

## **SECTION 15062**

### **DUCTILE IRON PIPE AND FITTINGS**

#### **PART 1 GENERAL**

##### **1.01 SCOPE OF WORK**

- A. Install within the project site all materials and incidentals including flanged joint, mechanical joint, push-on joint, and restrained joint ductile iron pipe and/or ductile iron restrained, flanged, or mechanical joint fittings for potable water mains, reclaimed water mains, wastewater treatment plant process piping, and gravity sewers, complete, as shown on the project drawings.
- B. The Contractor shall coordinate all deliveries with the related Vendor(s) in a manner not to impede construction.

##### **1.02 SUBMITTALS**

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples.
- B. Except as otherwise shown on the Drawings, either push-on, mechanical or flanged joints shall be used. Prior to commencing work, jointing systems for pipe shall be submitted to the Owner's Representative for approval. The joints of all buried pipe, fittings and valves on the treatment plant site shall be restrained.
- C. All ductile iron pipe and fittings to be installed under this Contract shall be inspected and tested at the foundry as required by the standard specifications to which the material is manufactured. Furnish in duplicate to the Owner's Representative sworn certificates of such tests and their results.
- D. Shop Drawings including layout drawings shall be submitted to the Owner's Representative for approval and shall include dimensioning, methods and locations of supports and all other pertinent technical specifications for all piping to be furnished. Layout Drawings shall be to scale, and shall clearly indicate the amount of pipe to be restrained from each fitting.

- E. The Contractor shall transmit from the Vendor to the Owner's Representative, the pipe manufacturer's certification of compliance with the applicable sections of the Specifications.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Pipe shall be supplied in lengths not in excess of 21-feet.
- B. Buried Pipe shall conform to ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51, current editions. Below grade pipe 4 to 12-inches in diameter shall be rubber-ring type push-on joint or mechanical joint, pressure Class 350. Below grade pipe 14 to 20-inches in diameter shall be rubber-ring type push-on joint, Pressure Class 250. Below grade pipe 24-inches in diameter shall be rubber-ring type push-on joint, pressure Class 200. Below grade pipe 30 to 60-inches in diameter shall be rubber-ring type push-on joint, pressure Class 150.
- C. Mechanical joint fittings for 4 to 24-inch diameter ductile iron pipe shall be compact ductile iron cast in accordance with ANSI/AWWA C153/A21.53. The working pressure rating for the fittings shall be 350 psi.
- D. Mechanical joint fittings for 30 to 60-inch diameter ductile iron pipe shall be compact ductile iron cast in accordance with ANSI/AWWA C153/A21.53. The working pressure rating for the fittings shall be 250 psi.
- E. Gaskets shall be EPDM (Ethylene-Propylene Dine Monomer) such as the "Fastite Gasket" of American Ductile Iron Pipe Co., or approved equal in conformance with ANSI/AWWA C111/A21.11, latest edition.
- F. All mechanical joints and push-on joints for pipe, fittings and valves on the wastewater treatment plant site shall be restrained. Restraints shall be Megalug by EBAA Iron, Romac, or equal. Restraints may also be American Ductile Iron Pipe's Fast Grip Gasket, U.S. Pipe's Field Lok Gasket, or equal.
- G. Below grade pipe shall have a one-mil coal tar enamel coating on the outside. The coal tar enamel shall be in accordance with ANSI/AWWA C151/A21.51.

- H. All buried ductile iron pipe and fittings shall be provided with a 4-mil thick cross laminated high density polyethylene encasement or an 8-mil thick polyethylene encasement per ANSI/AWWA C105/A21.5. Color of encasement shall be in accordance with Manatee County requirements based on the service type of the pipe.
- I. Flanged ductile-iron pipe for above ground piping shall conform to current ANSI/AWWA C115/A21.15 with factory applied screwed long hub flanges except as otherwise specified hereinafter. Flanges shall be faced and drilled after being screwed on the pipe with flanges true to 90 degrees with the pipe axis and shall be flush with end of pipe conforming to ANSI B16.1, 125 pounds standard. Flanged pipe shall be special thickness Class 53.
- J. Flanged fittings shall be ductile as specified herein. Flanges and flanged fittings shall be flat face and shall conform to ANSI/AWWA C110/A21.10 for 350 psi pressure ratings between 4 and 24-inch diameter pipe and for 250 psi pressure ratings for 30 to 60-inch diameter pipe. Full face type 1/8-inch thick SBR rubber ring gaskets shall conform to ANSI/AWWA C111/A21.11.
- K. Bolts and nuts on flanged fittings shall be Grade B, ASTM A-307, cadmium plated and conform to ANSI B16.1 for Class 125.
- L. Pipe and fittings exposed to view in the finished work to be painted shall not receive the standard tar or asphalt coat on the outside surfaces but shall be shop primed on the outside with one coat of Koppers No. 621 rust inhibitive primer or approved equal. All other pipe and fittings shall be shop coated on the outside with a 1.0 mil thick bituminous coat in accordance with ANSI/AWWA C151/A21.51.
  - 1. Should portions of the pipe inadvertently be given the outside coating of coal tar enamel instead of the rust inhibitive primer as required for exposed piping, the surfaces shall be sealed with a non-bleeding sealer coat such as Kopcoat Inertol Tar Stop, or Mobil Anti-bleeding Aluminum Sealer. Sealing shall be part of the work of this section.

- M. All ductile iron pipe and fittings carrying clarifier effluent, effluent, filter effluent, reclaimed water, reject, waste backwash from disk filters, and potable water shall have a standard thickness cement lining and seal coats on their interiors in accordance with ANSI/AWWA C104/A21.4.
- N. All ductile iron pipe and fittings carrying raw wastewater, internal recycle, mixed liquor, plant drain wastewaters, return activated sludge, thickened sludge and waste activated sludge shall have an interior lining of Protecto 401 ceramic epoxy applied at a nominal thickness of 40 mils. The Protecto 401 material shall be a high-build, multi-component, Amine-cured, Novalac epoxy lining. At least 20% of the volume of the lining material shall be ceramic quartz pigment. The linings shall be checked for thickness using a magnetic film thickness gauge and the method outlined in SSPC-PA-2, Film Thickness Rating. The interior lining of all pipe and fittings shall be tested for pinholes with a non-destructive 2,500 volt test. Each pipe and fitting shall be marked with the date of application of the lining system and with its sequence number of application on that date. The pipe and fitting manufacturers shall supply a certificate attesting that the lining material used was as specified, and that the lining material was applied as required by the specifications and the lining material manufacturer.
- O. All interior linings for potable water piping shall be EPA/NSF approved.
- P. Pipe and fitting manufacturers shall be the American Cast Iron Pipe Company, U.S. Pipe and Foundry Company, McWane, Tyler, or approved equal.

