolerance of air content is ±1-1/2 percent.

§Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on sieved fraction passing 1-1/2-inch sieve in accordance with ASTM C231/C231M.

3. Provide cementitious materials in accordance with one of the following:
a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.

2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
3) ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).

4. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent, unless otherwise specified.
   a. Limits are stated in terms of chloride ions in percent by weight of cement.
   b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to PART 1 through PART 3 of this section for additional requirements.

END OF SUPPLEMENT

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SECTION 05 05 19

POST-INSTALLED ANCHORS

PART 1 - GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
1. American Concrete Institute (ACI):
a. 318, Building Code Requirements for Structural Concrete.
b. 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
2. American Iron and Steel Institute (AISI): Stainless Steel Type 316.
3. American National Standards Institute (ANSI).
4. ASTM International (ASTM):
a. A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
b. A143, Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
c. A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
d. A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
e. A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
f. A380, Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
g. A385, Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
h. A563, Specification for Carbon and Alloy Steel Nuts.
i. A780, Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
j. A967, Specification for Chemical Passivation Treatments for Stainless Steel Parts.
k. E488, Standard Test Methods for Strength of Anchors in Concrete Elements.
l. F436, Specification for Hardened Steel Washers.
m. F468, Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
n. F568M, Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners.
o. F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
p. F594, Specification for Stainless Steel Nuts.
q. F1554, Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
5. International Association of Plumbing and Mechanical Officials Uniform ES (IAPMO-UES): Evaluation Reports for Concrete and Masonry Anchors.
6. International Code Council Evaluation Service (ICC-ES):
a. Evaluation Reports for Concrete and Masonry Anchors.
b. AC70, Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements.
c. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
d. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements. Evaluation Reports for Concrete and Masonry Anchors.

7. Specialty Steel Industry of North America (SSINA):
   a. Specifications for Stainless Steel.
   b. Design Guidelines for the Selection and Use of Stainless Steel.
   c. Stainless Steel Fabrication.
   d. Stainless Steel Fasteners.

1.2 DEFINITIONS

A. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

B. Exterior Area: Location not protected from weather by a building or other enclosed structure to include buried roof structures.

C. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or wash down, and where wall or roof slab is not common to a water-holding or earth-retaining structure.

D. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or wash down, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

E. Submerged: Location at or below top of wall of open water-holding structure, such as a basin or channel, or wall, ceiling, or floor surface inside a covered water-holding structure, or exterior below grade wall or roof surface of water-holding structure, open or covered.

1.3 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings: Specific instructions for concrete anchor installation, including drilled hole size and depth, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

B. Informational Submittals:
   1. Concrete Anchors:
      a. Manufacturer’s product description and installation instructions.
      b. Current ICC-ES or IAPMO-UES Report for each type of post-installed anchor to be used.
   2. Passivation method for stainless steel members.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Package stainless steel items in a manner to provide protection from carbon impregnation.

B. Protect hot-dip galvanized finishes from damage as a result of metal banding and rough handling.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Stainless Steel:	
Threaded Rods	F593, AISI Type 316, Condition CW
Nuts*	F594, AISI Type 316, Condition CW
Carbon Steel:	
Threaded Rods	F1554, Grade 36 or F568M Class 5.8
Flat and Beveled Washers (Hardened)	F436
Nuts*	A194/A194M, Grade 2H
Galvanized Steel:	
All	A153/A153M
*Nuts of other grades and styles having specified proof load stresses greater than specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than minimum tensile strength of specified threaded rod.	

B. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, and zinc-plated steel material types as indicated in Fastener Schedule at end of this section.

2.2 POST-INSTALLED CONCRETE ANCHORS

A. General:
1. AISI Type 316 stainless, hot-dip galvanized or zinc-plated steel, as shown in Fastener Schedule at end of this section.
2. Post-installed anchor systems used in concrete shall be approved by ICC Evaluation Services Report or equivalent for use in cracked concrete and for short-term and long-term loads including wind.
3. Mechanical Anchors: Comply with the requirements of ICC-ES AC193 or ACI 355.2.
4. Adhesive Anchors: Comply with the requirements of ICC-ES AC308 or ACI 355.4.

B. Torque-Controlled Expansion Anchors (Wedge Anchors):
1. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; Kwik-Bolt –TZ (KB-TZ) Anchors (ESR-1917).
   b. DeWalt/Powers Fasteners, Brewster, NY; Power-Stud +SD1, +SD2, +SD4, or +SD6 Anchors (ESR-2502 and ESR-2818).
   c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt 2 Anchors (ESR-1771 and ESR-3037).

C. Self-Tapping Concrete Screw Anchors:
   1. Manufacturers and Products:
      a. DeWalt/Powers Fasteners, Brewster, NY; Wedge-Bolt+ (ESR-2526).
      b. DeWalt/Powers Fasteners, Brewster, NY; Vertigo+ Rod Hanger Screw Anchor (ESR-2989).
      c. DeWalt/Powers Fasteners, Brewster, NY; Snake+ Flush Mount Screw Anchor (ESR-2272).
      d. Hilti, Inc., Tulsa, OK; HUS-EZ Screw Anchor (ESR-3027).
      e. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Titen HD Screw Anchor (ESR-2713 and IAPMO UES-493).

D. Adhesive Anchors:
   1. Threaded Rod:
      a. Diameter as shown on Drawings.
      b. Length as required to provide minimum depth of embedment indicated and thread projection required.
      c. Clean and free of grease, oil, or other deleterious material.
   2. Adhesive:
      a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
      b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
   3. Packaging and Storage:
      a. Disposable, self-contained system capable of dispensing both components in proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.
      b. Store adhesive on pallets or shelving in a covered storage area.
      c. Package Markings: Include manufacturer’s name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
      d. Dispose of When:
         1) Shelf life has expired.
         2) Stored other than in accordance with manufacturer’s instructions.
   4. Manufacturers and Products:
      a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT RE 500 V3 (ESR-3814).
      b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-3G Epoxy Adhesive Anchors. (ESR-4057).
      c. DeWalt/Powers Fasteners, Brewster NY; Pure 110+ Epoxy adhesive anchor system (ESR-3298).

E. Adhesive Threaded Inserts:
   1. Type 316 stainless steel, internally threaded inserts.
   2. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS-RN Insert with HIT-RE 500-V3 or HIT-HY 200 adhesive.

PART 3 - EXECUTION

3.1 CONCRETE ANCHORS

A. Begin installation only after concrete to receive anchors has attained design strength.

B. Locate existing reinforcing with Ground Penetrating Radar or other method approved by Engineer prior to drilling. Coordinate with Engineer to adjust anchor locations where installation would result in hitting reinforcing.

C. Install in accordance with written manufacturer's instructions.

D. Provide minimum embedment, edge distance, and spacing as indicated on Drawings.

E. Use only drill type and bit type and diameter recommended by anchor manufacturer.

F. Clean hole of debris and dust per manufacturer's requirements.

G. When unidentified embedded steel, rebar, or other obstruction is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than indicated in manufacturer's installation instructions to clear obstruction, notify Engineer for direction on how to proceed.

H. Adhesive Anchors:
   1. Unless otherwise approved by Engineer and adhesive manufacturer:
      a. Do not install adhesive anchors when temperature of concrete is below 40 degrees F or above 100 degrees F.
      b. Do not install prior to concrete attaining an age of 21 days.
      c. Remove any standing water from hole with oil-free compressed air. Inside surface of hole shall be dry.
      d. Do not disturb anchor during recommended curing time.
      e. Do not exceed maximum torque as specified in manufacturer's instructions.

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3.2 FASTENER SCHEDULE

A. Unless indicated otherwise on Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Post-Installed Anchors for Metal Components to Cast-in-Place Concrete		
Dry Areas	Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, zinc-plated anchors to anchor painted equipment, galvanized anchors to anchor galvanized equipment).	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application
Exterior, Wet, and Corrosive Areas	Stainless steel adhesive anchors	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application

B. Antiseizing Lubricant: Use on all stainless steel threads.

C. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

END OF SECTION 05 05 19

SECTION 23 11 13

FACILITY FUEL-OIL PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes diesel-fuel-oil distribution systems and the following:

1. Pipes, tubes, and fittings.
2. Piping and tubing joining materials.
3. Piping specialties.
4. Valves.
5. Fuel maintenance system
6. Fuel transfer pumps
7. Fuel
8. Liquid-level gage system.
9. Leak-detection and monitoring system.
10. Concrete bases.

1.3 DEFINITIONS

A. AST: Aboveground storage tank.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

E. FPM: Vinylidene fluoride-hexafluoropropylene copolymer rubber.

F. FRP: Glass-fiber-reinforced plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design restraint and anchors for fuel-oil piping, ASTs, and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, and dimensions of individual components and profiles. Also include, where applicable, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1. Piping specialties.
2. Valves: Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Liquid-level gage system.
4. Leak-detection and monitoring system.

B. Shop Drawings: For facility fuel-oil piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which fuel-oil piping is shown and coordinated with other installations, using input from installers of the items involved.

B. Welding certificates.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

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

C. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with ASME B31.9, "Building Services Piping," for fuel-oil piping materials, installation, testing, and inspecting.

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

1.9 DELIVERY, STORAGE, AND HANDLING

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

B. Store pipes and tubes with protective PE coating to avoid damaging the coating and to protect from direct sunlight.

1.10 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of double-containment piping and related equipment that fail in materials or workmanship within specified warranty period.

1. Flexible, Double-Containment Piping and Related Equipment:

a. Failures due to defective materials or workmanship for materials installed together, including piping, dispenser sumps, entry boots, and sump mounting adapters.
b. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. See Part 3 piping schedule articles for where pipes, tubes, fittings, and joining materials are applied in various services.

B. STAINLESS-STEEL PIPE AND FITTINGS (Socket-welded joints)

1. Pipe: Stainless steel, seamless, schedule 40S; ASTM A 312 or A 999 grade TP 316L, with ASME B36.19 socket-welded joints.
2. Fittings: Socket-welding, stainless steel, seamless, schedule 40S; ASTM A 182 grade WP 316L, ASME B16.11, and MSS SP-83.
3. Flanges: Socket-weld, 150-lb (1 035-kPa); MSS or ASME as follows.
   a. MSS SP-51 Flange: Diameter and drillings identical to 125-lb (865-kPa) flange in accordance with ASME B16.1 and 150-lb (1 035-kPa) in accordance with ASME B16.5, plain (flat) faced. Material shall conform to and comply with ASTM A 182 grade 316L for 2-inch (50-mm) size or smaller; ASTM A 351 grades CF8 and CF8M for all larger sizes.
   b. ASME Flange: ASME B16.5 raised face dimensions, ASTM A 182 grade F316L material.
4. Welding Process:
   a. Tungsten-inert-gas (TIG) process.
   b. Filler material shall be AWS A5.9 class ER 316L for type 316L stainless steel.
   c. The inert gas shall be argon.
5. Welding of Pipe Joints:
   a. Conform to the requirements of the American National Standard Code for Pressure Piping, ANSI B31, latest edition, including all addenda.
   b. Use fittings in welded pipe specifically designed for welding. 45° and 90° turns shall be long radius type welded fittings.
   c. Make branches from welded mains to welded branches with radius welding tees except 2 inches (50 mm) and smaller branches on 4 inches (100 mm) and larger mains may be made with specified welding outlets.
   d. "Cut-In" or mitered welding tees are specifically prohibited.
   e. Make branches from welded pipe to screwed pipe with threaded welded fittings.
6. Qualification of Welders:
   a. All welders for work in this Section shall be certified welders.
   b. Certification shall be for the welding processes performed and shall have been received within the last five (5) years.
   c. Upon request, the Contractor shall provide the names of welders employed in the work, together with certification that each of these welders has passed qualification tests as prescribed by the National Certified Pipe Welding Bureau, or by other reputable testing laboratory or agency in accordance with ANSI B31.1.3.

2.2 DOUBLE-CONTAINMENT PIPE AND FITTINGS

A. Flexible, Double-Containment Piping: Comply with UL 971.

1. Pipe Materials: PVDF complying with ASTM D 3222 for carrier pipe with mechanical couplings to seal carrier, and PE pipe complying with ASTM D 4976 for containment piping.
2. Fiberglass or PE sumps.
3. Watertight sump entry boots, pipe adapters with test ports and tubes, coaxial fittings, and couplings.
4. Minimum Operating Pressure Rating: 10 psig (69 kPa).
5. Plastic to Steel Pipe Transition Fittings: Factory-fabricated fittings with plastic end matching or compatible with carrier piping, and steel pipe end complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

6. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.

B. Rigid, Double-Containment Piping: Comply with UL 971.

1. RTRP: ASTM D 2996 or ASTM D 2997 carrier and containment piping and mechanical couplings to seal carrier and containment piping or individually bonded joints.

a. Minimum Operating-Pressure Rating for RTRP NPS 2 and NPS 3 (DN 50 and DN 80): 150 psig (1035 kPa).
b. Minimum Operating-Pressure Rating for RTRP NPS 4 and NPS 6 (DN 100 and DN 150): 125 psig (860 kPa). Compliance with UL 971 is not required for NPS 6 (DN 150) and larger piping.
c. Fittings: RTRF complying with ASTM D 2996 or ASTM D 2997 and made by RTRP manufacturer; watertight sump entry boots, termination, or other end fittings.

2. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.

2.3 PIPING SPECIALTIES

A. Flexible Connectors: Comply with UL 567.

1. Metallic Connectors:

a. Listed and labeled for aboveground and underground applications by an NRTL acceptable to authorities having jurisdiction.
b. Stainless-steel bellows with woven, flexible, stainless-steel, wire-reinforcing protective jacket.
c. Minimum Operating Pressure: 150 psig (1035 kPa).
d. End Connections: Socket-weld end to match connected piping.
e. Maximum Length: 30 inches (762 mm).
f. Swivel end, 50-psig (345-kPa) maximum operating pressure.
g. Factory-furnished anode.

B. Y-Pattern Strainers (Cast Stainless Steel):

1. Body: ASTM A351 Grade CF8M Stainless Steel with bolted cover and bottom drain connection.
2. Gasket: Spiral Wound SS, Graphite Filled
3. End Connections: Class 600, 764-SS Socket-weld
4. Strainer Screen: 304SS with 0.062 perforations
5. CWP Rating: 600 psig.

C. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.

3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/8 (DN 6).
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 225 deg F (107 deg C).

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for fuel oil.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

D. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

2.5 MANUAL FUEL-OIL SHUTOFF VALVES

A. See valve schedule in Part 3 for where each valve type is applied in various services.

B. General Requirements, NPS 2 (DN 50) and Smaller for Liquid Service: Comply with UL 842.

1. CWP Rating: 1500
2. Tamperproof Feature: Locking feature.
3. Fire-safe design.

C. Three-Piece, Full-Port, Stainless Steel Ball Valves: MSS SP-110.

1. Body: ASTM A351-CF8M.
2. Ball: ASTM A276-316SS.
3. Stem: ASTM A276-316SS.; blowout proof.
4. Seats: Multi-seal, fire safe design.
5. Packing: Adjustable multi-piece PTFE “V” style packing.
6. Ends: ASTM A351-CF3M, socket.
7. CWP Rating: 1500 psig (4140 kPa).
8. Service Mark: MSS SP-25

2.6 SPECIALTY VALVES

A. Pressure Relief Valves: Comply with UL 842.

1. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
2. Body: Brass, bronze, or cast steel.
3. Springs: Stainless steel, interchangeable.
4. Seat and Seal: Nitrile rubber.

5. Orifice: Stainless steel, interchangeable.
6. Factory-Applied Finish: Baked enamel.
7. Maximum Inlet Pressure: 150 psig (1035 kPa).
8. Relief Pressure Setting: 60 psig (414 kPa).

B. Mechanical Leak Detector: Comply with UL 842.

1. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
2. Body: ASTM A 126, cast iron.
3. O-Rings: Elastomeric compatible with fuel oil.
4. Piston and Stem Seals: PTFE.
5. Stem and Spring: Stainless steel.
6. Piston Cylinder: Burnished brass.
7. Indicated Leak Rate: Maximum 3 gph (3 mL/s) at 10 psig (69 kPa).
8. Leak Indication: Reduced flow.

2.7 DUPLEX FUEL-OIL TRANSFER PUMP SETS

A. Description: Comply with HI M109.

1. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
2. Type: Positive-displacement, rotary type.
3. Impeller: Carbon vane.
4. Housing: Cast-iron foot mounted.
5. Bearings: Bronze, self-lubricating.
6. Shaft: Polished steel.
7. Seals: Mechanical.
8. Base: Steel.
9. Pressure Relief: Built in.
10. Discharge Check Valve: Built in.

B. Drive: Direct close coupled.

C. Controls:

1. Run pumps to maintain minimum manifold pressure with outdoor-air temperature less than 60 deg F (16 deg C).
2. Run pumps on seven-day schedule.
3. Stage pumps on pressure at a common supply manifold.
4. Alternate pumps to equalize run time.
5. Alarm motor failure.
6. Manual reset dry-run protection. Stop pumps if fuel level falls below pump suction.
7. Deenergize and alarm pump locked rotor condition.
8. Alarm open circuit, high and low voltage.
9. Indicating lights for power on, run, and off normal conditions.
10. Interface with automatic control system is specified in Division 23 Section "Instrumentation and Control for HVAC" to control and indicate the following:

a. Start/stop pump set when required by day tank level control.

b. Operating status.
c. Alarm off-normal status.

D. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

E. Piping Furnished with Pumps: Stainless steel with SS fittings and welded joints.

F. Strainers Furnished with Pumps: Duplex, basket type with corrosion-resistant-metal-screen baskets.

2.8 FUEL MAINTENANCE SYSTEM

A. Description: Factory fabricated and wired fuel maintenance system for fuel-oil filtration; with enclosure, filter, fuel-oil pump, and controls; FMG approved, listed, and labeled by an NRTL acceptable to authorities having jurisdiction.

1. Enclosure: NEMA 250, Type 3R, Stainless steel containing pumps, filters, accessories, and controls. Hinged door on the front of enclosure.
2. Pump: Comply with HI M109, steel-gear-with-crescent, positive-displacement, direct-coupled, rotary-type.
3. Materials: Cast-iron housing; bronze bearings; steel shaft; mechanical seals; and built-in, pressure relief bypass valve.
4. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements.

a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

5. Piping: Stainless steel with SS fittings and welded joints.
6. Multistage Filter: Spin-on, replaceable types.

a. Stage 1: 100-mesh strainer.
b. Stage 2: Centrifuge to separate particulates and water from oil.
c. Stage 3: Coalescing water and particulate filter.
d. Stage 4: 30-micron particulate removal.
e. Stage 5: 10-micron particulate removal.
f. Stage 6: Minimum 99.5 percent water removal with see-through bowl and water-sensor probe.
g. Stage 7: 1.5-micron particulate removal.

7. Programmable Logic Controller:

a. Alarm on maximum 15-in. Hg (51-kPa) vacuum at pump suction indicating plugged filter.
b. Alarm on high water level in filter.
c. Alarm leak in enclosure.
d. Touch screen; with minimum 2-line, 20-character, backlit, LCD display.
e. Controller strip heater with thermostat.

8. Interface with automatic control system:

a. Start/stop system when required by schedule.
b. Operating status.
c. Alarm off-normal status.

B. Capacities and Characteristics:

1. Capacity (Each Pump): 10 gpm.
2. Maximum Suction Lift: 15 feet (4.6 m).
3. Inlet and Outlet Size: 1.5” NPS (DN).
4. Electrical Characteristics (Pump Set):

a. Volts: 120.
b. Phase: Single.
c. Hertz: 60.

2.9 LIQUID-LEVEL GAGE SYSTEM

A. Description: Calibrated, liquid-level gage system complying with UL 180 with floats or UL 1238 with probes or other sensors and remote annunciator panel.

B. Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in gallons (liters), and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.

C. Controls: Electrical, operating on 120 Vac.

2.10 LEAK-DETECTION AND MONITORING SYSTEM

A. Cable and Sensor System: Comply with UL 1238.

1. Calibrated, leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil storage tanks and fuel-oil piping.
2. Include fittings and devices required for testing.
3. Controls: Electrical, operating on 120-V ac.
4. Calibrated, liquid-level gage complying with UL 180 with floats or UL 1238 with probes or other sensors and remote annunciator panel.
5. Remote Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in gallons (liters), and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
6. Controls: Electrical, operating on 120-V ac.

B. Hydrostatic System: Comply with UL 1238.

1. Calibrated, leak-detection and monitoring system with brine antifreeze solution, reservoir sensor, and electronic control panel to monitor leaks in inner and outer tank walls.
2. Include fittings and devices required for testing.
3. Controls: Electrical, operating on 120-V ac.
4. Calibrated, liquid-level gage complying with UL 180 with floats or UL 1238 with probes or other sensors and remote annunciator panel.
5. Remote Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in gallons (liters), and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
6. Controls: Electrical, operating on 120-V ac.

2.11 FUEL OIL

A. Diesel Fuel Oil: ASTM D 975, Grade No. 2-D, general-purpose, high volatility.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for fuel-oil piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining, to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer. Review protective coating damage with Architect prior to repair.
3. Replace pipe having damaged PE coating with new pipe.

B. Install double-containment, fuel-oil pipe at a minimum slope of 1 percent downward toward fuel-oil storage tank sump.

C. Install vent pipe at a minimum slope of 2 percent downward toward fuel-oil storage tank sump.

D. Assemble and install entry boots for pipe penetrations through sump sidewalls for liquid-tight joints.

E. Install metal pipes and tubes, fittings, valves, and flexible connectors at piping connections to AST and UST.

F. Install fittings for changes in direction in rigid pipe.

G. Install system components with pressure rating equal to or greater than system operating pressure.

H. Install pressure gage on suction and discharge from each pump.

3.4 VALVE INSTALLATION

A. Install manual fuel-oil shutoff valves on branch connections to fuel-oil appliance.

B. Install valves in accessible locations.

C. Protect valves from physical damage.

D. Install metal tag attached with metal chain indicating fuel-oil piping systems.

E. Install pressure relief valves in distribution piping between the supply and return lines.

F. Install one-piece, bronze ball valve with hose end connection at low points in fuel-oil piping.

G. Install manual air vents at high points in fuel-oil piping.

3.5 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Bevel plain ends of steel pipe.
2. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness for service application. Install gasket concentrically positioned.

G. Flared Joints: Comply with SAE J513. Tighten finger tight, then use wrench according to fitting manufacturer's written recommendations. Do not overtighten.

3.6 FUEL-OIL PUMP INSTALLATION

A. Transfer Pumps:

1. Install pumps with access space for periodic maintenance including removal of motors, impellers, and accessories.
2. Set pumps on and anchor to concrete base.

B. Install two-piece, full-port ball valves at suction and discharge of pumps.

C. Install mechanical leak-detector valves at pump discharge.

D. Install Y-pattern strainer on inlet side of simplex fuel-oil pumps.

E. Install check valve on discharge of simplex fuel-oil pumps.

F. Install suction piping with minimum fittings and change of direction.

G. Install vacuum and pressure gage, upstream and downstream respectively, at each pump to measure the differential pressure across the pump.

3.7 FUEL MAINTENANCE SYSTEM INSTALLATION

A. Install suction line, with foot valve, at one end of storage tank, 1 inch (25 mm) from the bottom of tank.

B. Install return line at the opposite end of storage tank from suction line.

3.8 LIQUID-LEVEL GAGE SYSTEM INSTALLATION

A. Install liquid-level gage system. Locate panel inside building where indicated.

3.9 LEAK-DETECTION AND MONITORING SYSTEM INSTALLATION

A. Install leak-detection and monitoring system. Install alarm panel inside building where indicated.

1. Double-Wall, Fuel-Oil Storage Tanks: Install probes or use factory-installed integral probes in interstitial space.

2. Double-Containment, Fuel-Oil Piping: Install leak-detection sensor probes in fuel-oil storage tank containment sumps and at low points in piping.
3. Install liquid-level gage.

3.10 CONNECTIONS

A. Install piping adjacent to equipment to allow service and maintenance.

B. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.

C. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

D. Connect piping to equipment with ball valve and union. Install union between valve and equipment.

E. Install flexible piping connectors at final connection to burners or oil-fired appliances that must be moved for maintenance access.

3.11 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on or near each service regulator, service meter, and earthquake valve.

1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.12 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to section 01 88 15.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (457-mm) centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Use 3000-psig (20.7-MPa), 28-day, compressive-strength concrete and reinforcement.

3.13 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Piping: Minimum hydrostatic or pneumatic test-pressures measured at highest point in system:

   a. Fuel-Oil Distribution Piping: Minimum 5 psig (34.5 kPa) for minimum 30 minutes.
   b. Fuel-Oil, Double-Containment Piping:

      1) Carrier Pipe: Minimum 5 psig (34.5 kPa) for minimum 30 minutes.
      2) Containment Conduit: Minimum 5 psig (34.5 kPa) for minimum 60 minutes.

   c. Suction Piping: Minimum 20-in. Hg (68 kPa) for minimum 30 minutes.
   d. Isolate storage tanks if test pressure in piping will cause pressure in storage tanks to exceed 10 psig (69 kPa).

2. Inspect and test fuel-oil piping according to NFPA 31, "Tests of Piping" Paragraph; and according to requirements of authorities having jurisdiction.
3. Test liquid-level gage for accuracy by manually measuring fuel-oil levels at not less than three different depths while filling tank and checking against gage indication.
4. Test leak-detection and monitoring system for accuracy by manually operating sensors and checking against alarm panel indication.
5. Start fuel-oil transfer pumps to verify for proper operation of pump and check for leaks.
6. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
7. Bleed air from fuel-oil piping using manual air vents.

B. Fuel-oil piping and equipment will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.14 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain liquid-level gage systems and leak-detection and monitoring systems.

3.15 INDOOR PIPING SCHEDULE

A. Aboveground fuel-oil piping shall be the following:
   1. NPS 2 (DN 50) and Smaller: STAINLESS-STEEL PIPE AND FITTINGS (Buttweld joints)

3.16 OUTDOOR PIPING SCHEDULE

A. Aboveground fuel-oil piping shall be the following:
   1. NPS 2 (DN 50) and Smaller: STAINLESS-STEEL PIPE AND FITTINGS (Buttweld joints)

B. Underground fuel-oil piping shall be the following:
   1. NPS 2 (DN 50) and Smaller: Rigid, Double-Containment Piping: Comply with UL 971.
   2. Flexible, Double-Containment Piping: Comply with UL 971.

3.17 ABOVEGROUND MANUAL FUEL-OIL SHUTOFF VALVE SCHEDULE

A. Distribution piping valves for pipe NPS 2 (DN 50) and smaller shall be the following:

   1. Two-piece, full-port, stainless steel valves with stainless steel trim.

END OF SECTION

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SECTION 26 05 13

MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Certificates: For each cable and accessory type, signed by manufacturers.

C. Source quality-control test reports.

D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C2 and NFPA 70.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cables:

a. American Insulated Wire Corp.; a Leviton Company.
b. General Cable Technologies Corporation.
c. Kerite Co. (The); Hubbell Incorporated.
d. Okonite Company (The).
e. Pirelli Cables & Systems NA.
f. Rome Cable Corporation.
g. Southwire Company.

2. Cable Splicing and Terminating Products and Accessories:

a. Engineered Products Company.
b. G&W Electric Company.
c. MPHusky.
d. Raychem Corp.; Telephone Energy and Industrial Division; Tyco International Ltd.
e. RTE Components; Cooper Power Systems, Inc.
f. Scott Fetzer Co. (The); Adalet.

g. Thomas & Betts Corporation.
h. Thomas & Betts Corporation/Elastimold.
i. 3M; Electrical Products Division.

2.2 CABLES

A. Cable Type: MV105.

B. Comply with UL 1072, AEIC CS 8, and ICEA S-93-639.

C. Conductor: Copper.

D. Conductor Stranding: Compact round, concentric lay, Class B.

E. Strand Filling: Conductor interstices are filled with impermeable compound.

F. Conductor Insulation: Crosslinked polyethylene.

G. Conductor Insulation: Ethylene-propylene rubber.

1. Voltage Rating: 5 kV.
2. Insulation Thickness: 133 percent insulation level.

H. Shielding: Copper tape, helically applied over semiconducting insulation shield.

I. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

J. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together with ground conductors.

1. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.

K. Cable Armor: Corrugated aluminum tube applied over cable.

L. Cable Jacket: Sunlight-resistant PVC.

2.3 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
2. Pre-molded, cold-shrink-rubber, in-line splicing kit.

2.4 SOLID TERMINATIONS

A. Multiconductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.

1. Compound-filled, cast-metal body, metal-clad cable terminator for metal-clad cable with external plastic jacket.
2. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.

B. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
2. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.
3. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
4. Class 3 Terminations: Kit with stress cone and compression-type connector.

C. Non-shielded-Cable Terminations: Kit with compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

D. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

E. Install cable duct bank on leveled and tamped bed of 3-inch- (75-mm-) thick, clean sand. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

F. Install warning tape 12 inches (305 mm) above cable duct bank.

G. In handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

H. Install cable splices at pull points and elsewhere as indicated; use standard kits.

I. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits.

J. Seal around cables passing through fire-rated elements according to ASTM E 814 or UL 1479.

K. Ground shields of shielded cable at terminations, and splices. Ground metal bodies of terminators, splices, and hardware.

L. Identify cables according to Division 26 Section "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 13

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.

2. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

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

B. NBR: Acrylonitrile-butadiene rubber.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN

D. Multiconductor Cable: Comply with NEMA WC 70 metal-clad cable, Type MC and Type SO with ground wire.

2.2 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper for feeders smaller than No. 4 AWG; copper for feeders No. 4 AWG and larger. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

D. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway, Metal-clad cable, Type MC, or nonmetallic-sheathed cable, Type NM.

F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

G. Class 1 Control Circuits: Type THHN-THWN, in raceway, or securely supported and protected in free space.

H. Class 2 Control Circuits: Type THHN-THWN, in raceway, or securely supported and protected in free space.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. 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-486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm of slack.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to ASTM E 814 or UL 1479.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

D. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 19

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SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: Grounding systems and equipment.

B. Section includes grounding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Ground bonding common with lightning protection system.
3. Neutral Grounding Resistors for 4160V generators.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
1. Ground rods.
2. Grounding arrangements and connections for separately derived systems.

B. Qualification Data: For qualified testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. Include the following:

1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on:

a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet in diameter.

2.4 NEUTRAL GROUNDING RESISTORS FOR 4160V GENERATORS

A. UL Listed, designed and tested to IEEE Std. 32-1972.

1. System Voltage – 4160V, Line to Neutral Voltage – 2400V
2. Stainless Steel Resistor Elements – 12 Ohms (+10/-10%)
3. Current Rating – 800A
4. Current Transformer – Included, factory mounted and wired inside enclosure
5. Maximum On Time – 10 seconds
6. Enclosure Type – General Purpose Indoor/Outdoor rated. Bolt-on access panels to safely enclose all electrical connection and wiring with no exposed live bushings.
7. Enclosure Finish – Aluminized Steel with polyester powder coat paint finish.
8. Provide with a neutral grounding resistor/ground detection monitoring system. System shall alarm to the Generator Control Panel and BAS.
9. Neutral grounding resistor shall be provided by the generator manufacturer and tested with generator before shipment from factory.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Grounding Bus: Included in panelboards and enclosures where grounding connections are required. Install on wall where multiple grounding connections are required.

1. Install bus on insulated spacers.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Handholes: Install a driven ground rod through handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor.

C. Grounding Connections to Handhole Components: Bond exposed-metal parts such as inserts, and cable shields within each handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to handhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.

C. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.

1. Connect ground rods with grounding electrode conductor below grade as indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.5 LABELING

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

E. Grounding system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Pad-Mounted Equipment: 5 ohms.
3. Handhole Grounds: 10 ohms.

H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Owner promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

2. Nonmetallic slotted support systems.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

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

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

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

        1) Hilti Inc.
        2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.
        4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

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

        1) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.

7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with ASTM A 36/A 36M requirements for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with ASTM A 36/A 36M installation requirements for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 4500-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified on the structural drawings.

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Clean and provide touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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

END OF SECTION 26 05 29

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SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

A. RAC: Rigid Aluminum conduit.

B. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.
4. Electri-Flex Company.
5. O-Z/Gedney; a brand of EGS Electrical Group.
6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
7. Republic Conduit.
8. Robroy Industries.
9. Southwire Company.
10. Thomas & Betts Corporation.
11. Western Tube and Conduit Corporation.
12. Wheatland Tube Company; a division of John Maneely Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. RAC: Comply with ANSI C80.5 and UL 6A.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit or IMC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

F. EMT: Comply with ANSI C80.3 and UL 797.

G. FMC: Comply with UL 1; zinc-coated steel

H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Fittings for EMT:

a. Material: Steel or die-cast
b. Type: Set screw, or compression.

2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

J. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corp.
6. Condux International, Inc.
7. Electri-Flex Company.
8. Kraloy.
9. Lamson & Sessions; Carlon Electrical Products.
10. Niedax-Kleinhuis USA, Inc.
11. RACO; a Hubbell company.
12. Thomas & Betts Corporation.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ENT: Comply with NEMA TC 13 and UL 1653.

D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. LFNC: Comply with UL 1660.

F. Rigid HDPE: Comply with UL 651A.

G. Continuous HDPE: Comply with UL 651B.

H. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.

I. RTRC: Comply with UL 1684A and NEMA TC 14.

J. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

K. Fittings for LFNC: Comply with UL 514B.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

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

1. Cooper B-Line, Inc.
2. Hoffman; a Pentair company.

3. Mono-Systems, Inc.
4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 for interior applications and Type 3R for exterior applications unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged and gasketed type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

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

1. Allied Moulded Products, Inc.
2. Hoffman; a Pentair company.
3. Lamson & Sessions; Carlon Electrical Products.
4. Niedax-Kleinhuis USA, Inc.

B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

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

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. FSR Inc.
6. Hoffman; a Pentair company.
7. Hubbell Incorporated; Killark Division.
8. Kraloy.
9. Milbank Manufacturing Co.
10. Mono-Systems, Inc.
11. O-Z/Gedney; a brand of EGS Electrical Group.
12. RACO; a Hubbell Company.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
16. Thomas & Betts Corporation.
17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

I. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).

1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

K. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

L. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

M. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

N. Gangable boxes are allowed.

O. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 and Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

P. Cabinets:

1. NEMA 250, Type 1 and Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: RAC.
2. Underground Conduit: RNC.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R unless otherwise noted.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: Conduits containing cables 600V or less – EMT. Conduits containing cables >600V-RAC.

2. Exposed, Not Subject to Severe Physical Damage: Conduits containing cables 600V or less – EMT. Conduits containing cables >600V-RAC.

3. Exposed and Subject to Severe Physical Damage: RAC. Raceway locations include the following:

   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT or RAC.

5. Underground conduit elbows shall be RAC coated in 2 layers of bitumastic paint.

5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.

6. Damp or Wet Locations: RAC.

7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size, unless otherwise noted.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Aluminum Conduit: Use threaded rigid aluminum conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use setscrew or compression, fittings. Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. A. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Raceways Embedded in Slabs:

1. Do not run raceways in slab.

J. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

U. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

V. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
   d. Attics: 135 deg F (75 deg C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.

Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

1. Locate boxes so that cover or plate will not span different building finishes.
2. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
3. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
4. Set metal floor boxes level and flush with finished floor surface.
5. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with ASTM E 814 or UL 1479 requirements.

3.4 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
2. Handholes and boxes.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for handholes, and boxes.
4. Warning tape.
5. Warning planks.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Reinforcement details.
3. Grounding details.
4. Dimensioned locations of pulling-in and lifting irons.

C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

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

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

B. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.

C. Qualification Data: For professional engineer and testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

1.6 QUALITY ASSURANCE

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

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.9 COORDINATION

A. Coordinate layout and installation of ducts, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

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

1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.

11. Spiraduct/AFC Cable Systems, Inc.

B. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.

    a. Color: Red dye added to concrete during batching.
    b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

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:

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

1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.

C. Comply with ASTM C 858 for design and manufacturing processes.

D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.

    a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    b. Cover Handle: Recessed.

4. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.

    a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    b. Cover Handle: Recessed.

5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC."
7. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
8. Extensions: Designed to mate with bottom of enclosure. Same material as enclosure.

    a. Extension shall provide increased depth of 12 inches (300 mm).

9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.

    a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers

    b. of handholes, but close enough to corners to facilitate racking of cables on walls.
    c. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    d. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

10. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

    a. Type and size shall match fittings to duct or conduit to be terminated.
    b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

11. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Color: Gray.
2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC."

6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

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

a. Armorcast Products Company.
b. Carson Industries LLC.
c. CDR Systems Corporation.
d. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

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

a. Armorcast Products Company.
b. Carson Industries LLC.
c. Christy Concrete Products.
d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

2.5 UTILITY STRUCTURE ACCESSORIES

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

1. Bilco Company (The).
2. Campbell Foundry Company.
3. Carder Concrete Products.
4. Christy Concrete Products.
5. East Jordan Iron Works, Inc.
6. Elmhurst-Chicago Stone Co.
7. McKinley Iron Works, Inc.
8. Neenah Foundry Company.
9. NewBasis.
10. Oldcastle Precast Group.
11. Osburn Associates, Inc.

12. Pennsylvania Insert Corporation.
13. Riverton Concrete Products; a division of Cretex Companies, Inc..
14. Strongwell Corporation; Lenoir City Division.
15. Underground Devices, Inc.
16. Utility Concrete Products, LLC.
17. Utility Vault Co.
18. Wausau Tile, Inc.

B. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.

1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.

C. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (32-mm-) diameter eye, rated 2500-lbf (11-kN) minimum tension.

D. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

E. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater. Two required.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40 PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80 PVC, in direct-buried duct bank, unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-80 PVC, in direct-buried duct bank, unless otherwise indicated.

D. Underground Ducts Crossing Paved Paths, Walks, Driveways, and Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-10 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 Polymer concrete, SCTE 77, Tier 15, Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15, Fiberglass-reinforced polyester resin, SCTE 77, Tier 15 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10, Polymer concrete units, SCTE 77, Tier 8, Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earthwork," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top-soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Reference the civil drawings.

D. Cut and patch existing pavement in the path of underground ducts and utility structures. Reference the civil drawings.

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from buildings and equipment. Slope ducts from a high point in runs between two handholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1220 mm), both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) on center for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition.

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

G. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than **4** spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between handholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of

concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
    b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.

10. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

I. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than **4** spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earthwork" for pipes less than 6 inches (150 mm) in nominal diameter.
4. Install backfill as specified in Division 31 Section "Earthwork."
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and

hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earthwork."

6. Install ducts with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade, unless otherwise indicated.
8. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
    b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

10. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried ducts and duct banks, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches (300 mm) apart, horizontally.

3.5 INSTALLATION OF CONCRETE HANDHOLES, AND BOXES

A. Precast Concrete Handhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
2. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors.

D. Field-Installed Bolting Anchors in Concrete Handholes: Do not drill deeper than 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

F. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 4500 psi, 28-day strength. Reference the structural drawings for a "Cast In Place Concrete" description with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

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

END OF SECTION 26 05 43

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SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Equipment identification labels.
3. Miscellaneous identification products.

1.2 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with NFPA 70 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage

C. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.2 EQUIPMENT IDENTIFICATION LABELS

A. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Apply identification devices to surfaces that require finish after completing finish work.

C. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

D. Painted Identification: Provide surface preparation prior to paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the power systems with the wiring system legend and system voltage.

B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in junction boxes, and handholes, use color-coding conductors to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder, sub-feeders and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.

b. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

C. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual.

Apply labels to disconnect switches and protection equipment, central or master units, control panels, and terminal cabinets of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
    b. Outdoor Equipment: Engraved, laminated acrylic or melamine label
    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION 26 05 53

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SECTION 26 18 39

MEDIUM VOLTAGE MOTOR CONTROLLERS (AMPGARD)

PART 1 GENERAL

1.1 SCOPE

A. The Contractor shall furnish and install the medium voltage motor controller as specified herein and as shown on the contract drawings.

B. New two vertical section “shipping split” to be inserted within the existing line-up to replace vertical structures #8 and #9.

C. The two vertical section addition shall be transitioned into the existing line-up using bus.

D. The new Next Gen” Ampgard equipment will require an additional 4” wide transition extension where the new equipment connects to the TIE Breaker vertical section.

E. Once installed, the completed installation must be checked out and approved by an Eaton EESS field service engineer.

1.2 REFERENCES

A. Medium voltage motor starters shall be designed, manufactured, assembled and tested in accordance with the following standards:
   1. ANSI/NEMA ICS-3- 1993 (R2000)
   2. UL 347 or equivalent CSA C22.2 No. 14

1.3 SUBMITTALS – FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer:
   1. Master drawing index
   2. Front view elevation
   3. Floor plan
   4. Top view
   5. Schematic diagram
   6. Nameplate schedule
   7. Component list
   8. Conduit entry/exit locations
   9. Assembly ratings including:
      a. Short-circuit rating
      b. Voltage
      c. Continuous current
      d. Basic impulse level
   10. Major component ratings including:
      a. Voltage

b. Continuous current
c. Interrupting ratings

11. Cable terminal sizes
12. Descriptive bulletins
13. Product data sheets

B. Where applicable, the following additional information shall be submitted to the Engineer:

1. Connection details between close-coupled assemblies
2. Composite floor plan of close-coupled assemblies
3. Key interlock scheme drawing and sequence of operations

1.4 SUBMITTALS – FOR CONSTRUCTION

A. The following information shall be submitted for record purposes:

1. Final as-built drawings and information for items listed in Paragraph 1.04 above, and shall incorporate all changes made during the manufacturing process.
2. Wiring diagrams
3. Certified production test reports
4. Installation information, including equipment anchorage provisions

1.5 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.6 REGULATORY REQUIREMENTS

A. Equipment shall be provided with the following special labels UL (7.2kV and below). (Note: All optionally specified features must be confirmed to meet above specified labeling requirements to insure label can be applied.)

