SECTION 07 90 00– JOINT PROTECTION

PART 1 – GENERAL

1.1 THE SUMMARY

A. This section consists of sealant and caulking work required for a complete installation as indicated on the Drawings and specified herein.

B. The required applications of sealants and caulking include, but are not necessarily limited to, the following general locations:

1. Flashing, reglets and retainers;
2. Masonry joints, exterior and interior;
3. Joints at penetrations of walls, decks by piping and other services and equipment;
4. Joints between items of equipment and other construction;
5. Joints in concrete.

1.2 MANUFACTURERS

A. The following list of companies manufacture products that are acceptable for this section, subject to conformance with the specified requirements: **Tremco, Thiokol, Dymoric** or approved equal.

1.3 SUBMITTALS

A. Submit shop drawings and color samples of sealant for review in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit to the OWNER a two year guarantee on sealant type caulking to work against joint failure.

C. Joint failure is defined as leaks of air or water, evidence of loss of cohesion, fading of sealant material, migration of sealant, evidence of loss of adhesion between sealant and joint edge.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Primer:

1. Where required by sealant manufacturer, the primer shall be a compound designed to ensure the adhesion of sealant.
2. Material shall be provided by the sealant manufacturer and shall be selected for compatibility with substrate.

B. Sealant:

1. Sealant for vertical joints shall be two-component polytremdyne sealant meeting FS TT-S-00227E. Colors shall be selected by the ENGINEER.

2. Sealant for horizontal joints (non-contaminated) shall be a single component, pour grade, polyurethane sealant meeting FS TT-S-230A, Type 1. Materials shall attain Shore A Hardness of 40-45.

3. Sealant for horizontal joints (contaminated) shall be a single component, pour grade, coal tar edition, with amendments. Material shall attain Shore A Hardness of 25-30.

C. Caulking Compound:

1. Caulking compound for setting thresholds and for other interior caulking shall be oleo-resinous, gun grade, non-staining plastic compound conforming to FS TT-C-598-b.

2. Materials shall have a shrinkage factor not exceeding fifteen percent.

D. Joint Backing:

1. Joint backing shall be closed cell foam.

2. Material shall be non-reactive with caulking materials and non-oily.

3. Minimum density shall be 3.24 pcf.

4. Use no asphalt or bitumen-impregnated fiber with sealants.

E. Joint Cleaner:

1. Joint cleaner shall be as recommended by the sealant or caulking compound manufacturer.

F. Joint Primer:

1. Joint primer shall be as recommended by the sealant manufacturer.

G. Bond Breaker:

1. Bond breaker tape shall be either polyethylene or plastic as recommended by the sealant manufacturer.

PART 3 -- EXECUTION

3.1 GENERAL

A. Comply with sealant manufacturer's printed instructions except where more stringent requirements are shown or specified and except where manufacturer's technical representative directs otherwise.

3.2 SHIPPING, HANDLING AND STORAGE

A. Store and handle materials so as to prevent the inclusion of foreign matter or the damage of materials by water or breakage.

B. Procure and store in original containers until ready for use.

C. Material showing evidence of damage will be rejected.

3.3 INSTALLATION

A. Employ only proven installation techniques, which will insure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of the joint bond surface equally on opposite sides.

B. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces.

C. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.

D. Install sealants to depths as specified, or if not, as recommended by the sealant manufacturer and as follows:

1. Moving Joints:

   For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to fifty percent of joint width, but not more than 1/2" deep or less than 1/4" deep.

2. Sealed Joints:

   For joints sealed with non-elastomeric sealants and caulking compounds, fill joints to a depth in the range of seventy-five percent to one hundred twenty-five percent of joint width.

3. Thresholds:

   Set thresholds in full bed of caulking compound. Remove excess materials.

3.4 PROTECTION OF ADJOINING SURFACES

A. Prime or seal the joint surfaces wherever shown or recommended by the sealant manufacturer.

B. Do not all primer/sealer to spill or migrate onto adjoining surfaces.

3.5 SEALANT BACKER ROD

A. Install sealant backer rod for liquid elastomeric sealants, except where shown to be omitted or recommended to be omitted by the sealant manufacturer for the specific application shown.

3.6 . BOND BREAKER

A. Install bond breaker tape wherever shown and wherever required by manufacturer's recommendations to insure that elastomeric sealants will perform properly.

3.7 SPILLAGE

A. Sealants or compounds shall not overflow or spill onto adjoining surfaces, or to migrate into the voids of adjoining surfaces.

B. Masking tape or other precautionary devices shall be used to prevent staining of adjoining surfaces.

3.8 CURING

A. Sealants and caulking compounds shall be cured in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength, and surface durability.

3.9 CLEANING

A. Excess and spillage of compounds shall be promptly removed as the work progresses.

B. Adjoining surfaces shall be cleaned by whatever means may be necessary to eliminate evidence of spillage.

C. Do not damage the adjoining surfaces or finishes.

END OF SECTION

SECTION 09 96 00.1 - CORROSION BARRIER SYSTEM

PART 1 – GENERAL

1.1 WORK INCLUDED

A. Furnish all labor, surface preparation and coating material, tools, rigging, harness, lighting, ventilation, gas monitor and other related items of equipment and materials necessary to clean, prepare, cure, coat and cleanup a complete corrosion barrier system on all structures and/or equipment as specified or shown on the Drawings.

B. The work includes the application of the approved corrosion barrier system on the interior surface of existing and/or new wet wells, manholes and valve pits. These areas are located within confined space areas. All workers must be confined space certified prior to starting all work. All workers shall abide by OSHA 1910.146 and County PPM RSO-300.

C. Clean, prepare, and coat all surfaces in strict accordance with the manufacturer's published recommendations and specifications.

D. Perform all work by the use of skilled work persons in a safe and productive manner using equipment and procedures consistent with good coating practices.

1.2 RELATED SECTIONS

A. **Section 01300: Submittals.**

1.3 COATING SYSTEMS

A. For existing terminal manholes (last manhole before the lift station wet well), existing wet wells, and new valve vaults, use one of the following approved corrosion barrier systems:

1. Mortar/Epoxy Corrosion Barrier System (Mainstay System)

2. Calcium Aluminate Cementitious Corrosion Barrier System (SewperCoat, Strong Seal, and REFRATTA)

B. For new precast wet wells and new manholes, use the following approved corrosion barrier system:

1. Thermo-Plastic Protective Cast-In Liner System (Agru SURE-GRIP)

1.4 GENERAL REQUIREMENTS

A. For installation of systems listed on the applicable approved material list indicate by circling the appropriate name of the manufacturer on the material list.

B. Prior to preconstruction meeting submit a certification stating the applicator is:

1. Currently approved by the Manufacturer of the specified products.

2. Licensed and qualified in the application of the specified products.

1.5 QUALITY ASSURANCE

A. Preconstruction meeting: A preconstruction meeting shall be held prior to start of any application of restoration and corrosion barrier system. During the meeting, the process of preparation, application, curing, field inspection and coordination with other work shall be reviewed.

B. The approved specified products shall be applied in accordance with the Manufacturer's recommendations unless noted otherwise in this specification.

C. Material delivered to the site shall be in manufacturer's original, unopened containers and packaging, with label clearly identifying product name and Manufacturer, batch and lot number, and expiration date as applicable. The material shall be protected during storage, handling and application to prevent damage.

D. The liner manufacturer shall warrant the corrosion barrier system for five (5) years from the time of:

1. First permanent service activation discharging wastewater into the new structure, or;

2. Final payment to the CONTRACTOR by the OWNER.

The liner manufacturer shall warrant the corrosion barrier system for all labor and materials cost necessary to repair or replace the failed application, including related work (permits, bypass piping, pumps, flow monitoring, restoration, and record information) for a period of five (5) years.

1.6 ENVIRONMENTAL CONDITIONS

A. Do not apply materials under the following conditions:

1. Temperature exceeding the manufacturer's recommended maximum or minimum allowable.

2. Overflowing water condition.

PART 2 – PRODUCTS

2.1 MANUFACTURER REQUIREMENTS

A. Manufacturer must be listed on the OWNER's approved materials list.

B. Material must be from a single manufacturer.

2.2 MORTAR/EPOXY CORROSION BARRIER SYSTEM

A. Hydraulic Cement Mortar: Fast setting mortar used to stop leaks through cracks and holes.

1. Composition: Blend of hydraulic cements and fillers

2. Compressive strength: ASTM C109

   a. 1 day 2,400 psi

   b. 28 days 5,500 psi

3. Tensile Strength, ASTM C190

   a. 7 days 290 psi

   b. 28 days 575 psi

4. Working Time: 45 - 90 seconds at 77 degrees° F

5. Color: Dark Grey

B. Restoration Mortar: Low shrinkage, high strength, polymer modified, sprayable microsilica mortar.

1. Composition: Blend of cements, microsilica, thermo-plastic fibers, densifiers, polymer admixtures, and modifiers not to contain calcium aluminate cements or aggregates.

2. Compressive strength: ASTM C109

   a. 2 days 3,875 psi

   b. 7 days 4,550 psi

   c. 14 days 5,640 psi

   d. 28 days 6,190 psi

3. Flexural strength: ASTM C78

   a. 7 days 825 psi

   b. 28 days 985 psi

4. Tensile strength: ASTM C190

   a. 7 days 290 psi

   b. 28 days 575 psi

5. Shrinkage: ASTM C157 modified

a. 28 days - 0.04 percent

6. Uniaxial tensile bond strength: ACI 503R, Appendix A:

b. 28 days - greater than 500 psi

7. Color: Dark Gray

C. Corrosion Barrier Topcoat

1. Composition: 100 percent solids, modified epoxy sprayable coating

2. Thickness: min. of 100 mils in one (1) or two (2) coats (dry film thickness)

3. Number of components: wo (2)

4. Finish: Gloss

5. Color: White or Gray

D. Water: Water shall be potable and clean.

E. Manufacturer:

Madewell Products Corporation

7561 Industrial Court

Alpharetta, GA 30004

(770)-475-8199

(770)-475-8167 Fax

Or approved equal.

2.3 CALCIUM ALUMINATE CEMENTITIOUS CORROSION BARRIER SYSTEM

A. Material furnished under this specification shall be a prepackaged mortar mix, including all cement, aggregates, and any required additives. It is the intent of this specification that the CONTRACTOR only be required to add the proper amount of potable water so as to produce texture/density suitable for spray application. Do not add Portland cement, other aggregates, or any admixtures whatsoever to material furnished under these Technical Specifications. Typical package weights shall not be less than 50 lbs and shall be identical for all material furnished on this project.

The chemical composition of the cement portion as well as the aggregates of the mortar mix shall be as follows:

Al2O3	CaO	FeO + Fe2O3	SiO2
39-44%	35-39%	9-14%	5-7%

B. The design properties of the mortar mix shall be as follows:

Compressive Strength (ASTM C109)	> 5,500 psi	24
	> 7,000 psi	28
Flexural Strength (ASTM C348)	> 900 psi	24
	> 1,300 psi	28
Splitting Tensile Strength (ASTM 496)	> 550 psi	24
Bond Strength/Slant Shear (ASTM C886)	> 2,500 psi	28
Shrinkage at 28 days (ASTM 157)	< 0.07% humidity	
Freeze/Thaw after 300 Cycles (ASTM 666)		

C. The mortar mix shall be on the OWNER's Approved Material List.

D. Mortar mix must have at least five (5) years of successful performance in similar applications and be supplied by an ISO 9002 certified manufacturer. Manufacturer's ISO 9002 certificate shall be submitted to ENGINEER and OWNER.

E. In addition, the mortar mix shall be designed to withstand long-term exposure to a bacterially corrosive hydrogen sulfide environment that may be expected to produce a pH of one (1) on normal Portland cement concrete or typical brick and mortar surfaces.

F. Water used in mixing shall be fresh, clean, potable water, free from injurious amounts of oil, acid, alkali, vegetable, sewage and/or organic matter. Water shall be considered as weighing 8.33 pounds per gallon.

G. Mortar mix shall be stored with adequate provisions for the prevention of absorption of moisture. It shall be stored in a manner that will permit easy access for inspection and identification of each shipment.

H. Manufacturers:

1. Kerneos, Inc.
2. Madewell Corp.
3. Strong Seal
4. Global Materials Company

2.4 THERMO-PLASTIC PROTECTIVE CAST-IN LINER SYSTEM

A. Thermoplastic liner to be polypropylene, random copolymer (PP-R) concrete protective liner in the pre-cast wet wells.

B. Physical Properties

1. The concrete protective liner shall be free of pores, pinholes, voids and foreign bodies. All anchoring studs and/or vertical and horizontal flanges shall be manufactured during the injection/extrusion process in one piece with the sheet. No welding to attach the studs to the sheet or mechanical finishing work is permitted. All welding rod, profile strips, cap strips and polyester backed transition wrapping shall be manufactured from the same resins by the same manufacturer.

C. Liner Design.

1. The lining system shall be designed to be repaired or modified at anytime during the design life of the system.

2. Studded PP-R liner sheets shall have a minimum design thickness of two (2) mm (.079 inches) and have a minimum of 39 wedge shaped anchoring studs per square foot of liner. Minimum stud height shall be no less than nine (9) mm (.39 inches) with a minimum length of 14 mm (.55 inches). Anchoring studs must be capable of resisting continuous hydraulic backpressure, to a minimum of 40 feet of hydraulic backpressure, exerted between the interior wall of the concrete structure and the anchoring stud side of the protective liner. Non-studded PP-R cap strips, used to bridge construction joints, shall have a minimum design thickness of two (2) mm (.079 inches). Polyester backed non-studded PP-R transition sheets, used for the purpose of bonding PP-R to dissimilar materials, shall be attached to the PP-R sheets during the extrusion process.