### **PART 3 EXECUTION**

#### **3.01 HANDLING PIPE AND FITTINGS**

- A. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before installation, and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired as directed by the Owner's Representative.

- B. All pipe and fittings shall be subjected to a careful inspection and hammer test just prior to being installed.
- C. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional expense to the Owner.

### **3.02 UNDERGROUND PIPE INSTALLATION**

- A. Alignment and Grade: The pipelines shall be laid and maintained to lines and grades established by the Drawings and Specifications, with fittings, valves and hydrants at the required locations unless otherwise approved by the Owner's Representative. Valve-operating stems shall be oriented to allow proper operation. Hydrants shall be installed plumb.
- B. Underground Conflicts: Prior to excavation, investigation shall be made to the extent necessary to determine the location of existing underground structures and conflicts. Care shall be exercised to avoid damage to existing structures. When obstructions that are not shown on the drawings are encountered during the progress of the work and interfere so that an alteration of the Drawings is required, the Owner's Representative will alter the Drawings or order a deviation in line and grade or arrange for removal, relocation, or reconstruction of the obstructions. When crossing existing pipelines or other structures, alignment and grade shall be adjusted as necessary, with the approval of the Owner's Representative, to provide clearance as required by federal, state, or local regulations or as deemed necessary by the Owner's Representative to prevent future damage or contamination of either structure.
- C. Trench Construction:
  - 1. Trench preparation shall proceed in advance of pipe installation for only as far as necessary to allow proper pipe installation. The width of the trench at the top of the pipe shall be ample to permit the pipe to be laid and joined properly and allow the backfill to be placed as specified.
  - 2. Bedding shall be provided and compacted in accordance with the details shown on the Drawings.

3. Holes for the bells shall be provided at each joint but shall not be larger than necessary for joint assembly and assurance that the pipe barrel will lie flat on the trench bottom. Other than noted previously, the trench bottom shall be true and even in order to provide support for the full length of the pipe barrel, except that slight depression may be provided to allow withdrawal of pipe slings or other lifting-tackle.
4. When excavation of rock is encountered, all rock shall be removed to provide a clearance of at least 6-inches below and on each side of all pipe, valves, and fittings for pipe sizes 24-inches or smaller, and 9-inches for pipe 30- inches and larger. When excavation is completed, a bed of sand, crushed stone or earth that is free from stones, large clods, or frozen earth shall be placed on the bottom of the trench to the previously mentioned depths, leveled, and tamped. These clearances and bedding procedures shall also be observed for pieces of concrete or masonry and other debris or subterranean structures, such as masonry walls, piers, or foundations that may be encountered during excavation.
5. This installation procedure shall be followed when gravel formations containing loose boulders greater than 8 inches in diameter are encountered. In all cases, the specified clearances shall be maintained between the bottom of all pipe and appurtenances and any part, projection, or point of rock, boulder, or stones of sufficient size and placement which, in the opinion of the Engineer could cause a fulcrum point.
6. Should the trench pass over a sewer or other previous excavation, the trench bottom shall be sufficiently compacted to provide support equal to that of the native soil or conform to other regulatory requirements in a manner that will prevent damage to the existing installation.
7. When the subgrade is found to be unstable or to include ashes, cinders, refuse, organic material, or other unsuitable material, such material shall be removed, to a minimum of at least 3-inches, or to the depth ordered by the Engineer and replaced under the directions of the Engineer with clean, stable backfill material. The bedding shall be

consolidated and leveled in order that the pipe may be installed as specified.

8. When the bottom of the trench or the subgrade is found to consist of material that is unstable to such a degree that, in the judgment of the Engineer it cannot be removed, a foundation for the pipe and/or appurtenance shall be constructed using piling, timber, concrete, or other materials at the direction of the Engineer.

### **3.03 PIPE INSTALLATION**

- A. Proper implements, tools, and facilities shall be provided and used for the safe and convenient performance of the work. All pipe, fittings, valves, and hydrants shall be lowered carefully into the trench by means of a derrick, ropes, or other suitable tools or equipment in such a manner as to prevent damage to pipeline material and protective coatings and linings. Under no circumstances shall pipeline materials be dropped off or dumped into the trench. The trench shall be dewatered prior to installation of the pipe.
- B. All pipe fittings, valves, hydrants, and other appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective materials shall be marked and held for inspection by the Owner's Representative who may prescribe corrective repairs or reject the materials.
- C. All lumps, blisters, and excess coating shall be removed from the socket and plain ends of each pipe, and the outside of the plain end and the inside of the bell shall be wiped clean and dry and be free from dirt, sand, grit, or any foreign material before the pipe is laid.
- D. Foreign material shall be prevented from entering the pipe while it is being placed in the trench. During laying operations, no debris, tools, clothing, or other materials shall be placed in the pipe.
- E. As each length of pipe is placed in the trench, the joint shall be assembled and the pipe brought to correct line and grade. The pipe shall be secured in place with approved backfill material.
- F. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or

other means approved by the Owner's Representative. When practical, the plug shall remain in place until the trench is pumped completely dry. Care shall be taken to prevent pipe flotation should the trench fill with water.