1.7 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer’s instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.8 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

PART 2 PRODUCTS

2.2 MANUFACTURERS

A. Eaton

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.3 RATINGS

A. Starters shall have an integrated interrupting rating with current limiting fuses of ·400 MVA.

B. When starters are grouped together in a lineup, the entire assembly shall be suitable for application on a power system having a short-circuit capacity of 12,500A

The vacuum contactor shall have the following ratings:

7200V Max.	400 Amperes	800 Ampere
Max. Interrupting Current (3 OPS)	8500 Amperes	12500 Amperes
Rated Current – Enclosed	400 Amperes	720 Amperes
Rated Current – Open	400 Amperes	800 Amperes
Short-Time Current		
30 Sec.	2400 A	4320 A
1 Sec.	6000 A	10800 A
8.7 ms (0.5 Cycle)	63 kA Peak	86 kA Peak
Mechanical Life	2.5 Million	1.0 Million
Electrical Life at rated current	300,000	100,000
Impulse Withstand	60 kV (1.2 x 50 Micro Sec.)	60 kV (1.2 x 50 Micro Sec.)

2.4 CONSTRUCTION

A. Isolating switch and contactor assemblies, including current limiting fuses, shall be of the component-to-component design with a minimum amount of interconnecting cables. The isolating switch shall be easily removed from the enclosure by removing the pin securing the operating rod to the switch and then removing two bolts securing the removable portion of the switch. Line and load cable terminations shall be completely accessible from the front.

B. The isolating switch shall be an externally operated manual three-pole drawout type, such that in the open position it grounds and isolates the starter from the line connectors with an isolating shutter leaving no exposed high-voltage components. Integral mechanical interlocks shall prevent entry into the high-voltage areas while the starter is energized and shall block accidental opening or closing of the isolating switch when the door is open or the contactor is closed. The isolating switch handle shall have provisions for padlocking in the open position. The isolating switch shall have a mechanical blown fuse indicating device. The isolation switch shall be designed for a minimum of 10,000 operations.

C. Current limiting power fuses shall be provided with special fatigue proof elements that allow the elements to absorb the expansions and contractions created by the heating and cooling associated with severe cycling as is typical with motor starting. The fuses will include visible fuse condition indicators. The fuses shall incorporate special time/current characteristics for motor service allowing proper coordination with the contactor and overload relay for maximum motor protection. This coordination shall be such that under a low-fault condition the interrupting rating and dropout time of the contactor shall be properly coordinated with all possible fuse sizes to eliminate contactor racing. The power fuses shall be vertically mounted permitting easy inspection and replacement without starter disassembly.

D. The vacuum contactor shall be of the slide-out and latched magnetically-held design, rated 800 amperes with single-break high-pressure type main contacts with weld-resistant alloy contact faces. The vacuum contactor contact wear shall be easily checked with the use of a “go/no-go” feeler gauge.

E. A built-in test circuit shall be included to permit checking of the starter control and pilot circuit, with the high voltage de-energized and isolated, and the contactor in its normal position or in the drawout position. The control circuit shall be capable of being energized through a polarized plug connector from an external 115-volt supply while in the test mode.

F. The low voltage control compartment shall be isolated and barriered from the high voltage area and located behind a separate low voltage access door. The low voltage compartment shall be painted white to increase visibility of components mounted inside the compartment.

G. Each starter cell shall contain a vertical and horizontal low voltage wireway.

2.5 BUS

A. When starters are grouped together in a lineup, the horizontal main bus shall be located in its own separate, 12-inch high enclosure and isolated from the starters. To allow for ease of maintenance or extension of lineups without disassembling starters, the main bus shall be front, top and side accessible.

B. Starters shall be connected by an insulated vertical bus.

C. All bus bars shall be copper to match existing. Bus shall be rated for 1200A (7.2kV and below) continuous current.

D. Provide a 1/4 x 2-inch ground bus throughout the entire lineup. Ground bus shall also be supplied in upper compartments of 2-high starters and be bus connected to the ground bus supplied in the lower compartments.

2.6 WIRING/TERMINATIONS

A. All control wire shall be UL/CSA approved.

B. Standard control wire shall be 14GA, stranded, tin-plated, red, dual-rated type XLPE (3173) 125 degrees C, SIS 90 degrees C.

C. Current transformer circuits shall utilize #12 wire with the same characteristics as above. Provide shorting blocks for all current transformers.

D. Provide “plug-in” terminal blocks, rated 600 V, 50 A with “clamping collar.”

E. Wire markers shall be a molded plastic “clip-sleeve” type.

F. "Clamping-collar" type terminals shall be used to terminate control wiring. Current transformer circuits shall be provided with ring-type terminals where applicable.

2.7 STARTER/CONTACTOR

A. The starter shall be designed to accommodate motors of the size and type as shown on the drawings.

B. The starter shall be reversing to accommodate the following motor type:

1. Induction Motor Full-Voltage Start

C. The following equipment shall be provided for the starter type indicated in Paragraph 2.6B.

1. Induction motor full voltage starter shall include:
   a. Medium Voltage Section
      1. One – Fixed portion isolating switch with shutter mechanism
      2. One – Removable portion isolating switch with blown fuse indication
      3. Three – Bolt-in Current-limiting power fuses
      4. One – Bolt-in three-pole main vacuum contactor assembly
      5. One – Control circuit transformer 2 kVA @ 4.16 kV
      6. Two – Control circuit primary current limiting fuses
      7. One – Control circuit secondary fuse
      8. One – Run-test circuit
      9. Four – Electrical interlocks
      10. One Three-phase current transformer suitable for use with electronic overload and electronic meter
      11. Three – Current transformers
      12. One – Zero sequence ground fault current transformer where ground fault protection is specified
   b. Low Voltage Compartment and Door
      1. One – Interposing control relay
      2. One – Set of control circuit terminal blocks
      3. Two – PT's, Open Delta,
      4. Isolation switch viewing window to verify switch position
      5. One – CT shorting terminal block
   c. Where motor reversing is shown on the drawings, provide an additional vacuum contactor for reversing. Both contactors shall be mechanically and electrically interlocked.

2.8 NAMEPLATES

A. Nameplates shall be 2-inch high x 2-1/2 inch wide, laminated black with white core.

B. Unit nameplate and device marker lettering shall be 3/16-inch high.

2.9 FINISH

A. The finish for internal and external parts shall consist of a coat of ANSI 61 (gray) thermosetting, polyester, powder paint applied electrostatically to pre-cleaned phosphatized steel and aluminum surfaces.

2.10 ACCESSORIES

A. Provide a portable lifting device for transporting contactor outside its compartment.

PART 3 EXECUTION

3.1 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
   1. Wiring check
   2. Sequence of control circuits
   3. Dielectric Test (Hi Pot) per NEMA ICS 3 Part 2 at 2000 volts plus 2.25 times nominal voltage, for 60 seconds, phase-to-phase and phase-to-ground

B. The manufacturer shall provide three (3) certified copies of factory test reports.

C. Factory tests as outlined above shall be witnessed by the owner's representative.
   1. The manufacturer shall notify the owner two (2) weeks prior to the date the tests are to be performed

3.2 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer's representative to provide startup of the equipment specified under this section for a period of at least two working days to allow for a full functioning system.

B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative:
   1. Megger bus
   2. Ground test
   3. Verify that all mechanical interlocks are functioning properly

C. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.3 TRAINING

A. The Contractor shall provide a training session for five (5) owner representative(s) for ·at least one normal workday at a job site location determined by the owner to ensure that the owner is satisfied with the training.

B. The training session shall be conducted by a manufacturer's qualified representative and include instructions on assembly, starters and other major components.

3.4 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.

B. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

C. Check all bolted connections to assure that they are in accordance with the manufacturer's recommended torque requirements.

3.5 FIELD ADJUSTMENTS

A. Program the new generator contactor protective relay in conjunction with the existing feeder protection relay of the main-tie-main breakers to accommodate the sequence of operations as described

3.6 FIELD TESTING

A. Sequence the control circuit to verify that the contactor will close upon signal from the generator, and open upon signal from the main and tie breakers of the motor control center.

END OF SECTION 26 18 39

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SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes load center for installation within generator enclosure.

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: For each load center and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of load centers and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include time-current coordination curves for each type and rating of overcurrent protective device included in load centers.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Load center schedules for installation in load centers.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR LOAD CENTERS

A. Enclosures: Flush mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Directory Card: Inside load center door, mounted in transparent card holder.

B. Incoming Mains Location: Top.

C. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Sub-feed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. Load center Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 LIGHTING AND APPLIANCE BRANCH-CIRCUIT LOAD CENTERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Square D; a brand of Schneider Electric.

B. Load centers: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
3. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads;
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Shunt Trip: 120V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
    f. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
    g. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Receive, inspect, handle, store and install load centers and accessories according to NECA 407.

B. Mount top of trim 90 inches above finished floor unless otherwise indicated.

C. Mount load center cabinet plumb and rigid without distortion of box. Mount recessed load centers with fronts uniformly flush with wall finish and mating with back box.

D. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

E. Install filler plates in unused spaces.

F. Stub four 1-inch (27-GRC) empty conduits from load center into accessible ceiling space or space designated to be ceiling space in the future. Comply with NECA 1.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Load center Nameplates: Label each load center with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution load centers with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each load center bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Load centers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies load centers included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

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SECTION 26 32 13

ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Controls and Instrumentation, System Commissioning apply to this Section.

1.2 SUMMARY

A. This Section includes packaged engine-generator sets for standby power supply with the following features:

1. Diesel engine
2. Unit-mounted cooling system
3. Unit-mounted control and monitoring with connections to building BMS
4. Fuel system
5. External fuel tank
6. Transfer pumps
7. Leak detection monitoring
8. Outdoor enclosure
9. Exhaust
10. Mounting
11. Air make-up system

B. Related Sections include the following:

1. Division 26 Section 261839 "Medium-Voltage Motor Controllers" for circuit protection devices to initiate automatic-starting and -stopping signals for engine-generator sets.

2. Division 01 Section 018815 “Anchorage and Bracing Requirements” for generator anchoring to concrete base.

3. Division 26 Section 260526 “Grounding and Bonding for Electrical Systems” for generator neutral grounding resistors.

4. Division 23 Section 231113 “Facility Fuel-Oil Piping” for generator diesel-fuel-oil distribution systems.

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. BMS: Building Management Systems

1.4 ACTION SUBMITTALS

A. Bill of Materials: A listing shall include all panels, racks, instruments, components, and devices provided under this section

B. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Diesel engine data
   a. Manufacturer
   b. Model
   c. Revolutions per minute (RPM)
   d. Rated capacity brake horsepower (BHP)
   e. Make and model of governor
   f. Piston displacement (cubic inches)
   g. Fuel consumption rate in gallons per hour at:
      1) Full load
      2) 3/4 load
      3) 1/2 load
2. Generator data
   a. Manufacturer
   b. Model
   c. Rated kVA
   d. Rated kW
   e. Voltage
   f. Temperature rise above 40°C ambient at rated output with 0.8 power factor
   g. Motor starting capability (skVA) at 30% instantaneous voltage dip (motor starting at 90% rated voltage will not be accepted)
   h. Generator efficiency including excitation losses at:
      1) Full load
      2) 3/4 load
      3) 1/2 load
3. Package data
   a. Overall length, width, and height
   b. Weight of complete skid mounted unit
   c. Exhaust pipe size
   d. Air flow (in cubic feet per minute) of air required for combustion and ventilation
   e. Heat rejection to the atmosphere of the engine and generator in BTU/hr
   f. Cooling air volume required
   g. Emissions certification
   h. Sound data
4. Engine-generator unit and accessories to include:
   a. Enclosure
   b. Accessory sub-panel & transformer
   c. Control panels

d. Voltage regulator
e. Fuel system
f. Exhaust system
g. Batteries
h. Battery charger
i. Jacket water heater

5. Generator fused switch
   a. Catalog data
   b. Short circuit interrupt ratings
   c. Thermal-damage curve for generator
   d. Time-current characteristic curves for generator protective device

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design Calculations: Signed and sealed by a qualified professional engineer registered in the state of Florida.
   a. Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer licensed in the state of Florida. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Sizing calculation: Generator supplier to submit a project specific sizing calculation for engineering review and approval. Loading as shown on the electrical drawings.

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

C. Source quality-control test reports.

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
4. Report of sound generation.
5. Factory EPA Certificate showing compliance with applicable regulations.
6. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control test reports.

E. Warranty: Special warranty specified in this Section.

F. Calculations for generator enclosure signed and sealed by a qualified professional engineer registered in the state of Florida.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. Include the following:

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than (1) hours' normal travel time from Installer's place of business to Project site.
2. Engineering Responsibility: Preparation of data for vibration isolators of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer with a minimum of 25 years' experience building the specified products. The manufacture shall maintain, within 30 miles of Project site, a factory authorized and trained service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with ASME B15.1.

F. Comply with NFPA 37.

G. Comply with NFPA 70.

H. Comply with NFPA 110 requirements for Level 2 legally required power supply system.

I. Comply with UL 2200 (For generator assemblies rated 600V or less)

J. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

K. Sound Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.9 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 25 °C to plus 50 °C.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 3000 feet.

1.10 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.11 WARRANTY

A. Standard Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within two years warranty period.

1. The manufacturer’s standard warranty not less than a period of two (2) years from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Running hours to be limited to 500 hours annually for the system warranty by both the manufacturer and servicing distributor. Submittals received without written warranties as specified will be rejected in their entirety

2. Warranty to include a temporary generator set in the event a warrantable repair will take more than 48 hours. Selling dealer must have a minimum of 100 units in its rental fleet to assure a temporary unit is available if needed. Provide documentation as such

B. Special Warranty: Manufacturer's Extended Service Coverage.

1. The manufacturer’s Extended Service Coverage is provided for 5 year/2500 hours and includes no deductible. Extended Service Coverage provides for 100 percent of usual and customary parts and labor costs for failures due to defects in materials and workmanship to the “as shipped consist” from the factory, excluding filters, fluids, vee belts, hoses, power take-offs, paint, batteries and clutches. Platinum Extended Service Coverage provides for a rental power unit due to unscheduled failures causing unexpected downtime to the customer in excess of 48 hours from the time of diagnoses. All repairs will be performed by factory trained dealer service personnel, and allows for repairer travel and mileage for all repairs up to 8 hours and 320 miles per incident.