3. Ribbed PP-R liner sections shall have a minimum thickness of eight (8) mm (0.3") and consist of three (3) or more segments of equal height and radial length that when welded together will form a section which corresponds to the inside diameter of the concrete structure. The outside surface of the ribbed PP-R liner segment(s) shall incorporate outward facing horizontal returns/flanges to insure adequate anchoring with the precast concrete structure and meeting a pressure test of one (1) bar (14.7 psi) or the prescribed ASTM criteria for vacuum testing of concrete sewer manholes. Minimum spacing between each horizontal return/flange to be one (1) inches and maximum spacing between each horizontal return/flange to be six (6) inches. Additionally, the outside surface shall incorporate five (5) ribs molded on the vertical axis spaced evenly in direct relation to the radial length of the PP liner segment.

4. If the application or conditions warrant, the Thermoplastic Liner System may be substituted upon approval of the ENGINEER and the OWNER.

PART 3 - EXECUTION

3.1 INSTALLATION OF MORTAR/EPOXY LINER CORROSION BARRIER SYSTEM

A. Examination

1. Inspect surfaces to receive restoration and corrosion barrier system for leaks, deteriorated concrete, cracks and voids. Notify the ENGINEER and the PBCWUD Construction Coordinator in writing if surfaces do not meet the minimum conditions as set by the coating Manufacturer. Do not begin surface preparation or application until unacceptable conditions have been corrected. New structures to be inspected and visibly marked by the PBCWUD Construction Coordinator prior to system application.

2. Give the PBCWUD Construction Coordinator a minimum of two (2) days advance notice of completion of surface preparation and start of application. If the application required a wastewater service shut-down, a minimum 10-day notice is required in order to notify Customers.

3. Before application of each material, surfaces to be sprayed or coated will be inspected by the ENGINEER and by the PBCWUD Construction Coordinator. Correct defects or deficiencies before application of subsequent material.

4. Inspection or the waiver of inspection by the PBCWUD Construction Coordinator and /or the ENGINEER of any portion of the work shall not relieve the CONTRACTOR of responsibility to perform the work as specified.

B. Surface Preparation

1. Coordinate with the PBCWUD's Construction Coordinator any wastewater service shut-downs, invert plugging, temporary wastewater pumping arrangements and by-passing of existing facilities.

2. Place covers over inverts to isolate the structure receiving the surface restoration.

3. Place masking tape to protect equipment not intended for spraying/coating.

4. Prepare surfaces in accordance with manufacturer's instructions.

5. Cleaning: Clean surfaces by water (minimum 3500 psi) or abrasive blasting, or hand or power tools as required to remove all previously applied coatings, unsound concrete, contaminants, dirt, debris, and deteriorated reinforcing steel, laitance, efflorescence, form oils and spoiled concrete.

6. Rehabilitation of existing structures only:

   a. Inspect cleaned surfaces to identify and mark corroded reinforcing steel, and to locate cracks, leaks, and joints.

   b. Replace or treat corroded reinforcing steel, repair cracks and leaks, and treat joints in accordance with manufacturer's instructions and as approved by the ENGINEER.

   c. Refer to ICRI Technical Guideline No. 03730 - Surface Preparation Guidelines for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion.

   d. Apply approved epoxy putty promptly after cleaning reinforcing steel to protect the steel from contamination and re-rusting.

   e. Hydrostatic Leak Correction

      1) Stop visible hydrostatic leaks by application of hydraulic cement mortar, after completion of surface preparation.
         i. Mix only 1 to 2 pounds of mortar at a time.
         ii. Add water to form a viscous mass with consistency of modeling clay.
         iii. Apply by hand or trowel.
         iv. Press mixed material firmly into place, starting at top of leak and working downward.

      2) Inject flowing leaks using a suitable polymer gel or foam. Be sure to remove any excess or spilled material and clean/saturate the concrete surface with water prior to application of the restoration mortar.

7. Prepare surfaces to have a minimum profile of 1/16-inch, with aggregate exposed, then remove the water and any loose material.

8. Inspect surfaces for soundness.

9. Saturate all surfaces thoroughly with clean water.

10. Apply mortar as soon as water sheen is no longer visible (saturated surface dry).

C. Application of Restoration Mortar

1. Apply restoration mortar in accordance with manufacturer's instructions, no more than 24 hours after surface preparation.

2. Apply by one (1) of the following methods:

   a. Low pressure, low volume spray equipment.

b. Wet mix shotcrete equipment.

3. Apply uniformly to substrate.

4. Do not trap air in corners, behind exposed reinforcing steel, or between lifts.

5. Mortar Thickness: Apply in layers of a minimum thickness of ½ inches and no more than four (4) inches above peaks of existing profile after surface preparation. If material sags or slumps, remove it and replace with new material.

6. Finishing: Finish surface with wood float, sponge float, broom, or brush to produce a textured surface to apply corrosion barrier topcoat.

7. Remove excess material and overspray promptly.

8. Hot Weather Application:

   a. Follow manufacturer's instructions to reduce evaporation rate of surface moisture until topcoat can be applied.

   b. If applying mortar under conditions such as high temperatures of mortar, substrate, or air; high winds; and low humidity; alone or in combination; rapid evaporation of surface moisture can occur and cause plastic shrinkage cracking. Apply approved primer/sealer as specified by the coating Manufacturer.

   c. If conditions prevent application of epoxy topcoat or primer, refer to ACI 305R-91, Figure 2.1.5 to estimate the evaporation rate of surface moisture from the mortar, based on temperatures, relative humidity, and wind velocity. Cover with plastic film or wet burlap to limit evaporation rate to a maximum of 0.1 pounds per square foot per hour.

9. Cold Weather Application:

   a. Follow manufacturer's instructions for minimum application temperature and minimum number of days to protect from freezing.

D. Application of Corrosion Barrier Topcoat

1. Provide mixing and application equipment designed for mixing and spraying epoxy coating.

2. Apply corrosion barrier topcoat epoxy to all prepared surfaces in accordance with manufacturer's instructions.

3. Apply topcoat as soon as possible after finishing of restoration mortar.

4. Do not allow surface contamination to the finished restoration mortar before application of topcoat.

5. Topcoat Thickness: Spray apply a minimum thickness of 100 mils DFT.

E. Curing of Corrosion Barrier Topcoat

1. Foot Traffic: Allow a minimum cure time of 24 hours at 70 degrees F.

2. Chemical Service: Allow a minimum cure time of 6 hours at 70 degrees F.

3. Curing Conditions:

a. Continue to protect system from freezing throughout protection periods specified for cold weather application after application of corrosion barrier topcoat.

b. Shelter system from direct impingement of water until 1 to 3 hours after application of topcoat, depending on substrate temperatures, after which cure sufficiently to be undamaged by water impingement or immersion at ordinary velocities.

c. Sanitary Sewer Systems: It may be necessary to plug services or main lines temporarily in order to achieve these environmental conditions.

4. Immersion Service: Reach a tack-free condition before being immersed.

5. Remove any loose debris, plugs, covers and masking prior to inspection.

F. Field Quality Control:

1. The CONTRACTOR shall hire an independent testing laboratory to perform and certify check the application for minimum thickness of coatings (minimum ½-inches of restoration mortar, minimum 100 mils MDFT of epoxy topcoat). The test for the topcoat shall consist of five (5) separate spot measurements (average of three [3] readings each), spaced evenly over each 100 square feet of the area to be tested. The average of five (5) spot measurements for each such 100 square foot area shall not be less than 100 mils MDFT. No single spot measurement in any 100 square foot area shall be less than 80 mils MDFT. Any one (1) of three (3) readings which are averaged to produce each spot measurement may underrun be a greater amount. The five (5) spot measurement shall be made for each 100 square feet of area as follows:

a. Perform minimum one (1) set of tests for every manhole, and minimum of three (3) 100 square foot areas shall be randomly selected and measured for every wet well.

2. If the dry film thickness for any 100 square foot area is not in compliance with the average of 100 mils MDFT, then each 100 square foot area shall

be tested. Check the application for holidays using recognized testing procedures and equipment, such as "high voltage holiday detector test."

3. Coated Surfaces will be rejected by the OWNER if they fail:

   a. To meet the MDFT requirements, or;

   b. To stop inflow, infiltration, exfiltration, or;

   c. To restore the structural integrity of the reconstructed structure (if applicable), or;

   d. To pass the OWNER's inspections and testing.

4. Rejected Coated Surfaces: Coated and rejected areas must be identified and marked. To repair and recoat: sand or grind down to substrate, clean, spray with approved primer/ sealer, and recoat with specified corrosion barrier topcoat. Re-inspection will be required.

5. The certified laboratory performing the testing shall issue a written statement to the OWNER confirming the compliance of each structure.

6. The OWNER may require that additional testing of the liner be performed at the manufacturer's expense any time during the five years warranty period. Any deficiencies in performance shall be corrected without delay by the manufacturer's CONTRACTOR at no cost to the OWNER.

3.2 INSTALLATION OF CALCIUM ALUMINATE CEMENTITIOUS CORROSION BARRIER SYSTEM

A. Surface Preparation

1. To ensure sufficient bond, all sub-surfaces shall be cleaned and prepared to a degree of roughness designated as CSP 3 by the International Concrete Repair Institute (ICRI) Guideline No. 03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coating, and Polymer Overlays. Sub-surfaces shall also be thoroughly saturated with water prior to the application of the lining materials. In no instance shall shotcrete be applied in an area where running water exists. It is the intent of this specification that the existing surface be saturated and free of any running water just prior to installation.

2. Ensure all sub-surfaces are clean and free of laitance or loose material.

3. All surfaces to be lined shall be saturated with water just prior to lining materials application. If saturation does not occur naturally, it can be accomplished by presoaking all sub-surfaces for a minimum of 24 hours immediately prior to the application of the lining materials.

B. Application of Materials

1. Mortar mix shall not be applied to a frozen surface or to a surface that may freeze within 24 hours of application. Frozen conditions shall be defined as ambient temperatures of 32 degrees Fahrenheit or below.

2. Sequence of application may be from bottom to top or vice versa if rebound is properly removed.

3. Application shall be from an angle as nearly perpendicular to the surface as practicable, with the nozzle held at least one (1) foot from the working sub-surface (except in confined control). If the flow of material at the nozzle is not uniform and slugs, sand spots, or wet sloughs result, the nozzleman shall direct the nozzle away from the work until the faulty conditions are corrected. Such defects shall be replaced as the work progresses.

4. Application shall be suspended if:

   a. Air velocity separates the cement from the aggregate at the nozzle.

   b. Ambient temperature approaches freezing and the newly placed mortar mix cannot be protected and insulate.

5. The time interval between successive layers of material application must be sufficient to allow "tackiness" to develop but not final set. If final set does occur, this surface shall be prepared in accordance with Section 3.2.A of this document in order to provide a sufficient bond with succeeding applications.

6. Construction joints within a manhole shall be avoided. In the event a construction joint is necessary and approved by the ENGINEER, it shall be sloped off to a thin, clean, regular edge, at a 45-degree angle. Prior to placement of the adjoining materials, the sloped portion and adjacent applied material shall be thoroughly cleaned as necessary, then moistened and scoured with an air jet.

7. Nozzleman shall bring the material to an even plane and to well formed corners.

8. Manhole chimneys constructed with bricks or precast concrete rings shall be completely lined with the mortar mix but not overlap the bottom inside edge of the manhole frame. After the body coat has been placed, the surface shall be trued with a thin-edge screed to remove high areas and expose low areas. Low areas shall be properly filled with additional material to insure a true, flat surface in accordance with of this document.

9. For manhole applications, the minimum thickness of the mortar mix shall be a ½-inch cover over all surfaces. For other larger structures (lift

stations, wet wells, treatment plant structures, etc.), the minimum thickness of the mortar mix shall be a one (1) inch cover over all surfaces.

C. Curing

1. If the material has been applied and furnished in accordance to the Technical Specifications, and it has been determined that the environment is not moist enough for natural curing, the CONTRACTOR will be required to apply a curing compound to all coated surfaces. Curing compound shall meet the requirements of ASTM C309 and have the approval of the lining material manufacturer and the ENGINEER prior to use.

2. Moist curing may also be used in lieu of curing compound. If moist curing is selected, it should be implemented just after the notice of uniform heat generation of the installed lining. Moist curing can consist of the use of soaker hoses, water sprinklers, or vapor/misting machines. Regardless of delivery method, moist curing should continue for a minimum of 18 hours.

D. Quality Control:

1. The installation of the Calcium Aluminate Rehabilitation System into existing structures shall be performed in accordance with the manufacture's recommendation unless noted otherwise in this specification. Only personnel certified by the manufacturer of the cementitious material shall perform the work.

2. All work shall be supervised and performed by confined space trained and certified personnel. All work shall conform to OSHA safety requirements.