- G. Trench width at the top of pipe, bedding conditions, and backfill placement and compaction shall be such that design loadings on the pipe will not be exceeded.
- H. Joint Assembly: Pipe joints shall be assembled in accordance with the Manufacturer's instructions and the requirements of ANSI/AWWA C600.
- I. Pipe Deflection: When it is necessary to deflect pipe from a straight line in either the vertical or horizontal plane, or where long radius curves are permitted, the amount of deflection shall not exceed that shown in AWWA C600, latest edition.
- J. Pipe Cutting: Cutting pipe for the insertion of valves, fittings, or closure pieces shall be done in a neat, workmanlike manner without creating damage to the pipe or lining. Ductile cast iron may be cut using an abrasive pipe saw, rotary wheel cutter, guillotine pipe saw, milling wheel saw, or oxyacetylene torch. Cut ends and rough edges shall be ground smooth and for push-on joint connections, the cut end shall be beveled.
- K. Thrust Restraint:
  - 1. All pipe joints, plugs, caps, tees, and bends shall be suitably restrained by attaching steel tie rods or restrained joints as specified.
  - 2. Thrust-restraint design pressure shall be equal to the test pressure of the line.
  - 3. Restrained mechanical joints utilizing setscrew retainer glands or steel harness and tie rods shall be used in place of concrete. Steel tie rods or other components of dissimilar metal shall be protected against corrosion by hand application of a bituminous coating or by encasement of the entire assembly within an 8-mil thick, loose polyethylene casing in accordance with ANSI/AWWA C105/A21.5.



### **3.04 ABOVE GROUND PIPE INSTALLATION**

- A. Install pipe in horizontal or vertical planes, parallel or perpendicular to building surfaces unless otherwise shown. Support pipe and fittings to prevent strain on joints, valves and equipment. Install flanged joints so that contact faces bear uniformly on the gasket. Tighten bolts with relatively uniform stress.

### **3.05 TESTING**

- A. Hydrostatic pressure and leakage test shall conform to Section 4 of AWWA C600, with the exception that the Contractor shall furnish all gauges, meters, pressure pumps and other equipment needed to test the line.
- B. The pressure required for the field hydrostatic pressure test shall be 180 psi for potable water lines and reclaimed water lines, and shall be 150 psi for force mains. The Contractor shall provide temporary plugs and blocking necessary to maintain the required test pressure of 180 psi or 150 psi. Corporation cocks at least 3/4-inches in diameter, pipe riser and angle globe valves shall be provided at each pipe dead-end in order to bleed air from the line. Duration of pressure test shall be at least two hours.
- C. The leakage test may be conducted at the same time as the pressure test, and shall be of not less than one hour duration. All leaks evident at the surface shall be repaired and leakage eliminated regardless of total leakage as shown by test. Lines which fail to meet tests shall be repaired and retested as necessary until test requirements are complied with. Defective materials, pipes, valves and accessories shall be removed and replaced. The pipe lines shall be tested in such sections as may be required. The line shall be filled with water and all air removed and the test pressure shall be maintained in the pipe for the entire test period by means of a force pump to be furnished by the Contractor. Accurate means shall be provided for measuring the water required to maintain this pressure. The amount of water required is a measure of the leakage.
- D. The amount of leakage which will be permitted shall be in accordance with AWWA C600 Standards for all pressure tests. No pipe installation shall be accepted if the

leakage is greater than that determined by the following formula:

$$L = \frac{SD(P)^{1/2}}{133,200^*}$$

L = Leakage in gallons per hour  
S = Length of pipe in feet  
D = Nominal diameter in inches  
P = Pressure in psi

\* Note: If 20-foot pipe lengths are used, factor to be 148,000

- E. Ductile iron pipe used for gravity sanitary sewers shall be tested for leakage by conducting infiltration tests, exfiltration tests, or low pressure air tests.

### **3.06 SURFACE PREPARATION AND PAINTING**

- A. All piping and fittings exposed to view shall have their surfaces prepared and painted with a prime coat as defined in these Specifications. Surface preparation and shop priming is a part of the work of this Section.

**END OF SECTION**

## **SECTION 15063**

### **HIGH DENSITY POLYETHYLENE (HDPE) PIPE**

#### **PART 1 GENERAL**

##### **1.01 DESCRIPTION OF WORK**

- A. This Section includes materials and methods of installation of HDPE pipe. Pipe is intended for use in a reclaimed water system or in a potable water system.

##### **1.02 SUBMITTALS**

- A. Provide manufacturer's Certificate of Compliance with specified requirements.
- B. All submittals shall be in accordance with Section 01340 - Shop Drawings, Project Data and Samples.

##### **1.03 HANDLING AND STORAGE**

- A. All pipe, fittings, valves and accessories shall be loaded and unloaded by lifting with hoists or by skidding in order to avoid shock or damage. Under no circumstances shall materials be dropped. Pipe handled on skidways shall not be rolled or skidded against pipe on the ground. Slings, hooks or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior surface or interior of the pipe.
- B. Materials, if stored, shall be kept safe from damage. The interior as well as all sealing surfaces of all pipe, fittings, and other appurtenances shall be kept free from dirt or foreign matter at all times. Valves shall be drained and stored in a manner that will protect them from damage or freezing.
- C. Pipe stored outside and exposed to prolonged periods of sunlight shall be covered with canvas or other opaque material. Air circulation shall be provided under covering.
- D. Pipe shall not be stacked higher than the limits recommended by the manufacturer. The bottom tiers shall be kept off the ground on timbers, rails, or concrete. Pipe shall not be stored close to heat sources.

- E. Gaskets shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis. Mechanical-joint bolts shall be handled and stored in a manner that will ensure proper use with respect to types and sizes.

#### **1.04 REFERENCE DOCUMENTS**

- A. Ductile Iron Pipe ANSI/AWWA C151/A21.51
- B. HDPE Pipe AWWA C906.
- C. HDPE Pipe AWWA C901.
- D. Water Resources Act, Chapter 373, F.S.
- E. Chapter 17-40 Florida Administrative Code.
- F. Chapter 17-610 Florida Administrative Code.
- G. American National Standards Institute (ANSI).
- H. American Water Works Association (AWWA).
- I. American Society for Testing Materials (ASTM)
- J. American Association of State Highway Transportation Officials (AASHTO).
- K. American Society of Sanitary Engineers (ASSE).
- L. Plastic Pipe Institute (PPI).

#### **1.05 SHOP DRAWINGS AND SUBMITTALS**

- A. In general, shop drawings and related manufacturer's product certification shall be made in accordance with the General and Special Conditions of the Contract for approval prior to construction or fabrication of the material by the manufacturer. The following items which require shop drawings are brought to the Contractor's attention. The list may not include all items for which shop drawing submittals are required to meet the requirements of the project.
  - 1. Detail drawings of all classes of pipe, joints, and fittings.