1.12 MAINTENANCE SERVICE

A. The engine generator supplier shall maintain 24 hour parts and service capability within 30 Miles of the project site. The distributor shall stock parts as needed to support the generator set package for this specific project. The distributor shall carry sufficient inventory to cover no less than 80% of the parts service within 24 hours and 95% within 48 hours.

B. Initial Maintenance Service: Beginning at Substantial Completion, provide **12** months' full maintenance by certified employees of manufacturer's designated service organization. Include semi-annual exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide a 3,900 kW diesel generator set by Caterpillar Inc. The power system has been designed to the specified manufacturer's electrical and physical characteristics. The equipment sizing, spacing, amounts, electrical wiring, ventilation equipment, fuel, and exhaust components have all been sized and designed around Caterpillar supplied equipment. Should any substitutions be made, the CONTRACTOR shall bear responsibility for the installation, coordination and operation of the system as well as any engineering redesign costs and all liabilities which may result from such substitutions

2.2 ENGINE-GENERATOR SET

A. A new 2017-2018 manufactured, factory-assembled and -tested, engine-generator set.

B. The electric power generating system shall consist of (1) 3,900 kW, 4,875 kVA, 12,605 skVA @ 30% instantaneous voltage dip, 0.8 power factor, 4160 Volts, wye-connected, 3-Phase, 4-wire, 60 hertz generator system. Motor starting at 90% rated sustained voltage will not be accepted. Generator set shall be rated for Standby applications with typical usage of 500 hours per year.

C. Engine power shall not derate up to 50°C at sea level and shall be capable of providing 3,900 kW, at 122°F (50.0°C) and altitude of 3000.0 feet.

D. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

E. Capacities and Characteristics:

1. Power Output Ratings: 3,900 ekW / 4,875.0 kVA
2. Output Connections: 4160 Volt, three-phase, four-wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, plus model and serial number of component.

F. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: Fuel oil, Grade DF-2 ULS type

B. Rated Engine Speed: 1800 RPM

C. Lubrication System: The following items are mounted on engine or base rails:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Lube oil pump
3. Oil level regulator
4. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Engine Fuel System:

1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
3. Provide water separator and secondary fuel filters. Fuel filters shall have isolation valve for changing of filters during engine operation.

E. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity. Heater shall include a circulation pump. Provide isolation valves that allow for change out of the heater without having to drain the entire system

F. Governor: Adjustable isochronous control, with provisions to interface with load share modules and/or remote switchgear. The engine governor shall be an electronic Engine Control Module (ECM) with 24-volt DC Electric Actuator. The ECM shall be enclosed in an environmentally sealed, die-cast aluminum housing which isolates and protects electronic components from moisture and dirt contamination. The ECM shall adjust fuel delivery per exhaust smoke, altitude and cold mode limits. In the event of a DC power loss, the forward acting actuator will move to the minimum fuel position.

G. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame, radiator duct flange and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 100 percent load condition with an ambient temperature of 122°F / 50°C. Radiator shall be capable of providing cooling for an external restriction of 1.0 inch of water column.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

6. Integral fuel oil cooler shall ae provided as required by the OEM.

H. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. Provide a minimum critical grade exhaust silencer with valve condensate drain that extends beyond the depth of the insulation, and of the appropriate size for use with the engine. The silencer shall have inlet and outlets configured as required to meet the project exhaust system design with a 12 inch water column maximum pressure drop. Flexible, full length stainless steel connector/wye shall be furnished as required between the silencer and the engine exhaust outlet(s). The generator set manufacturer shall furnish all appropriate fittings, flanges, etc., as required between the engine and the silencer.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be **85** dBA or less.
3. Mount and insulate the exhaust silencer within the enclosure, and pre-pipe to the generator exhaust stack.

I. Air-Intake Filter: Heavy-duty, dual element, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

J. Starting System: 24 VDC electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Dual Cranking Motor: Dual electric starters that automatically engage and release from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level Type 10 (10 secs).
4. Battery: Oversize (10%) capacity to accommodate starting within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length required for operation on site, and to be field verified by manufacturer’s representative prior to order. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30 and all local codes and regulations required for installation.

B. Above Ground Fuel Oil Tank
1. Responsibility
a. It shall be the responsibility of the manufacturer to assemble the fuel tank at the manufacturing plant
b. Installing contractor shall be responsible for proper installation and testing of tank, field piping, and loose items as listed in shop drawings.
c. Installing contractor shall also coordinate wiring of interconnected devices.
d. The fire-regulating authority having jurisdiction should review all tank installations.
2. Codes Governing Tank Construction and Installation
a. ANSI / UL 142: Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids.
b. ANSI / UL 2085: Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids.
c. NFPA 30: Flammable and Combustible Liquids Code.
d. NFPA 37: Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
e. NFPA 110: Standard for Emergency and Standby Power Systems.
f. Florida Administrative Code.
3. Fuel Tank Labeling Requirements
a. The above ground storage tank shall be listed and labeled as follows:
1) “Manufactured by Phoenix Products, Jacksonville FL, 904-354-1858”
2) “Vehicle and Projectile Impact Resistant”
b. The tank shall bear a UL label indicating the following:
1) Type of product
2) Volume capacity
3) Emergency venting capacity
4) Manufacturer and manufacturing date
c. The fuel fill port shall be labeled with “Fill,” rated capacity, and product.
d. The Diesel tank shall be labeled “No Smoking” and “Combustible” on the corners such that the labels are visible from each side of the tank.

e. The Gas tank shall be labeled “No Smoking” and “Flammable” on the corners such that the labels are visible from each side of the tank.
f. NFPA diamonds shall be supplied and affixed by the installing contractor in accordance with NFPA requirements.
g. Tank fittings shall be labeled using a UL-approved label material denoting the proposed use of each port.

4. Design Criteria
   a. Material Thickness
      1) Primary Tank
         a) Tanks with capacity under 5000 gallons shall be constructed of minimum 3⁄16” ASTM A36 mild steel.
         b) Tanks exceeding 5000 gallons shall be constructed of minimum ¼” ASTM A36 mild steel.
      2) Secondary Tank
         a) Tanks with capacity under 5000 gallons shall be constructed of minimum 10ga ASTM A1011 mild steel.
         b) Tanks exceeding 5000 gallons shall be constructed of minimum ¼” ASTM A36.
   b. Tank Fittings
      1) All tank ports shall be Schedule 40 Type 304 Stainless Steel pipe.
      2) Primary and secondary tanks shall have no penetrations below the fuel level, in accordance with UL 2085 requirements.
      3) Fittings shall include, at a minimum:
         a) Tank fill – 4” MNPT
         b) Fill box drain
         c) Fuel level gauge – 2” MNPT
         d) Primary tank vent – sized per UL 142 requirements (minimum 2”)
         e) Primary emergency vent – sized per UL 142 requirements
         f) Secondary emergency vent – sized per UL 142 requirements
         g) Leak sensor port – 2” MNPT
         h) One spare port – 2” MNPT
         i) Four spare ports – 4” MNPT
         j) One 18” manway (tanks 5000 gallons and over)
   c. UL Testing Requirements
      1) The primary and secondary fuel tanks shall be tested at 3-PSI air pressure as outlined in UL 142.
   d. Tank Construction
      1) Tank Supports
         a) The tank shall include hurricane mounting provisions as an integral, permanent tank component.
         b) Mounting provisions shall allow minimum 2” airspace between concrete slab and secondary tank to facilitate inspection and maintenance of tank bottom.
         c) Mounting supports shall include a neoprene barrier of minimum 3⁄8” thickness to isolate fuel tank from concrete slab.
         d) Each mounting support shall include integral grounding provisions on each end.
         e) Each mounting support shall include 1” diameter mounting holes on each end.
      2) Fire-Rating and Insulating Material

a) The tank annular space shall be filled with a lightweight concrete mixture of minimum 6” nominal thickness.
b) The tank shall carry a two-hour fire rating per the International Building Code.

3) Tank Finish
a) Preparation: Outer tank shall be abrasive blasted per SSPC / SP10.
b) Primer Coat: Outer tank shall be primed with one coat of high-build polyester glassflake primer to a thickness of no less than 12 mils (DFT), color Charcoal Gray.
c) Finish Coat: Outer tank shall be finish coated with aliphatic polyurethane to a thickness of 3-5 mils (DFT), color Phoenix Gray.

e. Overfill Protection
1) Spill Containment Box
a) A spill containment box (UL-approved) shall be provided as an integral tank component and shall carry the same FDEP approval number as the tank.
b) Construction shall be 10-gauge Type 304 stainless steel.
c) The box shall be seal welded to the tank top and factory leak tested for liquid tightness.
d) The box shall be pad-lockable, employing stainless steel hardware and hinges.
e) The box shall be vented to the atmosphere via a vent stack terminating with a cast aluminum mushroom vent.

2) Overfill Prevention Equipment
a) Tank shall be equipped with an overfill prevention valve set to positively shut off fuel flow at 95%. Kamlok tight-fill adaptor with crossbar shall be factory installed in fuel fill fitting. Valve shall include a cast aluminum dust cap. Overfill prevention valve shall carry a valid FDEP approval number.
b) A high-level probe shall be installed at 90% of tank fill capacity. The probe shall carry a valid FDEP approval number.
c) An alarm panel shall be installed at the fill location in clear view of the filler. It shall annunciate high level and tank leak alarms. The alarm panel shall carry a valid FDEP approval number.
d) A mechanical fuel level gauge shall be provided. Gauge shall carry a valid FDEP approval number.

f. Leak Detection
1) A leak sensor probe assembly shall be provided to detect liquid in the tank interstitial and alarm locally. The leak sensor shall carry a valid FDEP approval number.
2) The leak sensor shall be wired to the alarm panel located at the fill location.
3) The leak sensor shall be shipped loose for installation and reconnection by responsible contractor, as tank shall be shipped equipped with vacuum gauge and shutoff valve assembly on leak sensor port.

g. Tank Venting
1) The primary vent assembly shall be shipped loose, for installation by responsible contractor.
2) Primary vent assembly shall consist of a coupling and pipe riser that will terminate 12’ 0” above finished grade and include a waterproof updraft vent cap.

3) An emergency vent shall be provided for the primary and secondary tanks, including a pressure-activated vent cap on each vent fitting.
4) The secondary emergency vent cap shall be shipped loose for installation by the responsible contractor.

5. Tank Warranty
   a. For a period of 30 years from the date of delivery, the tank shall be warranted against failure in material or workmanship that would make the tank unusable for its intended purpose. "Failure" encompasses structural failures such as cracking, breakup, and collapse. The manufacturer shall repair or replace the defective tank during normal working hours if it has remained at its original delivery point and has been used exclusively for gasoline, ethanol, methanol, diesel fuel, fuel oil, and/or waste oil.
6. Breach of Tank Integrity Test (State of Florida Requirement)
   a. Tank shall be shipped from the factory with a vacuum on the secondary tank to ensure integrity of primary and secondary tanks upon arrival at site.
   b. Secondary emergency vent port shall be capped airtight at the factory for vacuum test.
   c. Leak sensor port shall be shipped outfitted with a vacuum gauge / ball valve assembly to conduct vacuum test.
      1) Upon arrive on-site, inspector shall witness the vacuum on the secondary tank, as acceptance of the breach of integrity test per FL Administrative Code Chapter 62-762.
      2) Following inspection, the installing contractor shall release the vacuum on the secondary tank, remove the vacuum gauge / ball valve assembly, install the leak sensor and secondary emergency vent, and reconnect to annunciation panel.

C. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank with return pump. Coordinate other requirements from the latest edition of the JEA Facilities Standard Manual under Fuel System / Tank in this section. Base-mounted fuel oil tank features include the following:

1. Tank level indicator.
2. Capacity: Nominal 10,000 gallons providing thirty-three (33) hours' continuous operation at 100 percent rated power output.
3. Vandal-resistant fill cap.
4. Containment Provisions: Comply with requirements of authorities having jurisdiction.
5. Leak detection and monitoring.

2.5 CONTROL AND MONITORING

A. Provide a fully solid-state, microprocessor based, generator set controller. The control panel shall be designed and built by the engine manufacturer. The controller shall provide all operating, monitoring, and control functions for the generator set. The control panel shall provide real time digital communications to all engine and regulator controls via secure communication network.

B. Mounting:

1. The control panel shall have the option to be mounted on the generator set and include all interconnecting cables and harnesses to allow it to be remotely located within 20 meters of generator set.

C. Environmental

1. The generator set controller shall be tested and certified to the following environmental conditions:

a. -40°C to +70°C Operating Range

b. 100% condensing humidity, 30°C to 60°C

c. IP22 protection for rear of controller; IP55 when installed in control panel

d. 5% salt spray, 48 hours, +38°C, 36.8V system voltage

e. Sinusoidal vibration 4.3G's RMS, 24-1000Hz

f. Electromagnetic Capability (89/336/EEC, 91/368/EEC, 93/44/EEC, 93/68/EEC, BS EN 50081-2, 50082-2)

g. Shock: withstand 15G

D. Functional Requirements: The following functionality shall be integral to the control panel.

1. The control shall include a minimum 33 x 132 pixel, 24mm x 95mm, positive image, transflective LCD display with text based alarm/event descriptions.

2. The control shall include a minimum of 3-line data display

3. Audible horn for alarm and shutdown with horn silence switch

4. Standard ISO labeling

5. Multiple language capability

6. Remote start/stop control

7. Local run/off/auto control integral to system microprocessor

8. Cooldown timer

9. Speed adjust

10. Lamp test

11. Emergency stop push button

12. Voltage adjust

13. Voltage regulator V/Hz slope - adjustable

14. Password protected system programming

E. Digital Monitoring Capability: The controls shall provide the following digital readouts for the engine and generator. All readings shall be indicated in either metric or English units.