3. The cementitious liner shall be tested for cracks, voids, pinholes and delamination, the presence of each shall create a reason to reject the structure. At no cost to the OWNER, the CONTRACTOR shall hire an independent material-testing firm to perform appropriate testing and certify that the thickness of the Cementitious liner is in accordance with these Technical Specifications. Minimum 1 (one) test shall be performed per each two (2) vertical feet of each structure. Each passing thickness test shall have a minimum of 90 percent thickness required. The average of all tests performed for each structure shall be the minimum thickness specified. A written report from the firm is required for each tested structure.

3.3 INSTALLATION OF THERMO-PLASTIC PROTECTIVE CAST-IN LINER SYSTEM

A. Installation/Quality Control.

1. The installation of the Thermo-plastic concrete protective liner into precast wet wells and manholes shall be accomplished only by a precast concrete manufacturer certified by the liner manufacturer with a minimum of five (5) years of manufacturing experience and a minimum of five (5) years of experience in the installation of corrosion resistant thermo-plastic sheet liners in concrete structures. Upon request, the liner installer shall provide

written certification that the installation is in accordance with the liner manufacturer's installation specifications.

2. Placement of the liner on forms shall conform to the liner manufacturer's written instructions and shall conform to the approved shop drawings and standard details. All shop and field welding shall be performed only by thermo-plastic extrusion welders certified by the liner manufacturer. All field thermo-welding shall additionally be performed only by confined space trained, and certified personnel. A copy of the thermo-welder's certification shall accompany the submittal. All welded joints shall be spark tested prior to casting.

3. Approved sealing gasket, cast-in flexible connection sleeves, cast-in conduit connectors, waterstops, manhole adjusting rings, and access covers shall be installed in accordance with the manufactures specifications, approved shop drawings and standard details.

4. The precaster shall insure proper quality control procedures in handling of completed structures during loading, transport, and unloading. All structures shall be inspected by the OWNER's Construction Coordinator prior to installation. Any cracks, voids, gaps, or other damage to the liner and the structure shall be each a reason for rejection. Only structures approved by the OWNER shall be installed for use in the OWNER's service area

5. The on-site CONTRACTOR shall exercise utmost care while handling and installing the approved structures. Structures with any visible damage will not be accepted. The structures shall be installed in accordance with the precaster's specifications, approved shop drawings and standard detail drawings. Any deviation from the installation specifications must be approved prior to installation by the structure manufacturer, the ENGINEER and the OWNER. It is the responsibility of the ENGINEER to monitor and inspect the installation for conformance with the approved specifications. Only approved miscellaneous materials (rings, sealants, gaskets, sleeves, etc.) shall be used.

6. At no cost to the OWNER, the CONTRACTOR shall hire an independent material testing firm to perform appropriate testing and certify that the liner is free of holidays using recognized testing procedures and equipment, such as high voltage holiday detector test. A steel brush shall be used for high voltage testing. A written report from the laboratory is required for each tested structure. If a structure is rejected by the OWNER, the ENGINEER shall consult the structure manufacturer to obtain guidance to rectify the problem. The OWNER must approve the proposed solution prior to implementation. Any repair must be performed by a manufacturers approved CONTRACTOR.

7. The liner manufacturer and the structure manufacturer shall warrant the lined structure for minimum five (5) years from the time of: Acceptance of bill of sale by the OWNER or final payment to the CONTRACTOR by the OWNER. The warranty shall cover all labor and materials cost necessary

to repair or replace the "failed" application, including related work (permits, bypass piping, pumps, flow monitoring, restoration, record information). The structure/liner system shall be considered "failed" if: there is liner delamination, any cracks, voids, or pinholes are detected, there is water infiltration into the structure, the structure failed to pass the OWNER's inspection and testing. The OWNER may require that additional testing of the liner shall be performed at the manufacturers expense any time during the five (5) year warranty period. Any deficiencies in performance shall be corrected without delay by the manufactures CONTRACTOR at no cost to the OWNER. Re-inspection and retesting shall be required.

8. The structure manufacturer's warranty shall be accountable for protection against water infiltration.

9. The liner manufacturer's warranty shall be accountable for protection of the concrete structure against chemical attack and microbial corrosion typically found in the wastewater environment.

3.4 SAFETY

A. Make all necessary provisions regarding materials, confined space entry, equipment, personnel, procedures, and practices, to assure that the work is done safely and that the working area is maintained free of all health and safety hazards.

B. Observe manufacturer's health and safety precautions when storing, handling, and applying coating materials.

C. Direct personnel's attention to all product warnings and information given on the labels of all products.

D. Post warning signs outside of the work to apprise personnel of the hazards in the work area.

E. Remove waste coating materials and contaminated disposable items from the job site and dispose of them at the completion of work each a day in accordance with all applicable rules and regulations.

END OF SECTION

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SECTION 09 96 10 - PAINTING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section covers the specifications for painting and finishing of interior and exterior items and surfaces.

B. Painting includes shop and field painting of conveyors, hoppers, supports, exposed steel and ironwork, and primed metal surfaces of equipment installed under mechanical work.

C. Paint all exposed surfaces, except as otherwise indicated, whether or not colors are designated. If not designated, colors will be selected by the ENGINEER from standard colors available for the coatings required.

D. Painting shall be done at such times as the CONTRACTOR and ENGINEER may agree upon in order that dust-free and neat work be obtained. Painting shall be done strictly in accordance with the manufacturer's instruction and shall be performed in a manner satisfactory to the ENGINEER.

1.2 RELATED REQUIREMENTS

A. **Palm Beach County Water Utilities Department Minimum Design and Construction Standards.**

1.3 SUBMITTALS

A. In addition to manufacturer's data, application instructions, and label analysis for each coating material, submit samples for review by ENGINEER for color and texture only. Resubmit samples as requested until required sheen color and texture is achieved.

1.4 DELIVERY AND STORAGE

A. Deliver materials to job site in new, original, and unopened containers bearing manufacturer's name, trade name, and label analysis. Store where directed in accordance with manufacturer's instructions. All paint materials used on the job shall be kept in single place which shall be kept neat and clean. All oily rags, waste or debris shall be removed every night and all precautions taken to avoid the danger of fire.

PART 2 - PRODUCTS:

2.1 MATERIALS

A. Paint manufacturers mentioned in the following specifications are set up as standards of quality. Products of other manufacturers may be submitted to the ENGINEER for approval. When other manufacturer's products are submitted, they shall comply with the following:

1. The film thickness designated and/or the number of coats to be applied shall not be decreased.

2. There shall not be a change from the generic type of coating specified.

3. The full name of each product and descriptive literature be submitted.

4. Manufacturer's recommendations as to which finish coat should be used with a particular primer shall be observed. In all cases, the prime coat and finish coat shall be from the same manufacturer. All paint shall be mildew resistant.

5. When thinning is necessary, only the products for the particular purpose, and by the manufacturer furnishing the paint, shall be allowed. All thinning shall be done strictly in accordance with the manufacturer's instructions and with the full knowledge and approval of the ENGINEER.

PART 3 - EXECUTION:

3.1 PREPARATION

A. All surfaces to be painted shall be prepared in a workmanlike manner with the objective of obtaining a smooth, clean and dry surface. No painting shall be done before the prepared surfaces are approved by the ENGINEER.

B. Metal: All ferrous metal to be primed in the shop shall have all rust, dust and scale, as well as all other foreign substances, removed by sandblasting or pickling. Cleaned metal shall be primed or pretreated immediately after cleaning to prevent new rusting. All ferrous metals shall be sandblasted to near white (SSPC-SP-10-63), in the field prior to application of primer, pretreatment or paint. All nonferrous metals, whether to be shop or field primed, shall be solvent cleaned prior to the application of the pretreatment and/or primer. No prepared surface that has been approved by the ENGINEER for painting or coating, shall be left uncoated for more than five hours after approval.

C. Bituminous Pavement: Immediately before application of the paint, the surface shall be dry and free from dirt, grease, oil, laitance, or other foreign material which would reduce the bond between the paint and the pavement. The area to be painted shall be cleaned by sweeping and blowing or by other methods as required to remove all dirt, laitance, and loose materials.

D. Metal surfaces except stainless steel, galvanizing or aluminum, shall be painted including piping, conduit and supports. Those items which are furnished with factory shop applied finish coats shall not be painted in the field if the shop finish is intact and unmarred; however, if the shop coat is damaged in any way, it shall be touched up or replace as directed by the ENGINEER. Threaded surfaces shall be thoroughly cleaned after assembly and painted. Perform preparation and cleaning procedures in strict accordance with the coating manufacturer's instruction for each substrate condition.

3.2 APPLICATION

A. General:

1. Mix, prepare, and store painting and finishing materials in accordance with manufacturer's directions.

2. Apply painting and finishing materials in accordance with the manufacturer's directions. Use applicators and techniques best suited for the material and surfaces to which applied.

3. Workmanship for applying paint shall be of professional quality. The painter shall apply each coat at the rate recommended by the manufacturer smoothly without runs, sag, or holidays. If the material has thickened or must be diluted for use with a spray gun, the coating shall be built up to the same thickness as achieved with undiluted materials. In other words, one gallon of paint as originally furnished by the manufacturer shall not cover a greater square foot area when applied by spray gun than when applied unthinned by brush. Deficiencies in film thickness shall be corrected by the application of additional coat or coats of paint. On masonry, application rates will vary according to the surface texture; however, in no case shall the manufacturer's stated coverage rate be exceeded. Before succeeding coats are applied to a surface, the preceding coat shall have been approved by the ENGINEER.

4. Drying time shall be construed to mean "under normal conditions". Where conditions are other than normal because of the weather or because painting must be done in confined space, longer drying times will be necessary. Additional coats of paint shall not be applied, nor shall units be placed in service until paints are thoroughly dry.

B. Pavement Marking:

1. The paint shall be mixed in accordance with the manufacturer's instruction and applied to the pavement with a marking machine at the rate of 110 to 140 square feet per gallon. The addition of thinner will not be permitted.

2. A period of 24 hours shall elapse between placement of bituminous surface course or seal coat and application of the paint.

3. The edges of the markings shall not vary from a straight line more than ½-inch in 50 feet, and the dimensions shall be within a tolerance of plus or minus five (5) percent.

3.3 PAINT SCHEDULE

A. Paint for exposed ductile/cast iron pipe for water and wastewater mains shall be in accordance with **Approved Materials and Equipment List from the Palm Beach County Water Utilities Department Minimum Design and Construction Standards.** Surface preparation shall be in accordance with the paint manufacturer's recommendations.

B. Corrosion barrier system for concrete structures shall be in accordance with the latest **Approved Materials and Equipment List from the Palm Beach County Water Utilities Department Minimum Design and Construction Standards.** Surface preparation shall be in accordance with the paint manufacturer's recommendations.

END OF SECTION

SECTION 26 00 00.1 – ELECTRICAL GENERAL REQUIREMENTS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. The general provisions of the Contract, including General Conditions, apply to all the work specified in the Electrical 26000 Sections.

1.02 LAWS, PERMITS, FEES AND NOTICES

A. Secure and pay all permits, fees and licenses necessary for the proper execution of the work. Submit all notices and comply with all laws, ordinances, rules and regulations of any public agency bearing on the work. Contractor shall be licensed Electrical Contractor in the county of construction.

1.03 DEPARTURES

A. If any departures from the Contract Drawings or Specifications are deemed necessary, details of such departures and the reasons therefore shall be submitted to the Engineer for advance written approval, prior to departure.

1.04 GUARANTEES

A. Furnish written guarantee covering all materials, workmanship, labor and equipment for a period of one (1) year from the date of acceptance as described in the Contract General Conditions.

B. The Owner reserves the right to operate and use all materials and equipment failing to meet the requirements of the Contract Documents until such unacceptable materials and equipment are replaced or repaired to the satisfaction of the Engineer.

1.05 AS-BUILT INFORMATION

A. A set of "red-lined" electrical drawings shall be carefully maintained at the job site. Actual conditions are to be put on the drawings in red on a daily basis so the drawings will continuously show locations and routes of cable trays, conduits, pull-boxes, circuit numbers, and other information required by the Engineer.

1.06 JOB SITE VISIT

A. Visit the project site before submitting a bid. Verify all dimensions shown and determine the characteristics of existing facilities which will affect performance of the work, but which may not be shown on drawings or described within these Specifications.

1.07 CLEANUP

A. Maintain a continuous cleanup during the progress of the work and use appointed storage areas for supplies. The premises shall be kept free from accumulations of waste materials and rubbish.

1.08 CUTTING AND PATCHING

A. Cut and prepare all openings, chases and trenches required for the installation of equipment and materials. Repair, remodel and finish in strict conformance with the quality of workmanship and materials in the surroundings. Obtain written permission from the Engineer for any alterations to structural members before proceeding.

1.09 MAINTENANCE

A. Render all necessary measures to ensure complete protection and maintenance of all systems, materials and equipment prior to final acceptance. Any materials or equipment not properly maintained or protected to assure a factory new condition at the time of final acceptance shall be replaced immediately at no additional cost to the Owner.

1.10 WATERPROOFING

A. Whenever any work penetrates any waterproofing, seal and render the work waterproof. All work shall be accomplished so as not to void or diminish any waterproofing bond or guarantee.

1.11 TESTS

A. Conduct an operating test of equipment prior to the Engineer's approval. The equipment shall be demonstrated to operate in accordance with the requirements of these Specifications. The tests shall be performed in the presence of the Engineer or an authorized representative. The Electrical Contractor shall furnish all instruments, electricity and personnel required for the tests.