2. Detail Drawings of restrained and flexible joints, including test reports to confirm thrust restraint capacities and restraining mechanism application.
  3. Pipeline laying schedule tabulated and referenced to construction line and grade controls shown on plans, with station, offset and elevations. References shall be provided for pipe fittings, valves, service connections and other important features of the pipeline.
  4. All Appurtenant Items.
- B. Certification and test reports for the materials, manufacturing, and testing of the types of pipe supplied shall be performed and furnished by the pipe manufacturer in accordance with the latest standards of the industry as described in Sub-section 1.2 herein.
- C. Provide a statement in writing from the HDPE pipe manufacturer that it is listed with the Plastic Pipe Institute as a qualified extruder for the polyethylene resin being used to manufacture the pipe for this project.

## **PART 2 PRODUCTS**

### **2.01 REFERENCES**

- A. The following documents are a part of this Section. Where this Specification section differs from these documents, the requirements of this section shall apply.
1. ASTM D1248-84, Polyethylene Plastics Molding and Extrusion Materials.
  2. ASTM D3350-84, Polyethylene Plastic Pipe and Fittings Material.
  3. ASTM F714-85, Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

### **2.02 HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS**

- A. General:
1. All High Density Polyethylene (HDPE) shall be manufactured by Driscopipe, a subsidiary of Phillips Petroleum Company; PLEXCO, Division of Chevron Chemical Company; or approved equal.

2. All HDPE pipe 4-inches in diameter and larger shall have a Ductile Iron Pipe outside diameter unless otherwise specified in the Contract Documents.
3. All HDPE piping system components shall be the products of one manufacturer.

B. HDPE Pipe Specifications

1. High Density Polyethylene pipe 4-inches diameter and larger shall conform to material standard ASTM D3350 345464 C/E cell classification rated as PE 3408 by the Plastics Pipe Institute. Minimum pressure rating shall be 160 psi SDR 11 (Standard Dimension Ratio) for pipe sizes 4 inches and greater in diameter. For pipe sizes 3-inches and smaller in diameter, the minimum pressure rating shall be 200 psi SDR 9. All pipe 4-inches in diameter and greater shall have a ductile iron pipe O.D. HDPE pipe ½ " to 3-inches in diameter shall have a steel pipe O.D. Pressure ratings are at standard test conditions and temperature of 73.4°F (23°C).
2. The polyethylene compound shall be suitably protected against degradation by ultraviolet light by means of carbon black, well dispersed by precompounding in a concentration of not less than 2 percent.
3. The maximum allowable hoop stress shall be 800 psi at 73.4 degrees F.
4. The pipe manufacturer shall be listed with the Plastic Pipe Institute as meeting the recipe and mixing requirements of the resin manufacturer for the resin used to manufacture the pipe in this project.

C. Fittings.

1. D.I./HDPE Mechanical Joint Adaptors.
  - a. The manufacturer of the HDPE pipe shall supply all D.I./HDPE mechanical joint adaptors and accessories required to perform the work as shown on the Drawings.
  - b. The D.I./HDPE mechanical joint adaptor shall consist of:

- (1) A molded or fabricated HDPE mechanical joint transition fitting
  - (2) A standard rubber gasket for a D.I. mechanical joint.
  - (3) A D.I. mechanical joint backup drive ring.
  - (4) Cor-Ten mechanical joint tee bolts.
  - (5) A stainless steel stiffener inserted in the MJ end of the HDPE transition fitting.
- c. The D.I./HDPE mechanical joint adaptor shall be connected to the HDPE pipe by a heat-fused joint on one end, and connected to a ductile iron pipe valve, or fitting with a mechanical joint on the other end.
- d. The tee bolts and backup drive ring shall act as a joint restraint to keep the connecting pieces from pulling apart.
- e. The HDPE transition fitting shall be molded or fabricated by the manufacturer of the HDPE pipe. All molded fittings shall be fully pressure rated to match the SDR pressure rating for which they are made. Fabricated fittings shall be rated for internal pressure service equivalent to the full pressure rating of the mating pipe.
- f. If rework compounds are required, only those generated in the manufacturer's own plant from resin compounds of the same class and type from the same raw material supplier shall be used.
- g. Solvent epoxy cementing and mechanical joining with bolt on wrap around clamps shall not be used for connections.

D. HDPE Pipe Jointing Method

1. HDPE pipe shall be jointed by the butt-fusion process in accordance with pipe manufacturer's directions. Contractor shall provide butt-fusion technicians who are trained and certified by the P.E. pipe manufacturer to complete the project. The date of technician certification shall not exceed 12 months before commencing construction.

2. All HDPE pipe joined by butt-fusion shall be made from the same class and type of raw material made by the same raw material supplier.
3. Butt-fusion means the butt-joining of the pipe by softening the aligned faces of the pipe ends in a suitable apparatus and pressing them together under controlled pressure.
4. The internal and external beads resulting from the butt-fusion process shall be visible and examined for penetration 360 degrees around the pipe diameter.
5. Short pieces of pipe between valves and fittings shall be DIP with all joints restrained for sizes 4-inches and larger. For 3-inch and smaller HDPE pipe, the short pieces shall be brass or Sch. 80 PVC with IP threads and DI, HDPE or brass fittings with all joints restrained.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. All polyethylene pipe shall be cut, fabricated, and installed in strict conformance with the pipe manufacturer's recommendations. Joining, laying, and pulling of polyethylene pipe shall be accomplished by personnel experienced in working with polyethylene pipe. The pipe supplier shall certify in writing that the Contractor is qualified to join, lay, and pull the pipe or representative of the pipe manufacturer shall be on site to oversee the pipe joining. Expenses for the representative shall be paid for by the Contractor.

### **3.02 PIPE INSPECTION**

- A. The Contractor shall obtain from the pipe manufacturer a certificate of inspection to the effect that the pipe and fittings supplied for this Contract have been inspected at the plant and that they meet the requirements of these specifications. The Contractor shall submit these certificates to the Engineer prior to installation of the pipe materials. All pipe and fittings shall be subjected to visual inspection at time of delivery and before they are lowered into the trench to be laid. Joints or fittings that do not conform to these specifications will be rejected and must be removed immediately by the Contractor. The entire product of any plant may be rejected when, in



the opinion of the Owner, the methods of manufacture fail to secure uniform results, or where the materials used are such as to produce inferior pipe or fittings.