1. Engine
    a. Engine oil pressure
    b. Engine oil temperature
    c. Engine coolant temperature
    d. Engine RPM
    e. Battery volts
    f. Engine hours
    g. Engine crank attempt counter
    h. Engine successful start counter
    i. Service maintenance interval
    j. Real time clock
    k. Engine exhaust stack temperature
    l. Engine main bearing temperature
2. Generator
    a. Generator AC volts (Line to Line, Line to Neutral and Average).
    b. Generator AC current (Avg and Per Phase).
    c. Generator AC Frequency
    d. Generator kW (Total and Per Phase).
    e. Generator kVA (Total and Per Phase).
    f. Generator kVAR (Total and Per Phase).
    g. Power Factor (Avg and Per Phase).
    h. Total kW-hr
    i. Total kVAR-hr
    j. % kW
    k. % kVA
    l. % kVAR
    m. Generator bearing temperature
    n. Generator stator winding temperature
    o. Real (kW. Load Histogram – which tracks time that the generator kW is within predefined ranges)

3. Voltage Regulation

a. Excitation voltage

b. Excitation current

F. Alarms and Shutdowns: The control shall monitor and provide alarm indication and subsequent shutdown for the following conditions. All alarms and shutdowns are accompanied by a time, date, and engine hour stamp that are stored by the control panel for first and last occurrence:

1. Engine Alarm/Shutdown

a. Low oil pressure alarm/shutdown

b. High coolant temperature alarm/shutdown

c. Loss of coolant shutdown

d. Overspeed shutdown

e. Overcrank shutdown

f. Emergency stop shutdown

g. Low coolant temperature alarm

h. Low battery voltage alarm

i. High battery voltage alarm

j. Control switch not in auto position alarm

k. Battery charger failure alarm

l. ATS remote start wiring failure

2. Generator Alarm/Shutdown

a. Generator phase sequence

b. Generator over voltage

c. Generator under voltage

d. Generator over frequency

e. Generator under frequency

f. Generator reverse power (real and reactive.

g. Generator overcurrent (including inverse definite minimum time. for Normally Inverse, Very Inverse, Extremely Inverse conditions as well as those based on Thermal Damage Curve configurations

h. Generator current balance

3. Voltage Regulator Alarm/Shutdown

a. Loss of excitation alarm/shutdown

b. Instantaneous over excitation alarm/shutdown

c. Time over excitation alarm/shutdown

d. Rotating diode failure

e. Loss of sensing

f. Loss of PMG

G. Inputs and Outputs

1. Programmable Digital Inputs. The Controller shall include the ability to accept programmable digital input signals. The signals may be programmed for either high or low activation using programmable Normally Open or Normally Closed contacts.

2. Programmable Relay Outputs. The control shall include the ability to operate programmable relay output signals, integral to the controller. The output relays shall be rated for 2A @ 30VDC and consist of six (6) Form A (Normally Open) contacts and two (2) Form C (Normally Open & Normally Closed) contacts.

3. Programmable Discrete Outputs. The control shall include the ability to operate two (2) discrete outputs, integral to the controller, which are capable of sinking up to 300mA per input.

4. Integrated PLC Functionality. The panel shall allow the operator to create custom logic functions to provide additional user defined control of the generator set operation.

H. Accessibility and Maintenance

1. All engine, voltage regulator, control panel and accessory units shall be accessible through a single electronic service tool. The following maintenance functionality shall be integral to the generator set control:

a. Engine running hours display

b. Service maintenance interval (running hours or calendar days)

c. Engine crank attempt counter

d. Engine successful starts counter

e. 40 events are stored in control panel memory

f. Programmable cycle timer that starts and runs the generator for a predetermined time. The timer shall use 7 user-programmable sequences that are repeated in a 7-day cycle. Each sequence shall have the following programmable set points:

1) Day of week

2) Time of day to start

3) Duration of cycle

I. Remote Communications

1. Remote Communications. The control shall include Modbus RTU communications as standard via RS-485 half duplex with configurable baud rates from 2.4k to 57.6k.

2. Remote Monitoring Software. The control shall provide Monitoring Software with the following functionality

a. Monitor up to eight (8) generator sets, plus Cat automatic transfer switches.

b. Provide access to all date and events on generator set communications network

c. Provide remote control capability for the generator set(s)

d. Ability to communicate via Modbus RTU or remote modem

J. Local and Remote Annunciation

1. Local Annunciator (NFPA 99/110, CSA 282). Provide a local, control panel mounted, annunciator to meet the requirements of NFPA 110, Level 1.

a. Annunciators shall be networked directly to the generator set control

b. Local Annunciator shall include a lamp test pushbutton, alarm horn and alarm acknowledge pushbutton

c. Provide the following individual light indications for protection and diagnostics:

1) Overcrank

2) Low coolant temperature

3) High coolant temperature warning

4) High coolant temperature shutdown

5) Low oil pressure warning

6) Low oil pressure shutdown

7) Overspeed

8) Low coolant level

9) EPS supplying load

10) Control switch not in auto

11) High battery voltage

12) Low battery voltage

13) Battery charger AC failure

14) Emergency stop

15) ATS Remote Start wiring failure

16) Spare

2. Remote Annunciator (NFPA 99/110, CSA 282). Provide a remote annunciator to meet the requirements of NFPA 110, Level 1.

a. The annunciator shall provide remote annunciation of all points stated above and shall incorporate ring-back capability so that after silencing the initial alarm, any subsequent alarms will sound the horn. Ability to be located up to 4000 ft from the generator set without the use of a data repeater.

K. Telematics and Data Monitoring

1. There shall be a monitoring and data management system available on a 24/7/365 basis, which interfaces with the asset (generator set, switchgear, etc.) via a serial and/or direct I/O connection.

a. The system shall monitor the asset continually.

1) It will provide automated alarm notification via alphanumeric pager, cellular phone and/or e-mail. These alarms will also be displayed by a web-based system which will be updated automatically.

2) Asset functions being monitored will be displayed by a web-based system which will be updated automatically.

3) Standard reports which can be created by the user from the web-based system shall include:

a) Site Run Summary report that shows key items associated with generator set runs including the start/stop time and the run duration all within a user defined timeframe.

b) Alarm History report that shows a table listing alarms/events, their change in status, time-stamped within a user defined timeframe.

2. The web-based software shall be secure, requiring a registered user name and password structure for access.

3. The system will allow for the aggregation of multiple assets and/or sites to be viewed on one display and/or report.

4. General operations assistance shall be available 24/7/365, by trained personnel via a direct toll-free phone call.

5. All data from site shall be uploaded to a centralized database.

a. The centralized database shall be capable of storage and on-line access of data for at least 13 months.

b. The centralized database shall have a hot backup to ensure access to data is not lost and that Operations Center function may continue in the event of a server outage.

6. The system will offer the user the option of having alarms and/or events handled by trained Operations Center personnel on a 24/7/365 basis. The trained Operations Center personnel shall follow a user-defined procedure for handling alarms and/or events.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Metal-clad, fixed, medium voltage vacuum breaker with basic LSIG protection; complying with ANSI C37.04 and C37.09. Circuit breaker shall be generator enclosure mounted with maximum dimensions of 22" W x 20" D x 27" H.

1. Tripping Characteristics: LSIG; Adjustable long-time and short-time delay, instantaneous, and ground-fault.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Integrated gen-set enclosure mounted. Cable entry and conduit routing to be coordinated with generator enclosure.

B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

C. Ground-Fault Indication: Comply with NFPA 70 signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H insulation. Windings shall be of the form wound type. Temperature rise shall not exceed 105°C over 40°C ambient temperature. Alternator shall be model SR5/3066.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Drip proof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: 12 percent, maximum.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 150 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools.

B. Description: Prefabricated or pre-engineered walk-in enclosure with the following features:

1. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.
   a. The complete engine-generator set shall be enclosed in a modular, walk-in type, weatherproof enclosure. The enclosure shall provide 6 ft. minimum head clearance and 24 inches minimum walk around clearance on sides not including radiator. The enclosure will consist of two sidewalls, two end walls, louvers, and roof. Minimum distance from engine-generator and generator to end wall shall not be less than 3’-0” for walk in type enclosures.
   b. The enclosure shall be made of anodized marine grade aluminum white panels. Doors shall be lockable by padlock with stainless steel hardware for access to the engine-generator, controls and accessories. Doors shall also provide easy accessibility for maintenance. Enclosures shall be polished. Supplier will remove all advertising and labels on the exterior of any enclosure. Drop over type enclosures shall have a rubber gasket under it with a rubber cement type adhesive to keep gasket in place to prevent water intrusion into enclosure as well as keep engine fluids from leaking out.
   c. The enclosure shall be constructed of removable side panels and end panels. All fasteners and hardware used in construction of the enclosure shall be stainless steel. The enclosure shall be braced as necessary to support the silencer and designed to withstand 150-mph wind without damage. All bracing and reinforcing members shall be integral to the enclosure. Roof penetrations for the installation of the silencer shall have a gasket to prevent the entrance of rain. The unit shall have

continuous hinged side doors each side and continuous hinged doors at control end, equipped with pad lockable hardware for ease of engine maintenance and a three-point latch system. Doors shall be a minimum of 36". There shall be an expanded metal grating or a punched louvered radiator core guard installed - flush with the enclosure panels in front for the radiator grill, and fixed, punched louvered air intake ports on the enclosure sides and rear for proper air circulation within the housing provide lifting eyes and spreader bar reinforcement for crane unloading. A stainless steel handle mounted at the control panel entry door.

d. The louvers shall be screened from the inside to prevent the entry of insects. The enclosure shall have all penetrations gasketed or sealed to prevent the entry of rodents. "Rain Resistant" louvers, as manufactured by Ruskin or Cesco, vertical air turning plenums, or equal shall be provided to prevent the entrance of rain when the unit is operating and the wind direction is at 90 degrees to the air intake at 120 mph. The entire enclosure, except for the louvered openings, shall be provided with noise suppression insulation mechanically secured and fastened.

e. The enclosure shall be provided with noise suppression insulation and air plenums designed to provide a sound level of mechanical noise of 86 dB (A) at 15 feet from any point of the enclosure Minimum of two LED luminaires, light switches, prewired distribution circuits, power panel, and duplex receptacles shall be conveniently provided in the enclosure. The light switch and receptacles shall be provided near generator control panel. Provisions shall be made for mounting batteries and rack inside the enclosure. The generator breaker, generator control panel, load center for lights, jacket water heater, etc., batteries and accessories shall be located in the enclosure. Engine- generator supplier shall provide and install a 480/208V step-down transformer adequately sized to handle all enclosure loads from service voltage. Transformer shall be feed with circuit as indicated and with line side disconnecting means located inside the enclosure. Alternate to a transformer and load center, is a mini power zone with integral transformer and load center.

f. All engine oil and coolant drains shall be pipe to outside of enclosure with shutoff valves and shall have threaded stainless steel or aluminum caps. The threaded drain lines shall be labeled on the outside of the enclosure with an aluminum label with aluminum or stainless rivets.

2. Manufacturer: Enclosure shall be Phoenix Products, Advanced Manufacturing & Power Systems Inc., or Fidelity Manufacturing.

3. Exhaust Silencer: Complete exhaust system including a stainless steel exhaust silencer, all-stainless steel piping, all-stainless expansion joints and accessories as required for a complete operating system. The exhaust silencer shall be chamber type, of all-welded Type 304L stainless steel construction with all stainless steel hardware and fasteners.

   a. The silencer shall be of the side inlet type
   b. Secured in position at no less than (4) points
   c. The silencer shall be supported by a welded stainless angle iron cradle; silencer shall be bolted or strapped to cradle and then bolted to the roof support members mounted inside the roof to the enclosure for a horizontal mounting on top of the enclosure.
   d. The silencer shall be sized so that the backpressure at rated capacity of the engine does not exceed one half the supplier's maximum allowable backpressure. The silencer shall be suitable for critical type silencing and shall be a Maxim "Model M51" or equal.

e. All exhaust piping shall be Type 304L, Schedule 10S stainless steel, and the exhaust shall discharge horizontally at the silencer outlet, with 45 degree bevel cut with a stainless expanded metal bird screen.
f. The intake of the silencer shall connect to the flexible exhaust connection by stainless steel pipe. Size as required by engine manufacturer. A flexible stainless steel exhaust adapter, 18 inch minimum length, shall be furnished for mounting between the engine and silencer. The flexible exhaust connection as specified shall mount directly on exhaust manifold and shall be mounted so that no weight is exerted on the manifold at any time.

4. Instrument Transformers: Mounted within enclosure
   a. Current Transformers: Current Transformer mechanical and thermal limits shall be coordinated with the momentary and short time ratings of the switching device with which JEA utilizes. The thermal ratings shall be based on a short-circuit duration of 1 second or greater. The minimum current transformer accuracy rating shall be C200.
   b. Voltage Transformers: Voltage Transformer shall have a rating of not less than 500 Volt-Amperes on a thermal basis and a capability of withstanding a secondary short-circuit for not less than 1 second. Each transformer shall be provided primary and secondary fuses. The primary fuses shall be adequately rated for the transformer inrush and load current, and they shall have an interrupting capacity equal to or greater than the maximum short-circuit momentary current rating required. The connections from the main buses to primary of the voltage transformer shall be capable of carrying the rated short-circuit current for a minimum of 1 second.

2.9 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer. Provide owner color selection chart

2.11 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Provide 30 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch.

D. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel

piping materials and installation requirements are specified in Division 23 Section "Facility Fuel-Oil Piping."

1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section " Facility Fuel-Oil Piping."

E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted. Electrical wiring includes but is not limited to battery chargers, heaters, control power, grounding, remote annunciator panels, etc. Contractor to include as part of their scope of work, wall wiring and empty conduit indicated on contract drawings, specified herein, indicated/noted on approved manufacturers shop drawings and as required to provide a fully functional system.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine-generator set and with single braid corrosion resistant type 302 stainless steel wire braid and compression fittings.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Connect fuel piping to engines with a gate valve and union and flexible connector. Provide all required fire safe-off and solenoid valves.

F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

A. Identify system components according to Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Field Testing: If factory service technicians cannot provide the field testing specified as part of manufacturer’s start-up, this contractor shall engage a qualified factory certified and authorized testing agency to perform tests and inspections and prepare test reports required by manufacturer.

B. Manufacturer's Field Service: Contractor to include field services of factory-authorized service representatives to provide start-up testing as well as to assist in 3rd party system commissioning as specified under the system commissioning specifications. Testing will not be concurrent so multiple travel days shall be included as per the approved schedule.

C. Perform tests and inspections and prepare test reports.

D. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria to confirm adherence to EPA Tier rating.
8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
11. “Pull the Plug Test”: Automatic start-up by means of simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper system coordination. Engine coolant temperature, oil pressure, and battery charge level along with generator set voltage, amperes, and frequency shall be monitored throughout the test.