1.12 SUMMARY OF ELECTRICAL WORK

A. Provide all labor, materials, tools, supplies, equipment and temporary utilities to complete the work shown on the drawings and specified herein. All systems are to be completely installed and fully operational. Equipment not supplied with vendor packages shall be supplied by the Contractor. Specifically, the work includes, but is not necessarily limited to:

1. Demolition of the existing power services, as may be indicated.

2. Demolition of the existing lift station Service Rack and all associated equipment including but not limited to: the meter can, the main service disconnect, control panel and exposed

conduit and wire, as indicated by the drawings. Reuse existing RTU control panel where unit is to be reused, see drawings.

3. Provide new power service, as may be indicated by the drawings for each site.

4. Provide FPL coordination

5. Maintain existing systems to be reused, as may be indicated.

6. Install wet well located equipment, including but not limited to: conduit, wire, service rack, pumps, floats, wetwell level transducer, stainless steel cable hangers, basket grips, power service disconnect, pump station control panel, isolation panel, RTU and antenna at each station, as may be required for each station.

7. Coordinate with Owner and Engineer.

8. Provide start up assistance and O&M and close out documentation for each site.

9. As part of closeout documents the Contractor shall provide FPL account numbers (whether new or existing) and meter numbers for each site.

B. If conflicts arise between the standard drawings and other drawings. The other drawings shall take precedence. Other drawings shall include the Oneline, plan views, details and the like.

C. The Owner requires standardization. The standard materials shall be used. The standard drawings shall establish the minimum level of quality. Increase ratings as may be required.

D. Parts indicated on the drawings shall not be substituted.

E. Soft starters shall be oversized. The next standard size rated unit shall be provided. For example if the drawings indicate 20 hp, a 25 hp rated soft starter system shall be provided. The NEC recognized motor size shall be use as the standard basis of size. For example, if the motor is rated 19.5 hp the higher standard size would be 20 HP. Then the next standard size rating is 25 hp. A 25 hp would be required.

F. Standard A shall be used for 240v, 3phase pumps less than or equal to 15 hp.

G. Standard B shall be used for 240v, 3phase pumps greater than 15 hp.

H. Standard C shall be used for 480v, 3phase pumps.

I. Standard D shall be used for invertor applications. The pump motors shall be less than or equal to 7.5 hp.

J. Exceptions will be indicated by the drawings.

K. Some locations have an RTU in good working order and shall be reused. A low profile Control panel shall be provided. Refer to lift station specific drawings where a Low Profile control panel may still be required along with a new separately enclosed RTU.

1.13 CODES AND STANDARDS

A. General Applicable provisions of the following codes and standards and other codes and standards required by the State of Florida and local jurisdictions are hereby imposed on a general basis for electrical work (in addition to specific applications specified by individual work sections of these specifications):

1. U.L.: Electrical materials shall be approved by Underwriters' Laboratories, Inc. This applies to materials which are covered by U.L. standards. Factory applied labels are required.

2. National Electrical Code, latest edition.

3. OSHA: Standards of the Occupational Safety and Health Administration are to be complied with.

4. NEMA: National Electrical Manufacturers Association Standards are to be met wherever standards have been established by that agency and proof is specifically required with material submittals for switchboards, motor control centers, panelboards, cable trays, motors, switches, circuit breakers and fuses.

5. ANSI: America National Standards Institute

6. NESC: National Electrical Safety Code, latest edition.

7. NFPA 820, latest edition.

8. Florida Building Code, latest edition.

9. All National and Local codes.

1.14 ELECTRICAL TEMPORARY FACILITIES

A. The Electrical Contractor shall include in his bid the cost of furnishing, installing, maintaining and removing all materials and equipment required to provide temporary light and power to perform his work during construction and until work is completed.

B. Safety

1. All reasonable safety requirements shall be observed to protect workers and the public from shock and fire hazards. Ground fault interrupters shall be employed in accordance with codes.

2. Ground wires are required in all circuits. Ground poles are required on all outlets. All metallic cases shall be grounded.

3. Raintight cabinets shall be used for all equipment employed in wet areas.

1.15 EXCAVATING FOR ELECTRICAL WORK

A. General

1. Excavation or drilling, backfill and repair of paving and grassing is to be in the bid of the Electrical Contractor. The actual work need not be performed by electrical trades. However, the Electrical Contractor shall be responsible for all excavation, drilling, dewatering, backfilling, tamping and repair of pavements and grassing required in support of electrical work. All areas disturbed by electrical work shall be repaired to their original condition, or as indicated on the drawings.

2. Hand digging shall be required in congested areas or questionable areas.

B. Coordination

1. The Electrical Contractor shall check and avoid existing utilities before commencing any excavation or drilling.

2. Contract drawings and other trades are to be consulted to avoid interferences with other utilities on this project.

3. In the event of damage to existing utilities, the Engineer shall be immediately notified, and damage shall be immediately repaired.

4. The Owner is to be consulted to ascertain locations of existing interferences by referring to "As Built" drawings and Owner's experience. The excavations are to be scheduled at the Owner's convenience.

C. Precautions

1. The Electrical Contractor must take every reasonable precaution to avoid interferences. In the vicinity of a suspected interference, excavations shall be dug by hand.

1.16 ELECTRICAL SUBMITTALS

A. Submittals for Approval

1. Refer to Contract General Conditions for additional instructions on the General Conditions and this Section, the more stringent requirements shall apply.

2. Shop Drawings and manufacturer's data sheets are required for all electrical materials.

3. Submittals will not be accepted for partial systems. Submit all materials for each specification section at one time. Submittals must be arranged, correlated, indexed and bound in orderly sets for ease of review.

4. Samples are to be supplied for any substitute as requested by the Engineer.

5. The following numbers of copies are required:

Shop drawings	6 sets
Samples	1 each
Manufacturer's data	6 sets
Certifications	6 sets
Test reports	6 sets
Warranties/Guarantees	6 sets

6. Submit shop drawings, manufacturer's data and certifications on all items of electrical work prior to the time such equipment and materials are to be ordered. Order no equipment or materials without approval from the Engineer. Submittals will not be accepted for partial system submittals; submit all data at one time. Submittals will be promptly returned, approved, approved as noted, or not approved. Items "approved as noted" must be changed to comply with the Engineer's comments and need not be resubmitted for "approved" status. Items "not approved" are not suitable, requiring complete new submittals.

7. Time delays caused by rejection of submittals are not cause for extra charges to Owner or time extensions. Contractor shall be responsible for investigating existing systems or shop drawings in order to fully integrate the new equipment into the system. Adequate shop drawings may or may not exist for all existing systems.

B. Operation and Maintenance Manuals

1. Submit to the Engineer five (5) copies of all manufacturer's service installation and operation manuals, instructions and bulletins. These manuals shall be subject to review of the Engineer. If acceptable they shall be forwarded to the Owner. If not acceptable they shall be returned to the Contractor for revision and resubmittal. Manuals shall contain, but not be limited to, the following:

   a. Brief description of system and basic features.

b. Manufacturer's name and model number for all components in the system.

c. List of local factory authorized service companies.

d. Operating instructions.

e. Maintenance instructions

f. Trouble shooting instructions

g. Manufacturer's literature describing each piece of equipment.

h. Power and control wiring diagrams

i. Parts lists

1.17 ELECTRICAL PRODUCTS

A. Standards Products

1. Unless otherwise indicated in writing by the Engineer, the products to be furnished under this Specification shall be the manufacturer's latest design. Units of equipment and components of the same purpose and rating shall be interchangeable throughout the project. All products shall be newly manufactured. Defective equipment or equipment damaged in the course of installation or test, shall be replaced or repaired in a manner meeting with the approval of the Engineer at no additional expense to the Owner.

B. Delivery, Storage and Handling

1. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels and similar information needed for distinct identification; adequately packaged or protected to prevent deterioration during shipment, storage and handling. Store in a dry, well ventilated, indoor space, except where prepared and protected by the manufacturer specifically for exterior instructions for storage locations.

C. Substitutions

1. Comply with instructions in the Contract General Conditions and Special Conditions and obtain pre-approval of the Engineer regarding substitutions.

1.18 ELECTRICAL IDENTIFICATION

A. Color Coding Conductor colors shall be in accordance with the N.E.C. and NFPA requirements.

B. Nameplates

1. The following items shall be equipped with nameplates: All motors, motor starters, motor control centers, pushbutton stations, control panels, time switches, disconnect or relays in separate enclosures, receptacles, wall switches, high voltage boxes and cabinets. All light switches and outlets shall carry a phenolic plate with the supply identified. Special Electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks.

2. Nameplates shall adequately describe the function of the particular equipment involved. Nameplates for panelboards and switchboards shall include the panel designation, voltage and phase of the supply. For example, "Panel A, 277/480V, 3-phawe, 4-wire". The name of the machine on the motor nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and P.B. station nameplates for that machine. Normal power nameplates shall be laminated phenolic plastic, white front and back with black core, with lettering etched through the outer covering; black engraved letters on white background. Lettering shall be 3/16 inch high at pushbutton stations, thermal overload switches, receptacles, wall switches and similar devices, where the nameplate is attached to the device plate. At all other locations, lettering shall be ¼ inch high, unless otherwise detailed on the Drawings. Nameplates shall be securely fastened to the equipment with No. 4 Phillips, round-head, cadmium plated, steel self-tapping screws or nickel-plated brass bolts. Motor nameplates may be non-ferrous metal not less than 0.003 inch thick, die stamped. In lieu of separate plastic nameplates, engraving directly on device plates is acceptable. Engraved lettering shall be filled with contrasting enamel. Equipment nameplate schedule for all equipment shall be submitted with shop drawing submittal for Engineer's approval.

1.19 SKILLED ELECTRICAL CRAFTSMEN

A. Contractor shall employ and staff the project with skilled Craftsmen experienced in the project requirements.

B. As a minimum, a Licensed Journeyman Electrician shall be present on the project at all times.

C. Other skilled persons shall be present as the project requirements dictate including manufacturers representatives, start-up technicians, Engineers, etc.

END OF SECTION

SECTION 26 00 10 - ELECTRICAL DEMOLITION

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

A. Contractor shall take precautionary and safety measures to assure the safety of his personnel. All wires shall be identified and disconnected from power sources before removal.

B. Contractor shall coordinate with the Owner and Engineer.

C. The general demolition scope shall also include the following minimum requirements whether indicated on plans or not.

1. Before demolition, Contractor shall verify that the equipment is no longer needed or that the demolition will not adversely affect operation.

2. Removal of all exposed unused conduit. Removal of all abandoned wire within raceways, cabinets, outlet boxes, trenches and the like associated with equipment shown to be removed on plans.

3. Demolition of all concealed cable and wire. Remove conductors. Plug all raceways with concrete or grout.

4. Removal of all hangers and support systems which are not needed as a result of the demolition.

5. Contractor shall cover all openings as a result of demolition and removals including but not limited to the following:

a. Cabinets and enclosures

b. Wall and masonry openings.

c. Cut conduit, instrumentation line, etc. flush with slab, fill with concrete, patch and paint holes in walls.

D. Operational Systems

1. To the fullest extent possible, all required systems shall remain operational. Contractor shall replace and/or repair existing facilities which may be damaged due to equipment removals.

2. Where required wiring passes through or uses enclosures or raceways shown for demolition. Contractor shall provide raceways and wire as required to keep those systems operational.

3. Contractor shall remove existing equipment in an orderly, planned and coordinated fashion. All replacement equipment shall be on site and ready to install immediately after the removal of existing equipment.

4. Where demolition interrupts the normal automatic control of the station, Contractor shall provide full time manual control until automatic control is restored. Contractor shall obtain permission of the Owner before removing automatic control.

1.02 SPECIFIC EQUIPMENT REMOVALS

A. The following include but do not limit the specific pieces of equipment for the removal and disposition.

1. Demolition of the existing lift station systems.

1.03 DISPOSITION OF EQUIPMENT

A. Except as otherwise indicated, all removed or demolished electrical equipment shall become the property of the Contractor. All rubble shall be disposed of by the Contractor.

B. Contractor shall load, transport, and dispose of all or demolished equipment including all enclosed gear, cabinets, raceways, wire and cable, supports, control enclosures, starters, circuit breakers, terminal boxes, panel covers, light fixtures, rigid galvanized steel conduit and the like.

END OF SECTION

SECTION 26 05 00 - BASIC MATERIALS AND METHODS

PART 1 – GENERAL

1.01 SUBMITTALS

A. Submit data sheets on all items per Section 16000.

1.02 CODES AND STANDARDS

A. General applicable provisions of the following codes and standards and other codes and standards required by the State of Florida and local jurisdictions are hereby imposed on a general basis for electrical work (in addition to specific applications specified by individual work sections of these specifications):

1. U.L.: Electrical materials shall be approved by the Underwriters' Laboratories, Inc. This applies to materials which are covered by U.L. standards. Factory applied labels are required.

2. National Electrical Code

3. OSHA: Standard of the Occupational Safety and Health Administration are to be complied with.

4. NEMA: National Electrical Manufacturers Association Standards are to be met wherever standards have been established by that agency, and proof is specifically required with material submittals for switchboards, motor control centers, panelboards, cable trays, motors, switches, circuit breakers, and fuses.