### **3.03       TRANSPORTATION**

- A. Care shall be taken during transportation of the pipe that it is not cut, kinked, or otherwise damaged.

### **3.04       STORAGE**

- A. Pipes shall be stored on level ground, preferably turf or sand, free of sharp objects which could damage the pipe. Stacking of the polyethylene pipe shall be limited to a height that will not cause excessive deformation of the bottom layers at pipes under anticipated temperature condition. Where necessary due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such widths as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.
- B. Pipes shall be stored in such a manner as to limit their exposure to ultraviolet light as the pipe color will fade. Excessive loss of color in the pipe material may result in the rejection of piping material by the Project Representative.

### **3.05       HANDLING PIPE**

- A. The handling of the joined pipeline shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. Ropes, fabric, or rubber-protected slings and straps shall be used when handling pipes. Chains, cables, or hooks inserted into the pipe ends shall not be used. Two slings spread apart shall be used for lifting each length of pipe. Pipe or fittings shall not be dropped onto rocky or unprepared ground. Slings for handling the pipeline shall not be positioned at butt-fused joints. Sections of the pipes with cuts and gouges exceeding 10 percent of the pipe wall thickness or kinked sections shall be removed and the ends rejoined. The dragging of fused HDPE pipe along asphalt and concrete paving will not be allowed.
- B. The open ends of all sections of joined and/or installed pipe (not in service) shall be plugged at night to prevent animals or foreign material from entering the pipe line or pipe section.
- C. Waterproof nightcaps of approved design may be used but they shall be so constructed that they will prevent the entrance of any type of natural precipitation into the

pipe and will be fastened to the pipe in such a manner that the wind cannot blow them loose.

- D. The practice of stuffing cloth or paper in the open ends of the pipe will not be permitted.
- E. Where possible, the pipe shall be raised and supported at a suitable distance back from the open end such that the open end will be below the level of the pipe at the point of support.

### **3.06 LAYING PIPE.**

#### **A. Joints:**

- 1. All HDPE pipe shall be jointed by the heat fusion process which produces homogeneous, seal, leak tight joints.
- 2. Restrained mechanical joints shall be provided at tie-ins with valves and other pipe materials.

#### **B. Butt Fusion Testing:**

- 1. Contractor shall test the first fusion of the day on a daily basis.
- 2. In testing, the fusion shall be allowed to cool completely, and then fusion test straps shall be cut out. The test shall be a minimum of 12" or 30 times the wall thickness in length with the fusion in the center, and minimum of 1" or 1.5 times the wall thickness in width. Bend the test strap until the ends of the strap touch. Contractor shall not commence until a fusion test has passed the bent strap test.

### **3.07 PIGGING, FLUSHING AND CLEANING**

- A. All mains shall be pigged, cleaned and flushed to remove all sand and other foreign matter. The Contractor shall be responsible for developing a pigging and flushing plan to be submitted to the Engineer for approval prior to pigging and flushing. The Contractor shall dispose of all water used for pigging and flushing without causing a nuisance or property damage. Any permits required for the disposal of flushing water shall be the responsibility of the Contractor.
- B. Flushing water used by the Contractor for reclaimed water mains shall be provided by the County at the Southwest Water Reclamation Facility. The flushing

water shall consist of plant effluent (reclaimed water). The Contractor shall be responsible for conveying the reclaimed water to the point of application. Flushing water for potable water mains shall be taken by the Contractor from the potable water system at the Southwest Water Reclamation Facility. The County will provide a water meter and backflow device, the Contractor shall compensate the County for the meter usage and the quantity of potable water used.

### **3.08 INSPECTION AND TESTING**

- A. All HDPE pipelines shall remain undisturbed for 24 hours to develop complete strength at all joints. The Contractor shall conduct two (2) hydrostatic tests on each HDPE pipeline. The first test shall be performed when the pipe is above ground and before it is installed. The second test shall be performed on the pipe when it is below ground after installation.
- B. Hydrostatic Testing for High Density Polyethylene Pipe:
  - 1. HDPE hydrostatic testing shall be done in accordance with ASTM 2164-02 as briefly described below. Testing phase shall last 2-hours.
  - 2. For any test pressure from 1.0 to 1.5 times the system design pressure, the total test time including initial pressurization, initial expansion, and time at test pressure, shall not exceed eight (8) hours. If the pressure test is not completed due to leakage, equipment failure or other reason, the test section shall be depressurized, and allowed to "relax" for at least eight (8) hours before bringing the test section up to test pressure again.
  - 3. The test procedure consists of initial expansion, and the test phase:
    - a. During the initial expansion phase, the test section is pressurized to 10 psi above the test pressure (see Table A for Expansion Pressure), and sufficient make-up water is added each hour for three (3) hours to return to the expansion phase pressure.
    - b. After the initial expansion phase, about four (4) hours after pressurization, the test phase begins.
    - c. During the test phase, the pipe is stabilized at the test pressure (see Table A). The pressure shall remain steady within 5% of

this target value for two (2) hours. If the pressure falls below 5% of the test pressure (see Table A), leakage or insufficient expansion is indicated, and the test shall be repeated after the pipe is allowed to "relax" as indicated above. Make-up water is not allowed during the test phase.

TABLE A

Pipe Class	Expansion Pressure	Test Pressure	5% Pressure Reduction
SDR 17	150 psi	140 psi	133 psi
SDR 13.5	170 psi	160 psi	152 psi
SDR 11	170 psi	160 psi	152 psi
SDR 9	210 psi	200 psi	190 psi

### **3.9 CONNECTIONS TO EXISTING SYSTEM**

- A. Connections to existing pipelines shall be made as shown on the Contract Drawings. Coordination between the Owner and the Contractor shall be required in order to accomplish this task. The Contractor shall supply connection procedures to the Owner for approval two (2) weeks prior to the proposed connection date.

**END OF SECTION**

## **SECTION 15067**

### **PLASTIC PIPE FOR PRESSURE SERVICE**

#### **PART 1 - GENERAL**

##### **1.01 DESCRIPTION OF WORK**

- A. This Section includes materials and methods of installation of Plastic Pipe for pressure service as shown on the Drawings and as Specified herein.