E. Coordinate tests with tests for transfer equipment and run them concurrently.

F. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

G. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

H. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

I. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

J. Remove and replace malfunctioning units and retest as specified above.

K. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

L. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generator. Schedule at least 8 hours for this training.

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SECTION 31 20 00

EARTHWORK

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, equipment and materials required to complete all work associated with excavation, including off-site borrow excavation, dewatering, backfill, drainage layers beneath and around structures, foundation and backfill stone, filter fabric, embankments, stockpiling topsoil and any excess suitable material in designated areas, in place compaction of embankments, backfill and subgrades beneath foundations and roadways, excavation support, disposing from the site all unsuitable materials, providing erosion and sedimentation control grading, site grading and preparation of pavement and structure subgrade, and other related and incidental work as required to complete the work shown on the Drawings and specified herein.

B. All excavations shall be in conformity with the lines, grades, and cross sections shown on the Drawings or established by the Engineer.

C. It is the intent of this Specification that the Contractor conduct the construction activities in such a manner that erosion of disturbed areas and off-site sedimentation be absolutely minimized.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced Specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Florida Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.

2. City Standard Details for City of Jacksonville, latest edition.

3. American Society for Testing and Materials (ASTM):

ASTM C 127	Test for Specific Gravity and Absorption of Coarse Aggregate.
ASTM C 136	Test for Sieve Analysis of Fine and Coarse Aggregates.
ASTM D 422	Particle Size Analysis of Soils.
ASTM D 423	Test for Liquid Limit of Soils.
ASTM D 424	Test for Plastic Limit and Plasticity Index of Soils.
ASTM C 535	Test for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
ASTM D 698	Standard Method of Test for the Moisture - Density Relations of Soils Using a 5.5 lb. (2.5 kg) Rammer and a 12-inch (305 mm) Drop.

ASTM D1556	Test for Density of Soil in Place by the Sand-Cone Method.
ASTM D1557	Test for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lbs. (4.5 kg) Rammer and 18-inch (457 mm) Drop.
ASTM D2049	Test Method for Relative Density of Cohesionless Soils.
ASTM D2167	Test for Density of Soil in Place by the Rubber-Balloon Method.
ASTM D2216	Test for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures.
ASTM D2487	Test for Classification of Soils for Engineering Purposes.
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 SUBSURFACE CONDITIONS

A. A separate geotechnical report is included in an Appendix as a reference for information purposes only. The report identifies properties below grade and also offer recommendations for foundation design, primarily for use of the Engineer. The recommendations shall not be construed as requirements of the Contract unless specifically referenced by the Contract Documents.

B. JEA and/or the Engineer will not assume responsibility for variations of sub-soil quality or conditions at locations other than places shown and at the time the geotechnical investigation was made. The Contractor shall examine the site and review the available geotechnical boring logs or undertake its own subsurface investigation prior to submitting his bid, taking into consideration all conditions that may affect his work.

C. The Contractor shall satisfy himself as to the character and amount of different soil materials, groundwater and the subsurface conditions to be encountered in the work to be performed. Information and data, when furnished, are for the Contractor's general information. However, it is expressly understood that any interpretation or conclusion drawn there from is totally the responsibility of the Contractor. Engineer and JEA assume no liability for the accurateness of the data reported.

D. Attention is directed to the fact that there may be water pipes, storm drains and other utilities located in the area of proposed excavation. Locate existing underground utilities in areas of work. Test pits and hand excavation in critical areas will be required prior to initiating work. Perform all repairs to same in the event that excavation activities disrupt service.

E. All existing utilities including piping, electrical conduits, electrical duct banks and telephone cables that are shown on the Contract Documents to be relocated, shall be relocated prior to initiating earthwork. The Contractor shall coordinate relocation of utilities with utility companies having jurisdiction in the area. Should unknown or incorrectly identified piping or other utilities be encountered during excavation, the Contractor shall consult JEA and the Engineer immediately for directions.

F. The Contractor shall cooperate with JEA and utility companies in keeping respective services and facilities in operation.

1.4 SUBMITTALS

A. In accordance with the procedures and requirements set forth in JEA bid documents. The Contractor shall submit the following:

1. Name and location of all material suppliers.

2. Certificate of compliance with the standards specified above for each source of each material.

3. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.

4. Plans and cross sections of open cut excavations showing side slopes and limits of the excavation at grade.

5. Construction drawings and structural calculations for any types of excavation support required. Drawings and calculations shall be signed and sealed by a currently registered Professional Engineer in the State of Florida.

6. Monitoring plan and pre-construction condition inspection and documentation of all adjacent structures, utilities, and roadways near proposed installation of excavation support systems.

7. Dewatering procedures: The Contractor shall submit his proposed methods of managing storm and subsurface water. Methods shall be acceptable to the JEA before starting excavation. The plan should include both narrative and pictorial information clearly showing how storm and subsurface waters will be accumulated and disposed. The drawings shall include a sufficient number of detailed sections to clearly illustrate the Scope of Work. The drawings showing all of the above information, including calculations, shall be prepared by a qualified Professional Engineer registered in the State of Florida, and shall bear its seal and signature. Prior to any discharge of groundwater (dewatering) from construction activities associated with this project to waters of the state (including but not limited to, wetlands, swales, and municipal storm sewers), the Contractor must submit a Notice of Intent (NOI) to Use the Generic Permit for Discharge of Ground Water and Dewatering Operations if required by regulatory agencies, including but not limited to the St. Johns River Water Management District (SJRWMD). See 3.8 for additional information.

8. The Contractor shall notify the Engineer of the off-site sources of structural fill and submit to the Engineer a representative sample weighing approximately 50 lbs. The sample shall be delivered to a designated location on site.

9. Prior to any earthwork, the Contractor shall submit a sieve analysis of the proposed structural fill to Engineer for review and approval.

10. The Contractor shall not place any foundation reinforcement steel until excavations have been tested for compaction.

11. Samples of synthetic filter fabric and reinforced plastic membrane with manufacturer's certificates or catalog cuts stating the mechanical and physical properties. Samples shall be at least one (1) foot wide and four (4) feet long taken across the roll with the warp direction appropriately marked.

1.5 QUALITY CONTROL

A. All soils testing shall be performed by an independent testing laboratory retained by JEA. The Contractor shall schedule his Work so as to permit a reasonable time for testing before placing succeeding lifts of backfill and shall keep the laboratory informed of his progress. In the event any test shows the work is not in conformance with these Contract Documents, the cost of any subsequent testing to show conformance shall be borne by the Contractor. All test results shall be sent directly to the Engineer and JEA. All testing invoices shall be sent directly to JEA.

1.6 PRODUCT HANDLING

A. Soil and rock material shall be excavated, transported, placed, and stored in a manner so as to prevent contamination, segregation and excessive wetting. Materials which have become contaminated or segregated will not be permitted in the performance of the work and shall be removed from the site.

1.7 GROUNDWATER

A. The Contractor shall be responsible for anticipating groundwater conditions and shall provide positive control measures as required. Such measures shall ensure construction in the dry, stability of excavations, groundwater pressure control, prevention of tanks, pipes, and other structures from being lifted by hydrostatic pressures, and avoiding the disturbance of subgrade bearing materials.

1.8 USE OF EXPLOSIVES

A. The use of explosives for excavation work is strictly prohibited on this project.

1.9 PROTECTION OF PROPERTY AND STRUCTURES

A. The Contractor shall, at his own expense, sustain in place and protect from direct or indirect injury, all pipes, poles, conduits, walls, buildings, and all other structures, utilities, and property in the vicinity of his work. Such sustaining shall be done by the Contractor. The Contractor shall take all risks attending the presence of proximity of pipes, poles, conduits, walls, buildings, and all other structures, utilities, and property in the vicinity of his work. He shall be responsible for all damage, and assume all expenses, for direct or indirect injury and damage, caused by his work, to any such pipe, structures, etc., or to any person or property, by reason of injury to them, whether or not such structures, etc., are shown on the Drawings.

PART 2 -- PRODUCTS

2.1 SELECT FILL

A. Soils from the excavations meeting requirements stipulated herein with the exceptions of topsoil and organic material may be used as select fill for backfilling, constructing embankments,

reconstructing existing embankments, and as structural subgrade support. All fill material used for embankment construction shall be provided by the Contractor from any excess suitable on-site material or from off site sources, all subject to review by the Engineer prior to use. The Contractor must determine the volume of material required for the site.

B. Select fill used for embankment construction shall be noncohesive, nonplastic, granular mixture of local sand and limerock, shall be free from vegetation, organic material or muck, and shall contain not more than 8 percent material by weight which passes the No. 200 sieve. Broken concrete shall not be used in the fill. Fill material for embankment construction containing limerock shall have sufficient sand to fill the voids in the limerock, and no individual rocks or pieces or hard material that will not pass a 6-inch diameter ring shall be used in the fill; except that the upper 4-inches of all backfill or fills shall not contain any rock or hard material that will not pass a 3-inch diameter ring.

C. Select fill used for backfilling shall either be material as described in Paragraph B or a granular soil material with a maximum Plasticity Index (PI) of 6. Backfill against walls shall not contain any rock larger than ½-inches.

D. Select fill used under structures (structural fill) shall be furnished from off-site or on-site sources as required. Structural fill shall be clean sand or sand and rock free from vegetation, organic material, muck, or other deleterious matter. Structural fill shall be non-plastic soil having less than 12 percent material passing the No. 200 sieve and containing less than 4 percent organic material. All rock shall pass through a 6-inch diameter ring. Broken Portland cement or asphaltic concrete will not be considered an acceptable fill material. Unsuitable Fill Material: Classified as A-2-4, A-2-5, A-2-6, A-2-7, A-4, A-5, A-6, A-7, and A-8 in accordance with AASHTO Designation M 145. Peat and other highly organic soils are also unsuitable as structural fill.

E. Regardless of material used as select fill, materials shall be compacted at a moisture content satisfactory to the Engineer, which shall be approximately that required to produce the maximum density except that the moisture content shall not be more than 2% below nor more than 2% above the optimum moisture content for the particular material tested in accordance with the ASTM D1557.

F. Where excavated material does not meet requirements for select fill, Contractor shall furnish off-site borrow material meeting the specified requirements herein.

2.2 CLEAN SAND

A. Clean sand for use in backfilling shall be furnished from off-site or on-site sources as required. Material shall be clean sand free from vegetation, organic material, muck, or other deleterious material. Not more than 10 percent by weight shall pass the No. 200 sieve and shall have a classification of A-3 in accordance with AASHTO Designation M 145.

2.3 TOPSOIL

A. Topsoil shall be considered the surface layer of soil and sod, suitable for use in seeding and planting. It shall contain no mixture of refuse or any material toxic to plant growth.

PART 3 -- EXECUTION

3.1 STRIPPING OF TOPSOIL

A. In all areas to be excavated, filled, paved, or graveled, the topsoil shall be stripped to its full depth and shall be deposited in storage piles on the site, at locations designated by the Engineer, for subsequent reuse. Remove all tree stumps, concentration of roots, construction materials and other deleterious materials. Topsoil shall be kept separated from other excavated materials and shall be piled free of roots and other undesirable materials. Stripping of topsoil shall be carried to at least 5 feet beyond the footprint of proposed structures and paved areas.

3.2 EXCAVATION

A. Highly organic soils (peat or muck), weak silty materials, asphalt and concrete shall be removed from all foundation areas. In addition, all sandy silt zones shall be completely removed from mat foundation areas. Unsuitable material within structure footprints shall be over-excavated and backfilled with structural fill.

B. Excavations shall be carried 5-feet outside slab or footing limits or by one foot for each foot excavated below the bearing grade of the mat or footing, whichever is less, unless noted otherwise.

C. All material excavated, regardless of its nature or composition, shall be classified as UNCLASSIFIED EXCAVATION. Excavation shall include the removal of all soil, rock, weathered rock, rocks of all types, boulders, conduits, pipe, and all other obstacles encountered and shown to be removed within the limits of excavation shown on the Drawings or specified herein. The cost of excavation shall be included in the Lump Sum Bid Price and no additional payment will be made for the removal of obstacles encountered within the excavation limits shown on the Drawings and specified herein.

D. All suitable material removed in the excavation shall be used as far as practicable in the formation of embankments, subgrades, and shoulders, and at such other places as may be indicated on the Drawings or indicated by JEA. No excavated material shall be wasted except as may be permitted by JEA. The Contractor shall furnish off-site disposal areas for the unsuitable material and shall dispose of unsuitable material at such areas. Where suitable materials containing excessive moisture are encountered above grade in cuts, the Contractor shall construct above grade ditch drains prior to the excavation of the cut material when in the opinion of the Engineer such measures are necessary to provide proper construction.

E. All excavations shall be made in the dry and in such a manner and to such widths as will give ample room for properly constructing and inspecting the structures and/or piping they are to contain and for such excavation support, pumping and drainage as may be required. Excavation shall be made in accordance with the grades and details shown on the Drawings and as specified herein.

F. Excavation slopes shall be flat enough to avoid slides that will cause disturbance of the subgrade or damage of adjacent areas. Excavation requirements and slopes shall be as indicated in the Drawings or as specified herein. The Contractor shall intercept and collect surface runoff both at the top and bottom of cut slopes. The intersection of slopes with natural ground surfaces, including the beginning and ending of cut slopes, shall be uniformly rounded as shown on the Drawings or as may be indicated by JEA. Concurrent with the excavation of cuts the Contractor

shall construct intercepting berm ditches or earth berms along and on top of the cut slopes at locations shown on the Drawings or designated by JEA. All slopes shall be finished to reasonably uniform surfaces acceptable for seeding and mulching operations. No rock or boulders shall be left in place which protrude more than 1 foot within the typical section cut slope lines, and all rock cuts shall be cleaned of loose and overhanging material. All protruding roots and other objectionable vegetation shall be removed from slopes. The Contractor shall be required to submit plans of open-cut excavation for review by the Engineer before approval is given to proceed.

G. The bottom of all excavations for structures and pipes shall be examined by JEA for bearing value and the presence of unsuitable material. If, in the opinion of JEA, additional excavation is required due to the low bearing value of the subgrade material, or if the in-place soils are soft, yielding, pumping and wet, the Contractor shall remove such material to the required width and depth and replace it with thoroughly compacted select fill, and/or crushed stone or screened gravel as indicated by JEA. No payment will be made for subgrade disturbance caused by inadequate dewatering or improper construction methods.