5. ANSI: American National Standards Institute

6. NESC: National Electrical Safety Code

PART 2 – PRODUCTS

2.01 GROUNDING MATERIALS

A. All ground rods shall be 20 foot 5/8" copperclad.

B. Around wires shall be soft drawn copper sized per National Electrical Code, unless otherwise indicated.

2.02 CONDUIT

A. PVC Conduit

1. PVC conduit shall be Schedule 80 or Schedule 40 unless otherwise noted and shall be U.L. approved. Comply with Federal Spec WC-1094 and NEMA TC-1.

B. Flexible Conduit

1. All flexible conduits shall be liquidtight, made of corrosion resistant plated steel with extruded polyvinyl covering and watertight connectors.

C. Rigid Galvanized Steel U.L Listed

1. Provide RGS raceway system including all fittings, seal offs, etc.

2.03 CABLE, WIRE AND CONNECTORS

A. 600 Volt Power Wiring

1. Individual conductors shall be rated for 600 volts, stranded copper, THW and shall meet the requirements below:

a. Conductors shall be stranded.

b. All wire shall be brought to the job in unbroken packages and shall bear the date of manufacturing; not older than 12 months.

c. Type of wire shall be THW, except where required otherwise by the contract drawings.

d. No wire smaller than No. 12 gauge shall be used unless specifically indicated.

e. Conductor metal shall be copper.

f. All conductors shall be meggered after installation. Megger testing shall exceed 50 mega ohms.

B. Instrumentation Cable

1. Process instrumentation wire shall be 16 gauge twisted pair, 600V., aluminum tape shielded, polyvinyl chloride jacketed, as

manufactured by Houston Wire and Cable HW-106 or an approved equal.

C. Control Cable

1. Multiconductor control cable shall be stranded 14 gauge, 600 V. THWN insulated overall shielded with PVC jacket, as manufactured by Houston Wire and Cable HW-151 or an approved equal.

2.04 TERMINATIONS AND SPLICES (600 VOLTS AND LESS)

A. Terminations of power cable shall be by means of U.L. approved connectors. All connectors shall meet U.L. 486B and shall be compatible with the conductor material.

B. Terminate all control and instrumentation cable with fork type compression lugs.

C. Splicing of power, control, or instrumentation wiring will not be allowed except by written approval of the Engineer. Where splicing is allowed, splices shall be made with approved compression connectors, and splices shall be made waterproof regardless of location.

2.05 BOXES

A. Boxes for wiring devices, switches and receptacles installed outdoors shall be weatherproof fiberglass with polycarbonate cover plates.

2.06 PULL BOXES AND SPLICE BOXES

A. Location

1. Units used outdoor or in a damp or corrosive environment shall be 316 SS, above grade or concrete in the ground unless otherwise indicated on plans.

2. Units used indoors in dry and clean environments shall be NEMA 1.

B. Size

1. Units shall be sized per NEC as minimum.

C. Required Units

1. Plans depict minimum requirements. Additional units shall be provided as may be required to complete raceway systems.

2.07 MOUNTING AND SUPPORTING ELECTRICAL EQUIPMENT

A. Furnish and install all supports, hangers, and inserts required to mount fixtures, conduits, cables, pull boxes, and other equipment.

B. Support system used indoors in clean, dry and air conditioned areas shall be galvanized steel.

C. Perforated straps and wires are not permitted for supporting electrical devices. Anchors shall be of approved types.

D. All supports, hangers, hardware, fasteners, etc. shall be 316 stainless steel. Supports shall be selected to avoid galvanic reactions. Support devices shall be submitted for approval.

E. Provide trapeze, bridge systems or wall bracketed cantilevered system to support the raceway system.

F. Spacing of support systems shall be per NEC. Provide spacing of conduits according to the NEC and the materials used. For PVC conduit, refer to NEC table 347-8.

G. Plans depict minimum requirements. Provide additional units as required to complete raceway system.

H. Refer to material schedule on plans. These specified requirements shall apply to all requirements not included in the material schedule.

2.08 SAFETY DISCONNECT SWITCH

A. Fusible and non-fusible disconnect switches shall be heavy-duty, NEMA type H, quick-make, quick-break, visible blades, 600 volts, 3 pole with full cover interlock. Switches shall have copper lugs.

B. Unless otherwise indicated, disconnects shall be 3-pole, nonfusible switch in a NEMA 4x, 316 stainless steel enclosure.

C. Switches shall be horsepower rated, heavy duty as manufactured by the Square D Co., or equal.

D. Units provided as main service disconnects, shall be fused and labeled for service equipment.

E. Provide auxiliary contracts as may be required by drawings.

F. Units shall be padlockable.

G. For small motor loads less than 2HP, such as motor operated valves and the like. U.L. listed motor rated manual switches shall be used; unless otherwise indicated, provide NEMA 4 enclosures, padlockable.

PART 3 –EXECUTION

3.01 GROUNDING

A. Provide ground system as indicated on the drawings and as required by the National Electrical Code.

B. All raceways require grounding conductors. Metallic raceways are not adequate grounding paths. Bonding conductors through the raceway systems shall be continuous from main switch ground buses to panel ground bars of the panelboards, and from panel grounding bars of panelboards and motor control centers to branch circuit outlets, motors, lights, etc. THESE GROUND CONDUCTORS ARE REQUIRED THROUGHOUT THE PROJECT REGARDLESS OF WHETHER CONDUIT RUNS SHOW GROUND CONDUCTORS ON THE DRAWINGS.

C. All connections made below grade shall be of the exothermic type.

D. The grounding system test shall not exceed a 48 hours span dry resistance of 5 ohms. Additional grounding to meet this requirement shall be installed at no extra cost. Grounding and bonding connections shall not be painted.

3.02 CONDUIT

A. Locations:

1. Refer to schedule on drawings.

B. Installation

1. Conduits subjected to rough handling or usage shall be removed from the premises.

2. Conduits must be kept dry and free of water or debris with approved pipe plugs or caps. Care shall be given that plugs or caps be installed before pouring of concrete.

3. Where conduits pass through exterior concrete walls or fittings below grade, the entrances shall be made watertight.

4. In furred ceilings, conduit runs shall be supported from structure, not furring.

5. Conduits entering panelboards, pull boxes, or outlet boxes shall be secured in place by galvanized locknuts and bushings, one (1) locknut outside and one (1) locknut inside of box with bushing on conduit end. The locknuts shall be tightened against the box without deforming the box. Bushings shall be of the insulating type.

6. Field conduit bends shall be made with standard tools and equipment manufactured especially for conduit bending.

7. Where embedded conduits cross expansion joints, furnish and install offset expansion joints or sliding expansion joints. Sliding expansion joints shall be made with straps and clamps.

8. Exposed runs of conduits shall be installed with runs parallel or perpendicular to walls, structural members or intersections of vertical planes and ceilings, with right angle turns consisting of symmetrical bends. No attempts are made in plans to show required pull boxes, gutters, etc. necessary for the construction of the raceway system but the Contractor shall provide these raceways as may be required.

9. Conduits in structural slabs shall be placed between the upper and the lower layers of reinforcing steel, requiring careful bending of conduits. Conduits embedded in concrete slabs shall be spaced not less than eight (8) inches on centers or as widely spaced as possible where they converge at panels or junction boxes. Conduits running parallel to slab supports, such as beams, columns and structural walls shall be installed not less than 12 inches from such supporting elements. To prevent displacement during concrete pour, saddle supports for conduit, outlet boxes, junction boxes, inserts, etc., shall be secured.

10. Conduit runs shall always be concealed except where indicated on plans.

11. Pull lines shall be installed in all empty conduits. All pull wires shall be identified with conduit number at each end.

12. Where conduits are run individually, they shall be supported by approved pipe straps secured by means of toggle bolts or tapcons

on hollow masonry; tapcons on concrete or solid masonry; machine screws or bolts on metal surfaces and wood screws on wood construction. The use of perforated straps or wires will not be permitted.

13. Wire shall not be installed until all work of any nature that may cause damage is completed, including pouring of concrete. Mechanical means shall not be used in pulling in wires No. 8 or smaller.

14. Underground conduits not under concrete slabs are to be buried at least two (2) feet below finished grade for circuits rated 600 volts or less, except under traffic areas where motor vehicles may cross. Under traffic areas, conduits are to be buried at least three (3) feet below finished grade.

15. All conduits shall be cleaned by pulling a brush swab through before installing cables.

16. All conduits shall be sealed at each end with electrical putty.

17. No more than (2) feet of flexible conduit shall be used at connections of all motors, transformers, motor operated valve and gates, instruments and other items of equipment where vibration is present. It shall be supported where required with stainless steel bands.

20. PVC conduit shall be supported to walls and slabs using carlon snap strap conduit wall hangers. Two hole PVC conduit clamps shall not be permitted.

3.03 WIRES, CABLES AND CONNECTIONS

A. Cables pulled into conduits shall be pulled using pulling eyes attached to conductors.

B. Shields shall be grounded at only one termination point.

3.04 BOXES

A. Installation of boxes shall be in accordance with the National Electrical Code requirements.

B. Boxes shall be mounted plumb and level in accessible locations and mounting shall be secure, vibration resistant and galvanically compatible. Hardware shall be used that is specifically intended for the purpose. When

mounted in corrosive, damp or wet locations, stainless steel hardware shall be utilized.

3.05 WIRING DEVICES

A. Wiring devices shall be installed in device boxes approved for the application. All connections shall be made with screw terminals. Wiring devices shall be Leviton or approved equal.

B. Wire devices on UPS systems shall be isolated ground, colored orange.

C. Cover plates shall be provided as follows except as otherwise noted.

1. Interior finished area – brush alum.

2. Wet areas – gasketed plastic with flip cover.

D. Receptacles installed outdoors, below grade, or in areas other than clean and dry environments shall be GFI and weatherproof.

3.06 SUPPORTING DEVICES

A. All items shall be, 316 stainless steel, and types approved by Underwriters' Laboratories, unless otherwise indicated.

B. Straps, struts and fasteners shall be 316ss.

3.07 CLEANING

A. All electrical equipment enclosures shall be thoroughly cleaned before acceptable by the Owner. As a minimum, Contractor shall remove all debris including stripped wire insulation, dirt, empty food wrappers, soda cans, water bottles, coffee cups, etc.

END OF SECTION

SECTION 26 05 26 – GROUNDING

PART 1 – GENERAL

1.1 THE SUMMARY

A. Provide the electrical grounding system, complete and operable, as indicated in accordance with the Contract Documents.

B. Single Manufacturer

1. Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.2 ACTION SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

1. Include with each submittal a copy of this specification section, with addenda updates included, and all referenced and applicable sections included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the CONTRACTOR, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The ENGINEER shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the CONTRACTOR with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. Shop Drawings

1. Submit manufacturer's product information for connectors, clamps, and all grounding system components, showing compliance with the requirements of this Section.

PART 2 – PRODUCTS

2.1 EQUIPMENT

A. Components of the grounding electrode system shall be manufactured in accordance with UL 467 - Standard for Safety Grounding and Bonding Equipment, and shall conform to the applicable requirements of National Electrical Code Article 250 and local codes.

B. Grounding System

1. Grounding loop conductors shall be bare annealed copper conductors.

2. Conductors shall be No. 4/0 unless indicated otherwise.

3. Ground Rods

a. Unless indicated otherwise, provide ground rods minimum of 3/4 inch in diameter, 10 feet long, and with a uniform covering of electrolytic copper metallically bonded to a rigid steel core.

b. Provide corrosion-resistant copper-to-steel bond.

c. The rods shall conform to UL 467.

d. The rods shall be of the sectional type, joined by threaded copper alloy couplings.

4. Make buried, concrete-encased, or otherwise inaccessible cable-to-cable and cable-to-ground rod connections using exothermic welds by **Cadweld, Thermoweld,** or approved equal. Alternatively, non-reversible, compression connectors may be used for inaccessible grounding connections, constructed of high-copper alloy, and manufactured specifically for the particular grounding application. The connectors shall be **Burndy "Hyground"**, similar by **Thomas and Betts**, or approved equal.

5. Exposed Connectors

   a. Exposed grounding connectors shall be of the compression type (connector-to-cable), constructed of high-copper alloy, and manufactured specifically for the particular grounding application.

   b. The connectors shall be **Burndy, O.Z. Gedney**, or approved equal.

6. Use grounding clamps to bond each separately-derived system to the grounding electrode conductors.

7. Equipment Grounding Circuit Conductors

   a. The conductors shall be the same type and insulation as the load circuit conductors.

   b. The minimum size shall be as indicated. Where not indicated, sizes shall conform to Table 250.122 of the National Electrical Code.

   c. Metallic conduit systems shall have an equipment grounding wires as well as being equipment grounding conductors themselves.

8. Grounding Materials Manufacturer, or approved Equal

   a. **Copperweld**

   b. **Thermoweld**

   c. **Burndy**

   d. **Thomas and Betts**

   e. **OZ Gedney**

PART 3 -- EXECUTION

3.1 PREPARATION

A. Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material.

B. Provide a separate grounding conductor for each motor and connect at motor box. Provide a supplemental ground connection for motor shaft grounding rings, where applicable.

C. Do not use bolts for securing the motor box to the frame or the cover for grounding connectors.

D. Sizes shall be as indicated on the Conduit Schedule and in accordance with NEC Article 250.

E. Route the conductors inside the raceway.

F. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each MCC section, switchboard, or panelboard.