##### **1.02 SUBMITTALS**

- A. Three certified copies of the tests made by the manufacturer or by a reliable commercial laboratory shall be submitted to the Engineer with each shipment of pipe.
- B. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples.

##### **1.03 HANDLING AND STORAGE**

- A. All pipe, fittings, valves, hydrants and accessories shall be loaded and unloaded by lifting with hoists or by skidding in order to avoid shock or damage. Under no circumstances shall materials be dropped. Pipe handled on skidways shall not be rolled or skidded against pipe on the ground. Slings, hooks or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior surface or interior of the pipe.
- B. Materials, if stored, shall be kept safe from damage. The interior as well as all sealing surfaces of all pipe, fittings, and other appurtenances shall be kept free from dirt or foreign matter at all times. Valves and hydrants shall be drained and stored in a manner that will protect them from damage or freezing.
- C. Pipe stored outside and exposed to prolonged periods of sunlight shall be covered with canvas or other opaque material. Air circulation shall be provided under covering.
- D. Pipe shall not be stacked higher than the limits recommended by the manufacturer. The bottom tiers shall be kept off the ground on timbers, rails, or concrete.

Pipe in tiers shall be alternated: bell, plain end; bell, plain end. Pipe shall not be stored close to heat sources.

- E. Gaskets shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis. Mechanical-joint bolts shall be handled and stored in a manner that will ensure proper use with respect to types and sizes.

## **PART 2 - MATERIALS AND EQUIPMENT**

### **2.01 PLASTIC PIPE**

- A. Pipe for pressure service shall be Class 12454-A or B rigid PVC compound in accordance with the requirements of ASTM D1784. Pipe and appurtenances for use in potable water systems shall bear the seal of approval for potable water use of the National Sanitation Foundation or other accredited testing laboratory. All pipe shall have markings indicating pipe size, manufacturer's name, AWWA and/or ASTM specification number, working pressure, and production code.
- B. PVC pressure rated pipe having a nominal diameter between 1.5" and 3", shall be made of 2000 psi hydrostatic design stress compounds designated PVC 1120 and shall conform to ASTM D2241. PVC pipe shall be furnished in 20-foot lengths unless otherwise noted. PVC pipe shall have a standard dimension ratio of SDR 21 and a water pressure rating of 200 psi. Pipe couplings shall have a dimension ratio of SDR 21 and a water pressure rating of 200 psi. Pipe shall have both ends beveled for use with gasketed couplings or one end beveled and one end with a bell. Couplings and gaskets shall be furnished with each length of pipe. Rubber ring gaskets shall conform to ASTM D3139 Nontoxic gasket lubricant shall be as specified by the manufacturer.
- C. Pressure pipe 4-inches through 12-inches in diameter shall conform to the requirements of AWWA C900 for PVC pipe with cast iron pipe equivalent outside diameters. Pipe shall be minimum pressure class 150 unless otherwise shown. Pipe shall have a minimum wall thickness equivalent to a dimension ratio of DR 18 unless otherwise shown. Pipe may be furnished with plain ends for use with elastomeric-gasket couplings or with one end plain and one end with a gasket bell.

Couplings and gaskets shall be furnished with the pipe. Gaskets shall conform to ASTM D3139. Nontoxic gasket lubricant shall be as specified by the pipe manufacturer.

- D. Pressure pipe 14-inches through 48-inches in diameter shall conform to the requirements of AWWA C 905 for PVC pipe with cast iron pipe equivalent outside diameters. Pipe 14-inch through 48-inch shall have a minimum wall thickness equivalent to a dimension ratio of DR 25 unless otherwise shown. Pipe shall be pressure Class 165 unless otherwise shown. Pipe may be furnished with plain ends for use with elastometric gasket couplings or with one end plain and one end with a gasket bell. Couplings and gaskets shall be furnished with the pipe. Gaskets shall conform to ASTM 1869. Non-toxic gasket lubricant shall be as specified by the pipe manufacturer.

## **2.02 FITTINGS**

- A. Fittings for use with PVC pipe 3-inches through 24-inches in diameter shall be compact mechanical joint ductile-iron fittings conforming to the requirements of ANSI/AWWA C153/A21.53. Fittings for use with pipe 30-inches and larger shall be mechanical joint gray iron or ductile-iron conforming to the requirements of ANSI/AWWA C111/A21.11a. Bolts for use with mechanical joints shall conform to the requirements of the joint standard. Fittings shall be suitable for a working pressure of 150 psi.
- B. Exterior Coating. Fittings for buried service shall be coated with a 1 mil thick coal-tar enamel coating or a fusion-bonded epoxy coating. The finished coating shall be continuous, smooth, neither brittle when cold nor sticky when exposed to the sun and shall be strongly adherent to the pipe.
- C. Polyethylene Encasement. All buried ductile iron fittings shall be provided with a 4-mil thick cross-laminated high density polyethylene encasement or an 8-mil thick polyethylene encasement per ANSI/AWWA C105/A21.5.
- D. Fittings in exposed locations which are to be painted shall be primed with a universal shop primer suitable for use under the finish paint specified.
- E. Linings. Fittings shall have a cement-mortar lining conforming to the requirements of ANSI/AWWA C104/A

21.4, a fusion-bonded epoxy lining, or a Protecto 401 ceramic epoxy lining depending upon the type of fluid being conveyed. Cement mortar linings and fusion-bonded epoxy linings shall be used for all ductile iron fittings conveying potable water, reclaimed water, and waste backwash from the disk filters. Protecto 401 shall be used for all ductile iron fittings conveying wastewater sludge, sand filter backwash water, leachate, mixed liquor, sludge thickening water, and plant drain water.

## **2.03 RESTRAINED JOINTS**

- A. Restrained Joints. Restrained joints for use with PVC pipe shall consist of retainer glands fabricated of ductile-iron conforming to ASTM A536. The gland shall be such that it can replace the standard mechanical joint gland and can be used with the standardized mechanical joint bell conforming to ANSI/AWWA A21.11/C111 and ANSI/AWWA A21-53/C153. The retainer glands shall have a pressure rating equal to that of the PVC pipe on which it is used.
- B. PVC push-on joints adjacent to restrained fittings shall be restrained using harness restraint devices. This harness restraint shall be split to enable installation of the restraint after the spigot has been installed into the bell. The restraint shall consist of a split ring that fits behind the bell, a split restraint ring that installs on the spigot and a number of tie bars to connect the other two parts. Restraint components shall be of ductile-iron conforming to ASTM A536. The restraint ring shall consist of a plurality of individually activated gripping surfaces to hold the spigot and maximize restraint capability.
- C. Twist off nuts, sized same as the tee-head bolts shall be used to insure proper actuating of restraining devices.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Excavation. Excavate trenches as specified in Section 02221 - Trenching, Bedding and Backfill for Pipe.
- B. All pipe and appurtenances shall be examined at the point of delivery. Material found to be defective due



to manufacture or damage in shipment shall be rejected. Tests as specified in the applicable material standard may be performed to ensure conformance with the standard.