H. All cuts shall be brought to the grade and cross section shown on the Drawings, or established by JEA, prior to final inspection and acceptance by JEA.

I. Slides and overbreaks which occur due to negligence, carelessness or improper construction techniques on the part of the Contractor shall be removed and disposed of by the Contractor as indicated by JEA at no additional cost to JEA. If grading operations are suspended for any reason whatsoever, partially completed cut and fill slopes shall be brought to the required slope and the work of seeding and mulching or other required erosion and sedimentation control operations shall be performed.

J. Where the excavation exposes sludge, sludge contaminated soil or other odorous materials, the Contractor shall cover such material at the end of each workday with a minimum of 6-inches and a maximum of 24-inches of clean fill. The work shall be an odor abatement measure and the material shall be placed to the depth deemed satisfactory by JEA for this purpose.

K. The Contractor shall ensure that its excavation work does not adversely affect the bearing capacity of the structural subsurface. Also, the Contractor shall proceed with foundation work immediately after excavation work and as expeditiously as possible so as to minimize any potential for subsurface disturbance due to environmental factors, adverse weather, etc. The Contractor shall also take all necessary precautions to protect its work from potential adverse impacts. Where excavated areas are disturbed by subsequent operations or adverse weather, scarify surface, reshape, fill as required and compact to required density.

3.4 UNAUTHORIZED EXCAVATION

A. Excavation Work carried outside of the Work limits required by the Contract Documents shall be at the Contractor's expense, and shall be backfilled by the Contractor at his own expense with suitable material, as directed by the Engineer. Where, in the judgment of the Engineer, such over-excavation requires use of lean concrete or crushed stone, the Contractor, at his expense shall furnish and place such materials.

3.5 EXCAVATION SUPPORT

A. The Contractor shall furnish, place, and maintain such excavation support which may be required to support sides of excavation or to protect pipes and structures from possible damage and to provide safe working conditions. Excavation for deep structures shall be sufficient to provide a clearance between their outer surfaces and the face of the excavation, excavation support, or bracing, of not less than 3 feet. Materials encountered in the excavation which have a tendency to slough or flow into the excavation, undermine the bank, weaken the overlying strata, or are otherwise rendered unstable by the excavation operation shall be retained by an excavation support, stabilization, grouting or other acceptable methods. If JEA is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports put in at the expense of the Contractor. The Contractor shall be responsible for the adequacy of all supports used and for all damage resulting from failure of support system or from placing, maintaining and removing it.

B. Selection of and design of any proposed excavation support systems is exclusively the responsibility of the Contractor. Excavation support shall comply with all applicable OSHA requirements. Contractor shall submit drawings and calculations on proposed systems sealed by a Professional Engineer currently registered in the State of Florida.

C. The Contractor shall exercise caution in the installation and removal of supports to insure that excessive or unusual loadings are not transmitted to any new or existing structure. The Contractor shall promptly repair at his expense any and all damage that can be reasonably attributed to installation or removal of excavation support system.

D. Contractor shall monitor movement in the excavation support systems as well as movement at adjacent structures, utilities and roadways near excavation supports. Contractor shall submit a monitoring plan developed by the excavation support design engineer. All pre-construction condition assessment and documentation of adjacent structures on-site and off-site shall be performed by the Contractor. If any sign of distress such as cracking or movement occurs in any adjacent structure, utility or roadway during installation of supports, subsequent excavation, service period of supports, subsequent backfill and construction, or removal of supports, Engineer shall be notified immediately. Contractor shall be exclusively responsible for any damage to any roadway, structure, utility, pipes, etc. both on-site and off-site, as a result of his operations.

E. All excavation supports shall be removed upon completion of the work except as indicated herein. JEA may permit supports to be left in place at the request and expense of the Contractor. Any excavation supports left in place shall be cut off at least two (2) feet below the finished ground surface or as directed by JEA.

3.6 PROTECTION OF SUBGRADE

A. To minimize the disturbance of bearing materials and provide a firm foundation, the Contractor shall comply with the following requirements:

1. Use of heavy rubber-tired construction equipment shall not be permitted on the final subgrade unless it can be demonstrated that drawdown of groundwater throughout the entire area of the structure is at least 3 feet below the bottom of the excavation (subgrade). Even then, the use of such equipment shall be prohibited should subgrade disturbance result from concentrated wheel loads.

2. Subgrade soils disturbed through the operations of the Contractor shall be excavated and replaced with compacted select fill or crushed stone at the Contractor's expense as indicated by the Engineer.

3. The Contractor shall provide positive protection against penetration of frost into materials below the bearing level during work in winter months. This protection can consist of a temporary blanket of straw or salt hay covered with a plastic membrane or other acceptable means.

3.7 PROOFROLLING

A. The subgrade of all structures and all areas that will support pavements or select fill shall be proofrolled. After stripping of topsoil, excavation to subgrade and prior to placement of fills, the exposed subgrade shall be carefully inspected by probing and testing as needed. Any topsoil or other organic material still in place, frozen, wet, soft, or loose soil, and other undesirable materials shall be removed. The exposed subgrade shall be proofrolled to check for pockets of soft material hidden beneath a thin crust of better soil or until no further vertical settlement of the surface is visually discernable. Any unsuitable materials thus exposed shall be removed and replaced with an approved compacted material. Vibratory rollers for proofrolling shall not be used within 50 feet of existing structures. Within 50 feet of existing structures, proofrolling shall be performed with a track-mounted bulldozer or a vibratory roller operating in the static mode. Any unsuitable materials thus exposed shall be removed and replaced with select fill. Groundwater shall be maintained at least 30 inches below the work area.

3.8 DEWATERING

A. The Contractor shall do all dewatering as required for the completion of the work. Procedures for dewatering proposed by the Contractor shall be submitted to JEA for review prior to any earthwork operations. Disposal of water to any surface water body will require silt screens. All water removed by dewatering operations shall be disposed of in accordance with the Florida Air and Water Pollution Control Act. The Contractor is responsible for obtaining any dewatering permits as required by regulatory agencies. The means and methods of dewatering the excavation shall comply with all regulatory requirements for temporary diversion of groundwater and its discharge (including SJRWMD Consumptive Use Permitting and FAC Chapter 62-621 “General Permit for the Discharge of Produced Ground Water from Any Non-contaminated Site Activity”). The cost associated with excavation dewatering is to be included in all items of work requiring same.

B. The dewatering system shall be of sufficient size and capacity as required to control groundwater or seepage to permit proper excavation operations, embankment construction and reconstruction, subgrade preparation, and to allow concrete to be placed in a dry condition except where authorized tremie concrete construction work is shown or permitted. The system shall include a sump system or other equipment, appurtenances and other related earthwork necessary for the required control of water, and shall include automatic starting devices and standby pumps that will ensure continuous dewatering in the event of an outage of one or more pumps. The Contractor shall drawdown groundwater to at least 3 feet below the bottom of excavations (subgrade) at all times in order to maintain a dry and undisturbed condition. The groundwater level shall be controlled so as to permit the placing and curing of concrete and the maintenance of supporting foundations and adjacent work and structures. The Contractor is fully responsible for protecting structures from flotation until final acceptance of the work.

C. The Contractor shall control, by acceptable means, all water regardless of source. Water shall be controlled and its disposal provided for at each berm, structure, etc. The entire periphery of the excavation areas shall be ditched and diked to prevent water from entering the excavation. The Contractor shall be fully responsible for disposal of the water and shall provide all necessary means at no additional expense to JEA. The Contractor shall be solely responsible for proper design, installation, proper operation, maintenance, and any failure of any component of the system. If at any point during the dewatering operation it is determined that fine material is being removed from the excavation sidewalls, the dewatering operation shall be stopped if acceptable to the Engineer. If any of the subgrade or underlying material is disturbed by movement of groundwater, surface water, or any other reason, it shall be replaced at the Contractor's expense with crushed stone or gravel.

D. The Contractor shall be responsible for and shall repair without cost to JEA, any damage to work in place and the excavation, including damage to the bottom due to heave and including removal of material and pumping out of the excavated area. The Contractor shall be responsible for damages to any other area or structure caused by his failure to maintain and operate the dewatering system proposed and installed by the Contractor.

E. The Contractor shall take all the steps that he considers necessary to familiarize himself with the surface and subsurface site conditions, and shall obtain the data that is required to analyze the water and soil environment at the site and to assure that the materials used for the dewatering systems will not erode, deteriorate, or clog to the extent that the dewatering systems will not perform properly during the period of dewatering. Copies of logs of borings results are available in the Report of Geotechnical Exploration for JEA Springfield Plant Emergency Generator as prepared by Meskel & Associates Engineering. This data is furnished for information only, and it is expressly understood that JEA and Engineer will not be held responsible for any interpretations or conclusions drawn therefrom by the Contractor.

F. Prior to the execution of the work, the Contractor, JEA and Engineer shall jointly survey the condition of adjoining structures. Photographs and records shall be made of any prior settlement or cracking of structures, pavements, and the like, that may become the subject of possible damage claims.

G. If a surface to receive foundation slabs cannot be maintained dry by the Contractor’s dewatering efforts, the Contractor shall provide tremie seals at no additional cost to JEA. The placement of tremie seals shall not preclude dewatering operations specified herein. The limits of tremie seals shall be recommended by the Contractor and reviewed and accepted by JEA.

3.9 BACKFILLING

A. All structures and pipes shall be backfilled with the type of materials shown on the Drawings and specified herein. Select fill shall be deposited in successive, uniform, approximately horizontal layers not exceeding 12-inches loose lift thickness for the full width. Stones or fragmentary rock larger than 4-inches in their greatest dimension will not be allowed within the top 6-inches of the ground nor within 6 inches of pipes. No stone or fragmentary rock larger than 12-inches in their greatest dimension will be allowed for any portion of backfill. Compaction shall be in accordance with the requirements of Paragraph 3.10, COMPACTION.

B. Where excavation support is used, the Contractor shall take all reasonable measures to prevent loss of support beneath and adjacent to pipes and existing structures when supports are removed. If significant volumes of soil cannot be prevented from clinging to the extracted supports, the

voids shall be continuously backfilled as rapidly as possible. The Contractor shall thereafter limit the depth below subgrade that supports will be installed in similar soil conditions or employ other appropriate means to prevent loss of support.

3.10 COMPACTION

A. The Contractor shall compact embankments, backfill, crushed stone, aggregate base, and in place subgrade in accordance with the requirements of this Section. The densities specified herein refer to percentages of maximum density as determined by the noted test methods. Compaction of materials on the project shall be in accordance with the following schedule:

	Density % Std. Proctor (D698)	**Density % Mod. Proctor (D1557)**	**Max. Lift Thickness**
Embankments Beneath Structures*	--	98	8
Other Embankments	95	92	8
Backfill Around Structures	95	92	8
Backfill Below Structures	--	98	***
Crushed Stone Beneath Structures	**	**	12
Select Sand	--	98	8
Crushed Stone Backfill and Pipe Bedding	**	**	12
In place Subgrade Beneath Structures	--	98	Top 12-inched

* *Embankments beneath structures shall be considered to include a zone 10 feet out from the foundation of the structure extending down to the natural ground on a 45□ slope.*

** *The aggregate shall be compacted to a degree acceptable to the Engineer by use of a vibratory compactor and/or crawler tractor.*

*** *Structural backfill shall be placed in loose lifts not exceeding 12-inches in thickness. If track-mounted equipment or vibratory roller in static mode is used, the lift thickness shall be reduced to 8-inches. If hand held compaction equipment is used, the lift thickness shall be further reduced to 6-inches.*

B. Field density tests will be made by independent testing agency as described in Article 1.06. These tests shall be the basis for accepting or rejecting the compaction. In-place density tests will be performed in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 2922. The Engineer will be the sole judge as to which test method will be the most appropriate. Failure to achieve the specified densities shall require the Contractor to re-compact the material or remove it as required. The Contractor shall, if necessary, increase his compactive effort by increasing the number of passes, using heavier or more suitable compaction equipment, or by reducing the thickness of the layers. The Contractor shall adjust the moisture contents of the soils to bring them within the optimum range by drying them or adding water as required.

C. Testing will be performed as frequently as deemed necessary by the Engineer. As a minimum, one in-place density test shall be performed for each 1000 cubic yards of embankment placed, 500 cubic yards of backfill placed, 2500 square feet of foundation area, or one test performed each day for either.

D. Final grades shall be within 0.1 foot elevation shown. Where shown on the Drawings, surfaces shall be sloped for drainage or other purposes.

E. Vibration monitoring shall be performed at nearby structures when compaction work is ongoing. A single monitoring point using vibration monitoring equipment capable of detecting velocities of 0.1 inch/second or less and survey measurements shall be used for vibration monitoring at each of the nearest structures. An elevation measurement on nearby structures shall be taken before compaction work starts, and then at least twice a day during the work with one reading taken at the conclusion of the day's operations. Elevation measurements shall be recorded to an accuracy of 0.001 foot. If at any time the Contractor detects settlement or heave of 0.005-feet or more, or vibration levels of 0.5 inch/second or more, the vibratory compaction shall be stopped immediately and JEA notified.

3.11 REMOVAL OF EXCESS AND UNSUITABLE MATERIALS

A. The Contractor shall remove and dispose of off-site all unsuitable materials. Within thirty (30) consecutive days after Notice to Proceed, the Contractor shall submit to the Engineer and JEA for review all required permits and a list of disposal sites for the unsuitable materials. If the disposal site is located on private property, the submittal shall also include written permission from JEA of record.

B. All unsuitable materials shall be disposed of in locations and under conditions that comply with federal, state and local laws and regulations.

C. The Contractor shall obtain an off-site disposal area prior to beginning demolition or excavation operations.

D. All excess and unsuitable materials shall be hauled in trucks of sufficient capacity and tight construction to prevent spillage. Trucks shall be covered to prevent the propagation of dust.

E. When all excess and unsuitable material disposal operations are completed, the Contractor shall leave the disposal sites in a condition acceptable to JEA and owner(s) of the disposal site(s).

END OF SECTION 31 20 00