G. Individually bond the raceway to the ground bus in the secondary section.

H. Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw, and, for grounding type devices, to the equipment grounding conductor.

I. Provide a separate grounding conductor in each individual raceway for parallel feeders. Connect the parallel ground conductors together at each end of the parallel run, as required by the NEC.

J. Interconnect the secondary switchgear MCC or panelboard neutral bus to the ground bus in the secondary switchgear compartment only at the service entrance point. For wye connected, 3 phase, separately derived systems with 3 wire distribution, connect the transformer neutral to the grounding electrode system at the transformer. Connections shall be in accordance with the NEC.

K. Provide the duct bank ground system as indicated, including trenching, splices, ground rods, and connections to equipment and structures.

L. Measure ground impedance in accordance with IEEE STD 81 after installation but before connecting the electrode to the remaining grounding system.

M. Low Voltage Grounded System (600V or less)

1. A low-voltage grounded system is defined as a system where the local power supply is a transformer, with the transformer secondary grounded.

2. Grounding system connections for a premises-wired system supplied by a grounded AC service shall be provided with a grounding electrode connector connected to the grounded service conductor at each service, in accordance with the NEC.

3. The grounded circuit conductor shall not be used for grounding non-current-carrying parts of equipment, raceways, and other enclosures except where specifically listed and permitted by the NEC.

N. Embedded Ground Connections

1. Underground and grounding connections embedded in concrete shall be UL-listed ground grid connectors.

2. The connection shall be made in accordance with the manufacturer's instructions.

3. Do not conceal or cover ground connections until the ENGINEER or an authorized representative has established that every grounding connection conforms to the requirements of the Contract Documents and has given the CONTRACTOR written confirmation.

O. Ground Ring

1. Furnish trenching and materials as necessary to install the ground ring as indicated.

2. The bonding conductor shall be in direct contact with the earth and of the indicated size.

3. Provide a minimum burial depth of 36 inches or as indicated on the Drawings, whichever is greater.

4. Re-compact disturbed soils to their original density in 6-inch lifts.

P. Duct Bank Ground

1. Embed a grounding conductor in every duct bank as indicated. The ground conductor shall be terminated at the ground grid at each end of the duct bank. Where no ground grid is installed, terminate at a suitable grounding electrode conductor near the end of the duct bank in accordance with the NEC.

Q. Ground Rods

1. Provide ground rods at the indicated locations.

2. A single electrode that does not have resistance-to-ground of 5 ohms or less shall be augmented by additional electrodes to obtain this value.

3. Take the resistance-to-ground measurement during dry weather, a minimum of 48 hours after a rainfall.

4. Rods forming an individual ground array shall be equal in length.

R. Instrumentation Shield Grounding

1. Shielded instrumentation cable shall have its shield grounded at one end only unless the approved Shop Drawings indicate that the shield will be grounded at both ends.

2. The grounding point shall be at the control panel or at the receiving end of the signal carried by the cable.

3. The termination of the shield drain wire shall be on its own terminal screw.

4. Jumper together the terminal screws, using manufactured terminal block jumpers or a No. 14 green insulated conductor.

5. Connect the ground bus via a green No. 12 conductor to the main ground bus for the panel.

END OF SECTION

SECTION 26 10 00 - CONDUCTORS

PART 1 GENERAL

1.1 REFERENCES

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

1. American National Standards Institute (ANSI): 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.

2. American Society for Testing and Materials (ASTM):

   a. A167, Standard Specification for Stainless and Heat Resisting Chromium-Nickel-P1ated Steel Plate, Sheet, and Strip.

   b. B3, Standard Specification for Soft or Annealed Copper Wire.

   c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

   d. B263, Standard Test Method for Determination of Cross-Sectional Area of Stranded Conductors.

3. Association of Edison Illuminating Companies (AEIC):

   a. CS 5, Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 Through 35 kV.

   b. CS 6, Ethylene- Propylene-Rubber-Insulated Shielded Power Cables Rated 5 Through 69 kV.

4. Insulated Cable Engineer's Association, Inc. (ICEA): T-29-250, Procedure for Conducting Vertical Cable Tray Flame Test with a Theoretical Heat Input of 210,000 Btu/hour.

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

   a. 48, Standard Test Procedures and Requirements or High-Voltage Alternating Current Cable Terminations.

   b. 404, Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5,000V through 46,000V and Cable Joints for Use with Laminated Dielectric Cable Rated 2,500V through 500,000V.

6. National Electrical Contractors Association, Inc. (NECA): 5055, Standard of Installation.

7. National Electrical Manufacturers' Association (NEMA):

   a. CC 1, Electric Power Connectors for Substations.

   b. WC 3, Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

   c. WC 5, Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

   d. WC 7, Crosslinked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

   e. WC 8, Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

   f. WC 55, Instrumentation Cables and Thermocouple Wire.

8. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

9. Underwriters Laboratories, Inc. (UL):

   a. 13, Standard for Safety Power-Limited Circuit Cables.

   b. 44, Standard for Safety Rubber-Insulated Wires and Cables.

   c. 62, Standard for Safety Flexible Cord and Fixture Wire.

   d. 486A, Standard for Safety Wire Connector and Soldering Lugs for Use with Copper Conductors.

   e. 486B, Standard for Safety Wire Connectors and Soldering Lugs for Use with Aluminum Conductors.

   f. 510, Standard for Safety Insulating Tape.

   g. 854, Standard for Safety Service-Entrance Cables.

   h. 910, Standard for Safety Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air Handling Spaces.

   i. 1072, Standard for Safety Medium-Voltage Power Cables.

   j. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

k. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.2 SUBMITTALS

A. Shop Drawings:

1. Wire and cable descriptive product information.

2. Wire and cable accessories descriptive product information.

3. Manufactured wiring systems descriptive product information.

4. Manufactured wire systems rating information.

5. Manufactured wire systems dimensional drawings.

6. Manufactured wire systems special fittings.

B. Quality Control Submittals:

1. Certified Factory Test Report for conductors 600 volts and below.

2. Certified Factory Test Report per AEIC CS6, including AEIC qualification report for conductors above 600 volts.

1.3 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2. 1 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 3, WC 5, and WC 7.

B. Conductor Type:

1. 120- and 277-Volt Lighting, No. 10 AWG and Smaller: Stranded copper.

2. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Stranded copper.

3. All Other Circuits: Stranded copper.

C. Insulation: Type THHN/THWN, except for sizes No. 6 and larger, with XHHW insulation.

D. Direct Burial and Aerial Conductors and Cables:

1. Type USE/RHH/RHW insulation, UL (54 listed, Type RHW-2/USE-2.

2. Conform to physical and minimum thickness requirements of NEMA WC

E. Flexible Cords and Cables:

1. Type SOW-A50 with ethylene propylene rubber insulation in accordance with UL 62.

2. Conform to physical and minimum thickness requirements of NEMA WC 8.

F. Cable Tray Conductors and Cables: Type TC.

2.2 600-VOLT RATED CABLE

A. General:

1. Type: TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu/hr, and NFPA 70, Article 340, or UL 13 Listed Power Limited Circuit Cable meeting requirements of NFPA 70, Article 725.

2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.

3. Suitable for installation in open air, in cable trays, or conduit.

4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.

5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. Wire and Connectors:

1. Cable shall be rated for 600 volts and shall meet the requirements below:

2. Conductors shall be stranded

3. All wire shall be brought to the job in unbroken packages and shall bear the data of manufacturing; not older than 12 months.

4. Type of wire shall be XHHW or THHN, rated 75 degrees C suitable for wet locations except where required otherwise by the drawings.

5. No wire smaller than No. 12 gauge shall be used unless specifically indicated.

6. Conductor metal shall be copper.

7. All conductors shall be megger tested after installation and insulation must be in compliance with the Insulated Power Cable Engineers Association Minimum Values of Insulation Resistance.

C. Type I-Multiconductor Control Cable:

1. Conductors:

a. No. 14 AWG, seven-strand copper.

b. Insulation: 15-mil PVC with 4-mil nylon.

c. UL 1581 listed as Type THHN/THWN rated VW-I.

d. Conductor group bound with spiral wrap of barrier tape.

e. Color Code: In accordance with NEMA WC 5, Method 1, Sequence K-2.

2. Cable: Passes the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.

3. Cable Sizes:

No. of Conductors	Max. Outside Diameter (inches)	Jacket Thickness (mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	00.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:

a. Okonite Co.

b. Rome Cable.

D. Type 2-Multiconductor Power Cable:

1. Conductors:

   a. Class B stranded, coated copper.

   b. Insulation: Chemically crosslinked ethylene-propylene with Hypalon jacket.

   c. UL 1581 listed as Type EPR, rated VW-1.

   d. Color Code: Conductors, size No. 8 AWG and smaller, colored conductors, NEMA WC5 Method 1, color 5 per Article POWER CONDUCTOR COLOR CODING. Conductors, size No. 6 AWG and larger, NEMA WC5, Method 4.

2. Cable pass the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.

3. Cable Sizes:

Conductor Size	Minimum Ground Wire Size	No. of Conductors	Max.Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
12	12	2 3 4	0.42 0.45 0.49	45 45 45
10	10	2 3 4	0.54 0.58 0.63	60 60 60
8	10	3 4	0.66 0.72	60
6	8	3 4	0.74 0.81	60
4	6	3 4	0.88 0.97	60 80
2	6	3 4	1.01 1.11	80
1/0	6	3 4	1.22 1.35	80
2/0	4	3 4	1.32 1.46	80
4/0	4	3 4	1.56 1.78	80

4. Manufacturers:

   a. Okonite Co.

   b. Pome Cable.

E. Type B-No. 16 AWG, Twisted, Shielded Pair (TSP), Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.

1. Outer Jacket: 45-mil nominal thickness.

2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.

3. Dimension: 0.31-inch nominal OD.

4. Conductors:

   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8

   b. 20 AWG, seven-strand tinned copper drain wire.

   c. Insulation: 15-mil nominal PVC.

   d. Jacket: 4-mil nominal nylon.

   e. Color Code: Pair conductors black and red.

5. Manufacturers:

   a. Okonite Co.

   b. Alpha Wire Corp.

6. The following test shall be performed on instrumentation and control system cables. All tests shall be end-to-end test of installed cables with the ends supported in free air, not adjacent to any ground object. All test data shall be recorded on forms acceptable to the Engineer. Complete records of all tests shall be made and delivered to the Engineer.

   a. Continuity tests shall be performed by measuring wire/shield loop resistances of signal cable as the wires, taken one at a time, are shorted to the channel shield. No loop resistance measurement shall carry by more than ±2 ohms from the calculated average loop resistance valve.

b. Insulation resistance tests shall be performed by using a 500 volt megohmeter to measure the insulation resistance between each channel wire and channel shield, between individual channel shields in a multi-channel cable, between each individual channel and the overall cable shield in multi-channel cable, between each wire and ground, and between each shield and ground. Values of resistance less than 10 megohms shall be unacceptable.

2.3 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.4 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.

2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.

3. Arcs and Fireproofing:

a. Not used.

B. Identification Devices:

1. Sleeve: Permanent, PVC, yellow or white, with legible machine-printed black markings.

2. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.

3. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:

1. Nylon, Self-Insulated Crimp Connectors:

a. Manufacturers and Products:

i. Thomas & Betts; Sta-Kon.

ii. Burndy; Insulink.

iii. ILSCO.

2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:

a. Manufacturers and Products:

i. Thomas & Betts; Sta-Kon.

ii. Burndy; Insulink.

iii. ILSCO.

D. Cable Lugs:

1. In accordance with NEMA CC I.

2. Rated 600 volts of same material as conductor metal.

3. Insulated, Locking-Fork, Compression Lugs:

a. Manufacturers and Products:

i. Thomas & Betts; Sta-Kon.

ii. ILSCO; ILSCONS.

4. Un-insulated Crimp Connectors and Terminators:

a. Manufacturers and Products:

i. Square D; Versitide.

ii. Thomas & Betts; Color-Keyed.

iii. ILSCO.

5. Un-insulated, Bolted, Two-Way Connectors and Terminators:

a. Manufacturers and Products:

i. Thomas & Betts; Locktite.

ii. Burndy; Quiklug.

iii. ILSCO.

E. Cable Ties: Nylon, adjustable, self-locking, and reusable.

1. Manufacturers and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation: Thermally stabilized, crosslinked polyofin.

1. Manufacturers and Product: Thomas & Betts; SHRINK-KON.

2.5 PULLING COMPOUND

A. Nontoxic, non-corrosive, noncombustible, nonflammable, wax-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

D. Manufacturers and Products:

1. Ideal Co.; Yellow 77.

2. Polywater, Inc.

3. Cable Grip Co.

2. 6 WARNING TAPE

A. As specified in Section 16110, RACEWAYS.

2.7 SOURCE QUALITY CONTROL

A. Conductors 600-Volts and Below: Test in accordance with UL 44 and 854 Standards.

PART 3 EXECUTION

3.1 GENERAL

A. Conductor installation to be in accordance with NECA 5055.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

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

D. Tighten screws and terminal bolts in accordance with UL 486A for copper conductors.

E. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

F. Bundling: Where single conductors and cables in manholes, hand holes, vaults, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.

G. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

3.2 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.