### **3.02 TRENCH CONSTRUCTION**

- A. Alignment and Grade. The pipelines shall be laid and maintained to the lines and grades established by the Drawings and Specifications, with fittings, valves and hydrants at the required locations unless otherwise approved by the Engineer. Valve-operating stems shall be oriented to allow proper operation. Hydrants shall be installed plumb.
- B. Underground Conflicts. Prior to excavation, investigation shall be made to the extent necessary to determine the location of existing underground structures and conflicts. Care shall be exercised to avoid damage to existing structures. When obstructions that are not shown on the drawings are encountered during the progress of work and interfere so that an alteration of the plans is required, the Owner's Representative will alter the Drawings or order a deviation in line and grade or arrange for removal, relocation, or reconstruction of the obstructions. When crossing existing pipelines or other structures, alignment and grade shall be adjusted as necessary, with the approval of the Owner's Representative, to provide clearance as required by the Owner's Representative to prevent future damage or contamination of either structure.
- C. Trench Construction. The trench shall be excavated to the required alignment, depth, and width. Trench preparation shall proceed in advance of pipe installation for only as far as necessary to allow proper pipe installation. The width of the trench at the top of the pipe shall be ample to permit the pipe to be laid and joined properly and allow the backfill to be placed as specified.
- D. PVC pipe shall be installed with pipe bedding and backfill as shown on the drawings.
- E. Holes for the bells shall be provided at each joint but shall not be larger than necessary for joint assembly and assurance that the pipe barrel will lie flat on the trench bottom. Other than noted previously, the trench bottom shall be true and even in order to provide support for the full length of the pipe barrel, except

that a slight depression may be provided to allow withdrawal of pipe slings or other lifting tackle.

- F. When excavation of rock is encountered, all rock shall be removed to provide a clearance of at least 6-inches below and on each side of all pipe, valves and fittings. When excavation is completed, a bed of sand, crushed stone or earth that is free from stones, large clods, or frozen earth, shall be placed on the bottom of the trench to the previously mentioned depths; leveled, and tamped. These clearances and bedding procedures shall also be observed for pieces of concrete or masonry and other debris of subterranean structures, such as masonry walls, piers, or foundations that may be encountered during excavation. This installation procedure shall be followed when gravel formations containing loose boulders greater than 8-inches in diameter are encountered. In all cases, the specified clearances shall be maintained between the bottom of all pipe and appurtenances and any part, projection, or point or rock, boulder, or stones of sufficient size and placement which, in the opinion of the Engineer could cause a fulcrum point.
- G. Should the trench pass over a sewer or other previous excavation, the trench bottom shall be sufficiently compacted to provide support equal to that of the native soil or conform to other regulatory requirements in a manner that will prevent damage to the existing installation.
- H. When the subgrade is found to be unstable or to include ashes, cinders, refuse, organic material, or other unsuitable material, such material shall be removed, to a minimum of at least 4-inches, or to the depth ordered by the Engineer and replaced under the directions of the Engineer with clean, stable backfill material. The bedding shall be consolidated and leveled in order that the pipe may be installed as specified.
- I. When the bottom of the trench or the subgrade is found to consist of material that is unstable to such a degree that, in the judgment of the Engineer it cannot be removed, a foundation for the pipe and/or appurtenance shall be constructed using piling, timber, concrete, or other materials at the direction of the Engineer.

### **3.03 PIPE INSTALLATION**

- A. The Contractor shall install all pipe in accordance with the recommendations of the pipe manufacturer and as specified herein.
- B. The Contractor shall take care in handling, storage and installation of pipe and fittings to prevent injury to the pipe or coatings. All pipe and fittings shall be examined before installation and pipe which is deemed to be defective by the Owner/Engineer shall not be installed.
- C. The Contractor shall thoroughly clean and keep thoroughly clean, all pipe and fittings prior to, during, and after installation.
- D. The Contractor shall lay the pipe to the lines and grades shown on the Contract Drawings with bedding and backfill as shown on the Drawings or called out in the Contract Documents. Blocking under the pipe shall not be permitted except through casing sleeves.
- E. The Contractor shall keep the open ends of all pipe closed with a tightly fitting plug when installation is not in progress or the potential exists for dirt or debris to enter the pipe.
- F. The pipe or accessories shall not be dropped into the trench under any circumstances.
- G. The Contractor shall construct all water mains pursuant to the provisions of "Recommended Standards for Water Works", Part 8, incorporated by reference in Rule 17-555.330(3), F.A.C.
- H. Proper implements, tools, and facilities shall be provided and used for the safe and convenient performance of the work. All pipe, fittings, and valves, and hydrants shall be lowered carefully into the trench by means of suitable tools or equipment in such a manner as to prevent damage to pipeline materials. Under no circumstances shall pipeline materials be dropped or dumped into the trench. The trench shall be dewatered prior to installation of the pipe.
- I. As each length of pipe is placed in the trench, the joint shall be assembled and the pipe brought to correct line and grade. The pipe shall be secured in place with approved backfill material.