2. No. 8 AWG and Smaller: Provide colored conductors.

3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Gray Brown Purple Yellow
NOTE: Phase A, B, C implies direction of positive phase rotation		

4. Tracer: Outer covering of white with an identifiable colored strip other than green in accordance with NFPA 70.

3.3 CIRCUIT IDENTIFICATION

A. Circuits Appearing in Circuit Schedules: identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, hand holes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Not Appearing in Circuit Schedules:

1. Assign circuit name based on device or equipment at load end of circuit.

2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

C. Method:

1. Conductors No. 3 AWG and Smaller: Identify with sleeves.

2. Cables, and Conductors No. 2 AWG and Larger:

a. Identify with marker plates.

b. Attach marker plates with nylon tie cord.

3. Taped-on markers or tags relying on adhesives not permitted.

3.4 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors No. 6 AWG and larger unless specifically indicated or approved by ENGINEER.

C. Connections and Terminations:

1. Install wire nuts only on solid conductors.

2. Install nylon self-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 6 AWG and smaller.

3. Install un-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.

4. Install un-insulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.

5. Install un-insulated bolted, two-way connectors for motor circuit conductors No. 12 and larger.

6. Tape insulates all un-insulated connections.

7. Place no more than one conductor in any single-barrel pressure connection.

8. Install crimp connectors with tools approved by connector manufacturer.

9. Install terminals and connectors acceptable for type of material used.

10. Compression Lugs:
    a. Attach with a tool specifically designed for purpose.

    b. Tool shall provide complete controlled crimp and shall not release until crimp is complete.

    c. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:

1. Indoors: Use general purpose, flame retardant tape.

2. Outdoors: Use flame retardant, cold- and weather-resistant tape.

F. Cap spare conductors and conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:

1. Remove surplus wire, bridle and secure.

2. Where conductors pass through openings or over edges in sheet metal, remove burns, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:

1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.

2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.

3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.

4. Where connections of cables installed under this section are to be made under Section 13300, PROCESS INSTRUMENTATION AND CONTROLS - GENERAL, leave pigtails of adequate length for bundled connections.

5. Cable Protection:

   a. Under Infinite Access Floors: May be installed without bundling.

   b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under the floor or grouped into bundles at least 1/2-inch in diameter.

   c. Maintain integrity of shielding of instrumentation cables.

   d. Ensure grounds do not occur because of damage to jacket over the shield.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

3.5 UNDERGROUND DIRECT BURIAL CABLE

A. Install in trench as required.

B. Warning Tape: Install approximately 12 inches above cable, aligned parallel to, and within 12 inches of centerline of the run.

END OF SECTION

SECTION 26 29 13.16 – REDUCED-VOLTAGE MOTOR CONTROLLERS

PART 1 – GENERAL

1.1 THE SUMMARY

A. General: The CONTRACTOR shall provide solid-state reduced voltage motor starters, complete and operable, in accordance with the Contract Documents.

B. Single Manufacturer: Like products shall be the end product of one manufacturer in order to standardize appearance, operation, maintenance, spare parts, and manufacturer's services. However, the CONTRACTOR shall remain responsible to the OWNER for the WORK of the Contract.

C. Coordination: Equipment provided under this Section shall operate the electric motor and the driven equipment indicated under other equipment specifications. The CONTRACTOR's attention is specifically directed to the need for proper coordination of the WORK under this Section with the WORK under the equipment.

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

E. Related sections:

1. Section 01 33 00 – Submittal Procedures

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

1. NFPA 70 - 2014, National Electrical Code
2. CSA
3. NEMA ICS 1 - 2000, Industrial Control and Systems: General Requirements
4. NEMA ICS 2 - 2000, Industrial Control and Systems: Controllers, Contactors and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC
5. NEMA ICS 6 - 1993, Industrial Control and Systems: Enclosures
6. UL 508 - 1998, Industrial Control Equipment

1.3 CONTRACTOR SUBMITTALS

A. Product Data:

B. Shop Drawings:

1. Equipment information
   a. Name of drive manufacturer
   b. Type and model

c. Assembly drawing and nomenclature

d. Maximum heat dissipation capacity (KW)

2. Written description of ladder diagram operation. Custom schematics shall be furnished. Diagrams shall include remote devices.

3. System block diagram and interconnection diagrams.

4. Replacement parts list and operation and maintenance instructions.

5. ISO 9001 or 9002 Certification.

6. Installation list.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five years. The Vendor shall provide a list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

PART 2 – PRODUCTS

2.1 GENERAL EQUIPMENT REQUIREMENTS

A. The CONTRACTOR shall provide a total of one (1) solid-state starter per pump. Equipment to be operated through the starters includes the following:

Qty.	Equipment	Tag. No.	HP	Volt	RPM	Enclosure

B. Solid-state reduced voltage starters (SSRV) shall be UL-listed and CSA certified and consist of a SCR-based power section, logic board, and internal paralleling bypass contactor.

C. Starters shall conform to the following:

1. The SCR-based power section shall consist of 6 back-to-back SCRs, 2 SCRs per phase, and shall be rated for a minimum peak inverse voltage rating of 2.5 times line voltage, 1200 PIV for 480 volts. Units using triacs or SCR/diode combinations shall not be acceptable. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dv/dt characteristics of the electrical system.

2. Starters shall include the following logic and control functions:

a. Adjustable maximum starting current from 200 percent to 500 percent

b. Ramp time adjustment from 1 to 40 seconds

c. Adjustable linear voltage deceleration

d. Kick start

e. Phase loss protection

f. Undervoltage protection

g. Current unbalance protection

h. Phase rotation protection (prevents starting)

i. Class 20 electronic overload protection. Heat sink over-temperature protection shall be provided.

j. Dry contacts for remote indication of RUN and TRIP status

3. The paralleling bypass contactor shall energize when the motor reaches full speed. The contactor shall be an integral part of the reduced voltage starter and be connected directly across the power SCRs.

4. The starter shall be housed in a NEMA 3R enclosure. Heaters and cooling fans shall be provided if required to maintain the equipment within the manufacturer's environmental guidelines.

5. The starter shall be provided with a control power transformer sized to accommodate controls indicated on the Contract Drawings. An input power circuit breaker shall be provided. Lug termination of the incoming power conductors shall not be permitted. The starter and circuit breaker shall be rated for 65 KAIC RMS at 480 V.

6. The starter shall have door-mounted indication of run, phase rotation, phase loss, undervoltage, current unbalance, and current trip.

7. The starter shall be provided with the operator controls indicated. Operator interface controls shall be heavy duty, oil-tight, 30.5-mm.

2.2 FACTORY TESTING

A. Standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.

B. The manufacturer shall provide three certified copies of factory test reports prior to shipping the solid state reduced voltage motor starter.

2.3 ACCEPTABLE MANUFACTURER

A. **Square D,** ATS 22D88S6U

PART 3 -- EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall install the solid-state reduced voltage starters in accordance with the manufacturer's published instructions.

B. The CONTRACTOR shall

1. Verify that the overload devices are properly adjusted for the equipment installed.

2. After the equipment is installed, touch up scratches and verify that nameplate and other identification is accurate.

3.2 FIELD QUALITY CONTROL

A. Inspection, Startup, Field Adjustment: An authorized service representative of the manufacturer shall supervise the following and certify the equipment and controls have been properly installed, aligned, and readied for operation.

1. Installation of the equipment

2. Inspection, checking, and adjusting the equipment

3. Startup and field testing for proper operation

END OF SECTION

SECTION 26 30 00 - RACEWAYS

PART 1 GENERAL

1.1 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO): Division I, Standard Specifications for Highway Bridges, Fourteenth Edition.

2. American National Standards Institute (ANSI):

   a. C80.1, Rigid Steel Conduit-Zinc Coated.

   b. C80.3, Electrical Metallic Tubing-Zinc Coated.

   c. CS0.5, Rigid Aluminum Conduit.

   d. C80.6, Intermediate Metal Conduit (IMC)-Zinc Coated.

3. American Society for Testing and Materials (ASTM):

   a. A123 EI, Standard Specification for Zinc-Coated (Galvanized) Coatings on Iron and Steel Products.

   b. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.

4. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.

5. National Electrical Manufacturers Association (NEMA):

   a. RN 1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

   b. TC 2, Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).

   c. TC 3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.

   d. TC 6, PVC and ABS Plastic Utilities Duct for Underground Installation.

   e. VE 1, Metallic Cable Tray Systems.

6. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC)

7. Underwriters Laboratories, Inc. (UL):

   a. 1, Standard for Safety Flexible Metal Conduit.

   b. 6, Standard for Safety Rigid Metal Conduit.

   c. 360, Standard for Safety Liquid-Tight Flexible Steel Conduit.

   d. 514B, Standard for Safety Fittings for Conduit and Outlet Boxes.

   e. 514C, Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.

   f. 651, Standard for Safety Schedule 40 and 80 PVC Conduit.

   g. 651A, Standard for Safety Type EB and Rigid PVC Conduit and HDPF Conduit.

   h. 797, Standard for Safety Electrical Metallic Tubing.

   i. 870, Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings.

   j. 1242, Standard for Safety Intermediate Metal Conduit.

   k. 1660, Standard for Safety Liquid-Tight Flexible Nonmetallic Conduit.

1.2 SUBMITTALS

A. Shop Drawings:

1. Manufacturer's Literature:

   a. Rigid galvanized steel conduit.

   b. Rigid aluminum conduit.

   c. PVC Schedule 80 conduit.

   d. Flexible metal, liquid-tight conduit.

   e. Flexible, nonmetallic, liquid-tight conduit.

   f. Conduit fittings.

g. Wireways.

2. Precast Manholes and Handholes:

a. Dimensional drawings and descriptive literature.

b. Traffic loading calculations.

c. Accessory information.

3. Conduit Layout:

a. Not used.

1.3 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.1 CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit (RGS):

1. Meet requirements of ANSI C80.1 and UL6.

2. Material: Hot-dip galvanized, with chromated protective layer.

B. Electric Metallic Tubing (EMT):

1. Not used.

C. PVC Schedule 80 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.

2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

D. PVC-Coated Rigid Galvanized Steel Conduit:

1. Not used.

E. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.

2. Material: Galvanized steel, with an extruded PVC jacket.

F. Flexible, Nonmetallic, Liquid-Tight Conduit:

1. Material: PVC core with fused flexible PVC jacket.

2. UL 1660 listed for:

a. Dry Conditions: 80 degrees C insulated conductors.

b. Wet Conditions: 60 degrees C insulated conductors.

3. Manufacturers:

a. Carlon; Carflex or X-Flex.

b. T & B; Xtraflex LTC or EFC.

2.2 FITTINGS

A. Rigid Galvanized Steel and Intermediate Metal Conduit:

1. General:

a. Meet requirements of UL 514B.

b. Type: Threaded, galvanized. Set screw fittings not permitted.

2. Bushing:

a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.

b. Manufacturers:

i. Thomas & Betts; Type BIM.

ii. O.Z./Gedney; Type HB.

3. Grounding Bushing:

a. Material: Malleable iron with integral insulated throat rated for 150 degrees C, with solderless lugs.

b. Manufacturers:

i. Appleton; Series GIB.

ii. O.Z. Gedney; Type HBLG.

4. Conduit Hub:
   a. Material: Malleable iron with insulated throat.
   b. Manufacturers:
      i. O.Z. Gedney; Series CH.
      ii. T & B; Series 370.
5. Conduit Bodies:
   a. Material: Malleable iron, sized as required by NFPA 70.
   b. Manufacturers (For Normal Conditions):
      i. Appleton; Form 35 threaded Unilets.
      ii. Crouse-Hinds; Form 7 or 8 threaded condulets.
      iii. Killark; Series O Electrolets.
   c. Manufacturers (For Hazardous Locations):
      i. Appleton.
      ii. Crouse-Hinds.
      iii. Killark.
6. Couplings: As supplied by conduit manufacturer.
7. Conduit Sealing Fitting Manufacturers:
   a. Appleton; Type EYF, EYM, or ESU.
   b. Crouse-Hinds; Type EYS or EZS.
   c. Killark; Type EY or EYS.
8. Drain Seal Manufacturers:
   a. Appleton; Type SF.
   b. Crouse-Hinds; Type EYD or EZD.
9. Drain/Breather Fitting Manufacturers:

a. Appleton; Type ECDB.

b. Crouse-Hinds; ECD.

10. Expansion Fitting Manufacturers:

a. Deflection/Expansion Movement:

i. Appleton; Type DF.

ii. Crouse-Hinds; Type XD.

b. Expansion Movement Only:

i. Appleton; Type XJ.

ii. Crouse-Hinds; Type XJ.

11. Cable Sealing Fittings:

a. To form watertight nonslip cord or cable connection to conduit.

b. For Conductors With OD of 1/2 Inch or Less: Neoprene bushing at connector entry.

c. Manufacturers:

i. Crouse-Hinds; CGBS.

ii. Appleton; CG-S.

B. Electric Metallic Tubing:

1. Not used.

C. PVC Conduit and Tubing:

1. Meet requirements of NEMA TC-3.

2. Type: PVC, slip-on.

D. PVC-Coated Rigid Galvanized Steel Conduit:

1. Not used.

E. Flexible Metal, Liquid-Tight Conduit:

1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.

2. Insulated throat and sealing O-rings.

3. Long design type extending outside of box or other device at least 2 inches.

4. Manufacturer: T & B; Series 5300.

F. Flexible, Nonmetallic, Liquid-Tight Conduit: Meet requirements of UL 514B.

1. Type: One-piece fitting body, complete with lock nut, O-ring, threaded ferrule, sealing ring, and compression nut.

2. Manufacturers:

a. Carlon; Type LT.

b. Kellems; Polytuff.

c. T & B; LT Series.

G. Watertight Entrance Seal Device:

1. New Construction:

a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.

b. Manufacturer: O.Z./Gedney; Type FSK or WSK, as required.

2. Gored-Hole Application:

a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.

b. Manufacturer: O.Z./Gedney; Series CSM.

H. Hazardous Locations: Approved for use in the atmosphere involved.

1. Manufacturer: Crouse-Hinds; Type ECGJH.

I. Corrosive Locations:

1. Material: Rigid galvanized steel.

2. Manufacturers:

a. Robroy Industries.

b. Carlon.

c. Crouse-Hinds.

2.3 ACCESSORIES

A. Duct Bank Spacers:

1. Type: Nonmetallic, interlocking, for multiple conduit sizes.

2. Suitable for all types of conduit.

3. Manufacturer: Underground Device, Inc.; Type WUNPEECE.

B. Identification Devices:

1. Raceway Tags:

a. Material: Permanent, nylon.

b. Shape: Round.

c. Raceway Designation: Pressure stamped, embossed, or engraved.

d. Tags relying on adhesives or taped-on markers not permitted.

2. Warning Tape:

a. Material: Polyethylene, 4-mil gauge.

b. Color: Red.

c. Width: Minimum 6-inch.

d. Designation: Warning on tape that electric circuit is located below tape.

e. Manufacturers:

i. Blackburn, Type RT.

ii. Griffolyn Co.

3. Buried Raceway Marker:

a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.

b. Designation: Incise to depth of 3/32 inch, ELECTRIC CABLES. in letters 1/4-inch high.

c. Minimum Dimension: 1/4-inch thick, 10 inches long, and 3/4-inch wide.

C. Raceway Coating:

1. Material: Bitumastic or plastic tape coating.

2. Manufacturers:

a. Koppers bitumastic; No. 505.

b. Scotchwrap; No. 51, plastic tape.

D. Wraparound Duct Band:

1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.

2. Manufacturer: Raychem; Type TWDB.

PART 3 EXECUTION

3.1 GENERAL

A. Conduit and Tubing sizes shown are based on the use of copper conductors. Reference Section 16120, CONDUCTORS.

B. All installed Work shall comply with NECA 5055.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Aluminum Conduit: Not used.

G. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

H. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

I. Group raceways installed in same area.

J. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

K. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

L. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

M. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.

N. Install watertight fittings in outdoor, underground, or wet locations.

O. Paint threads, before assembly of fittings, of galvanized conduit or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

P. All metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

Q. Do not install raceways in concrete equipment pads, foundations, or beams.

R. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

3.2 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

A. Minimum cover 1-1/2 inches.

B. Provide support during placement of concrete to ensure raceways remain in position.

C. Floor Slabs:

1. Outside diameter of conduit not to exceed one-third of the slab thickness.

2. Separate conduit by minimum six times conduit outside diameter, except at crossings.

3.3 CONDUIT APPLICATION

A. Diameter: Minimum 3/4 inch.

B. Exposed:

1. Rigid galvanized steel.

C. Underground:

1. PVC schedule 80 in all underground application except the followings:
   - Rigid galvanized steel conduit between utility pole to meter
   - HDPE conduit for directional bored

D. Interior, Concealed (Not Embedded in Concrete):

1. Rigid galvanized steel.

E. Use long radius elbows for all conduits runs.

3.4 CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:

1. Conduit Size 4 Inches or Less: Flexible metal, liquid-tight conduit.

2. Conduit Size Over 4 Inches: Nonflexible.

3. Corrosive Areas: Flexible, nonmetallic, liquid or PVC-coated metallic, liquid-tight.

4. Length: 18-inch minimum, 60-inch maximum, of sufficient length to allow movement or adjustment of equipment.

B. Lighting Fixtures in Dry Areas: Flexible steel, nonliquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

D. Transition From Underground or Concrete Embedded to Exposed: Rigid galvanized steel conduit with two coats of bitumastic or plastic tape coating.

E. Under Equipment Mounting Pads: Rigid galvanized steel conduit.

F. Exterior Light Pole Foundations: Rigid galvanized steel conduit.

3.5 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Fire-stop openings around penetrations to maintain fire-resistance rating.

D. Apply single layer of wraparound duct band to all metallic conduit in contact with concrete floor slabs to a point 2 inches above concrete surface.

E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.

F. Entering Structures:

1. General: Seal raceway at the first box or outlet with minimum 2 inches thick expandable plastic compound to prevent the entrance of gases or liquids from one area to another.

2. Concrete Roof or Membrane Waterproofed Wall or Floor:

a. Provide a watertight seal.

b. Without Concrete Encasement: Install watertight entrance seal device on each side.

c. With Concrete Encasement: Install watertight entrance seal device on the accessible side.

d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.

e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.

3. Heating, Ventilating, and Air Conditioning Equipment:

a. Penetrate equipment in area established by manufacturer.

b. Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.

c. Seal penetration with silicone type sealant.

4. Corrosive-Sensitive Areas:

   a. Seal all conduit passing through chlorine and ammonia room walls.

   b. Seal all conduit entering equipment panel boards and field panels containing electronic equipment.

   c. Seal penetration with silicone type sealant.

5. Existing or Precast Wall (Underground): Core drill wall and install a watertight entrance seal device.

6. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):

   a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.

   b. Fill space between raceway and sleeve with an expandable plastic compound on each side.

7. Manholes and Handholes:

   a. Metallic Raceways: Provide insulated grounding bushings.

   b. Nonmetallic Raceways: Provide bell ends flush with wall.

   c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.6 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.

B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 40 percent extra space for future conduit.

C. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:

   1. Wood: Wood screws.

   2. Hollow Masonry Units: Toggle bolts.

   3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.

4. Steelwork: Machine screws.

D. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.7 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance with long radius elbows.

B. Make bends and offsets of longest practical radius.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory long radius elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:

1. Bends 30-Degree and Larger: Provide factory-made long radius elbows.

2. 90-Degree Bends: Provide rigid steel long radius elbows.

3. Use manufacturer's recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.8 EXPANSION/DEFLECTION FITTINGS

A. Provide on all raceways at all structural expansion joints, and in long tangential runs.

B. Provide expansion/deflection joints for 50 degrees F maximum temperature variation.

C. Install in accordance with manufacturer's instructions.

3.9 PVC CONDUIT

A. Solvent Welding:

1. Provide manufacturer recommended solvent; apply to all joints.

2. Install such that joint is watertight.

B. Adapters:

1. PVC to Metallic Fittings: PVC terminal type.
2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.

C. Belled-End Conduit: Bevel the unbelled end of the joint prior to joining.

3.10 PVC-COATED RIGID STEEL CONDUIT

A. Not used.

3.11 TERMINATION AT ENCLOSURES

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

B. Sheet Metal Boxes, Cabinets, and Enclosures:

1. Rigid Galvanized Conduit:

a. Provide one lock nut each on inside and outside of enclosure.

b. Install grounding bushing.

c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.

d. Install insulated bushing on ends of conduit where grounding is not required.

e. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.

2. Electric Metallic Tubing: Provide gland compression, insulated connectors.

3. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.

4. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.

5. PVC Schedule 80 Conduit: Provide PVC terminal adapter with lock nut.

C. Motor Control Center, Switchboard, Switchgear, and Free-Standing Enclosures: Terminate conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.

3.12 UNDERGROUND RACEWAYS

A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

B. Cover: Maintain minimum 2-foot cover above conduit and concrete encasement, unless otherwise shown.

C. Make routing changes as necessary to avoid obstructions or conflicts.

D. Couplings: In multiple conduit runs, stagger so that couplings in adjacent runs are not in same transverse line.

E. Union type fittings not permitted.

F. Spacers:

1. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.

2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.

G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

H. Installation with Other Piping Systems:

1. Crossings: Maintain minimum 12-inch vertical separation.

2. Parallel Runs: Maintain minimum 12-inch separation.

3. Installation over valves or couplings not permitted.

I. Metallic Raceway Coating: At couplings and joints and along entire length, apply wraparound duct band with one-half tape width overlap to obtain two complete layers.

J. Concrete Encasement: As specified in Section 03 00 00, Concrete.

1. Concrete Color: Gray, dust top of concrete ductbank with powdered red concrete dye before concrete sets and trowel dry onto top of ductbank.

K. Backfill:

1. As specified in Section 31 23 00, excavation and Fill.

2. Do not backfill until inspected by ENGINEER.

3.13 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Paragraph IDENTIFICATION DEVICES, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.14 IDENTIFICATION DEVICES

A. Raceway Tags:

1. Identify origin and destination.

2. Install at each terminus, near midpoint, and at minimum intervals of every 50 feet of exposed Raceway, whether in ceiling space or surface mounted.

3. Provide nylon strap for attachment.

B. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of runs.

C. Buried Raceway Markers:

1. Install at grade to indicate direction of underground raceways.

2. Install at all bends and at intervals not exceeding 100 feet in straight runs.

3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

3.15 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over all conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

END OF SECTION

SECTION 26 36 23.1 - AUTOMATIC TRANSFER SWITCH

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Automatic transfer switches (ATS) with delayed transition.

1.02 REFERENCES

A. Transfer switches shall be designed and manufactured to the latest revision of UL-1008 and shall be provided with a UL label.

1.03 SUBMITTALS

A. Submittals shall be provided in accordance with the general conditions but not less than six (6) copies.

B. Detailed fully engineered drawings shall be provided. Standard product data sheet will be rejected.

1.04 QUALIFICATIONS

A. To be considered for approval, a manufacturer shall be specialized in manufacturing products specified in this Section with a minimum of ten (10) years documented experience.

1.05 WARRANTY

A. Manufacturer shall warrant specified equipment to be free from defects in materials and workmanship for one (1) year from date of installation.

1.06 INTEGRATION

A. Units shall be provided to fully integrate with the standby generator system. Coordination shall be required.

PART 2 – PRODUCTS

2.01 MODEL

A. Model shall be Cutler Hammer or Lakeshore.

B. The switch shall be of the automatic power sensing, delayed transition type. The switch shall be UL approved rated to carry full

name plate current at all times. A manual handle shall be provided for emergency operation. Units shall be manually operable from the dead front without exposing the operation to live parts.

C. ATS Minimum Features

1. Voltage sensing on all three phases on normal and emergency sources with automatic low voltage and phase loss detection. Adjustable over/under frequency sensor shall be provided on the emergency source.

2. Adjustable time delay after line failure before engine start, 0-5 minutes.

3. Automatic transfer to generator when voltage is present.

4. Adjustable time delay on retransfer when normal power is available, 2-30 minutes. Push button to cancel time delay on return to normal.

5. Adjustable time delay for engine running unloaded after transfer to normal source, 2-30 minutes.

6. 4-Pilot lights or LEDs

   a. Green for switch in normal position.

   b. Red for switch in emergency position.

   c. Green for normal power available.

   d. Red for emergency power available.

7. 4-Position selector switch, maintained or keypad front door mounted on deadfront:

   a. Off – Switch position remains constant, generator shall not crank.

   b. Auto – Normal automatic control.

   c. Test – Test operation of the transfer system and standby generator by simulating line power loss. System shall remain in the test mode until selector switch in returned to the auto mode which will allow normal retransfer, logic and/or time delays shall be

provided to allow switch mode change without undesired actions.

d. Engine test – start engine without ATS transfer.

8. Status contacts (form A) wired to terminals (future monitoring):

   a. Switch in normal position.

   b. Switch in emergency position.

   c. Normal voltage present.

   d. Emergency voltage present.

9. Engine start contact (Form A) wired to terminals for engine start.

10. Short circuit withstand rating shall be 65,000 amps minimum.

11. Provide adjustable time delay for transition period in the neutral position with the pole of the switch de-energized.

12. Enclosure shall be NEMA 4X 316 SS, padlockable. Unit shall be front accessible only. Wall mounted. Provide top sunshields.

13. Provide lugs for cable connections as required.

14. Unit shall be U.L. labeled.

15. Installation Contractor shall be responsible for all field power and control wiring.

16. Provide digital multi-meter equal to Cutler Hammer IQ 200 Series with front panel display volts, amps, kWD etc. or equal.

17. The drawings include additional requirements. See the drawings.

18. ATS shall be electronic.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install ATS in accordance with manufacturers written instructions and the National Electrical Code.

3.02 FIELD QUALITY CONTROL

A. Inspect ATS visually.

B. Perform several manual operations.

C. Verify circuit continuity and megger each conductor. Minimum megger valve shall be 50 mega-ohms.

D. Check tightness of all connections using calibrated torque wrench per manufacturers recommended torque values.

3.03 ADJUSTING

A. Adjust time delay setting to values as required for proper operation of the power system.

3.04 TESTING

A. Test manual operation of the unit under load. Test all automatic features of ATS including transfer from normal to emergency and from emergency to normal, remote generator start control. Provide testing in the presence of the Owner and Engineer.

3.05 TRAINING

A. Provide a minimum of 4 hours training.

3.06 PROGRAMMING

A. Program switch features per Engineer/Owner requirements.

B. Provide typewritten listing of final parameter setting with O&M manuals.

C. Provided print out of all parameter settings.

END OF SECTION