- J. Trench width at the top of pipe, bedding conditions, and backfill placement and compaction shall be such that design loadings on the pipe will not be exceeded.
- K. Joint Assembly. Pipe joints shall be assembled in accordance with the manufacturer's instructions.
- L. Pipe Deflection. When it is necessary to deflect pipe from a straight line in either the vertical or horizontal plane, or where long radius curves are permitted, the amount of deflection shall not exceed 75% of the amount recommended by the manufacturer.
- M. Pipe Cutting. Cutting pipe for the insertion of valves, fittings, or closure pieces shall be done in a neat, workmanlike manner without creating damage to the pipe. Ends shall be cut square and perpendicular to the pipe axis.
- N. Burrs shall be removed from spigots and ends shall be smoothly beveled. Field cut ends shall be marked for proper depth of joint assembly.
- O. Locator Tape. Install all plastic pipe with a locator tape of the type specified.
- P. Electronic Marker. Install electronic markers of the type specified for all buried piping at 24-inches below grade.
- Q. Thrust Restraint. All plugs, caps, tees, and bends, unless otherwise specified, shall be provided with reaction backing, or restrained joints as specified.
- R. Thrust-restraint design pressure shall be equal to 1.5 times the design pressure of the line.

### **3.04 TESTING**

- A. 48-hour notice is needed prior to testing. A letter stating the reasons testing should be scheduled ahead of other jobs must accompany all emergency testing requests.
- B. Owner's Representative and Contractor must be present for all testing, except for testing tapping valves and sleeves.
- C. All pressure pipe lines shall remain undisturbed for 24 hours to develop complete strength at all joints. All pipe lines shall be subjected to a hydrostatic pressure

test for two (2) hours at full working pressure, but not less than 180 psi for water/reclaimed (150 psi for force main). Maximum length of pipe to be tested at one time is 2,600 feet. If line is longer than 2,600 feet and cannot be sectioned in 2,600 feet (max.) lengths, the allowable leakage will be figured at 2,600 feet.

- D. Allowable leakage shall be determined by AWWA C600 table for hydrostatic tests. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof; to maintain the test pressure after the air in the pipe line has been expelled and the pipe has been filled with water.
- E. All digging on the job site in the right-of-way must be completed before any testing of water or sewer. Any digging or boring across water or sewer lines after they have been tested may result in a retest of the lines at the County's request.
- F. If any revisions or changes are made after initial testing, lines will be re-tested at the County's request.
- G. Disconnect water supply during test.
- H. All force mains will be tested from the valves in the valve vault at the lift station to the point of connection, whether it be against a valve on another force main or into a manhole.
- I. All services to be aboveground during test. The services should be the correct length so they will be one (1) foot inside right-of-way line.
- J. All fire hydrant gate valves to be open during test.
- K. All visible leaks are to be repaired, regardless of the amount of leakage.
- L. Check gauge pressure periodically during test. If test pressure drops to 175 psi for water/reclaimed lines or to 145 psi for force mains during test, the line must be repumped back to 180 psi for water/reclaimed (150 psi force mains) and the amount of leakage measured. The test will continue on with the remaining time left. At the end of the test, the line must be repumped again back to 180 psi (150 psi for force main) and the amount

- of leakage measured and added to any previous leakage determined earlier in the test.
- M. After the line passes the test, the pressure will be blown off from the opposite end of line from the gauge location. Fire hydrants, services and end-of-line blow offs will be opened to demonstrate they were on line during the test.
  - N. At end of test, the test gauge must return to zero. The pressure gauge must read 0 psi to a maximum of 300 psi in 5 psi increments.
  - O. The section of line being tested must be identified on the charge sheet. The length and size of pipe, the exact area being tested and the valves being tested against, must be identified. Use Station numbers if available.
  - Q. A copy of the charge sheet will be given to the Owner's Representative and the Contractor at the end of the test.

**END OF SECTION**

## **SECTION 15100**

### **VALVES AND APPURTENANCES**

#### **PART 1 GENERAL**

##### **1.01 SCOPE OF WORK**

- A. Furnish all labor, materials, equipment and incidentals required and install complete and ready for operation all valves and appurtenances as shown on the Drawings and as specified herein.
- B. All valves and appurtenances shall be of the size shown on the Drawings and to the extent possible, all equipment of the same type shall be from one manufacturer.
- C. All valves and appurtenances shall have the name of the maker and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.
- D. The equipment shall include, but may not be limited to, the following:
  - 1. Plug Valves
  - 2. Swing Check Valves
  - 3. Resilient Seated Gate Valves
  - 4. Air Release Valves
  - 5. Wastewater Air Release Valve
  - 6. Combination Air Valve
  - 7. Corporation Stops and Saddles
  - 8. Valve Boxes
  - 9. Restrained Flange Adapter
  - 10. Solid Sleeve Couplings
  - 11. Restraining Clamps
  - 12. Manual Valve Actuators
  - 13. Tapping Sleeves
  - 14. Small Gate Valves
  - 15. Ball Valves
  - 16. Butterfly Valves
  - 17. Pressure Regulating Globe Valve

##### **1.02 DESCRIPTION OF SYSTEMS**

- A. All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of potable water, reclaimed water, chemicals, wastewater, etc., depending on the applications.

### **1.03 QUALIFICATIONS**

- A. All of the types of valves and appurtenances shall be products of well established reputable firms who are fully experienced and qualified in the manufacture of the particular equipment to be furnished. The equipment shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications as applicable.

### **1.04 SUBMITTALS**

- A. Submit to the Engineer within 30 days after execution of the contract a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site.
- B. Complete shop drawings of all valves and appurtenances shall be submitted to the Engineer for approval in accordance with the requirements of Section 01340 - Shop Drawings, Project Data and Samples.

### **1.05 TOOLS**

- A. Special tools, if required for normal operation and maintenance shall be supplied with the equipment.

## **PART 2 PRODUCTS**

### **2.01 PLUG VALVES**

- A. Eccentric Plug Valves 3"-36" shall meet or exceed the latest revision of AWWA Standard C517, and shall meet or exceed the requirements of this specification.
- B. Valves shall be of the non-lubricated eccentric type with resilient faced plugs and shall be furnished with end connections as shown on the plans. Flanges shall be per the ANSI B16.1 125 lb. standard. End-to-end length of flanged valves shall be per AWWA C517, Table 1. Mechanical joint ends shall be to the AWWA Standard C111-64.
- C. Bodies shall be of ASTM A126 Class B cast iron. Port



area shall be 100% of standard pipe area. The body shall have minimal pooling, and provide complete flushing of the valve every time it cycles. Port of valve shall be rectangular on valves sizes 14" and larger. Port of valve shall be either rectangular or round on valves sizes 12" and smaller. The term "full port" shall represent 100% port.

- D. Seats shall be rectangular ported, 1/8" thick welded overlay of not less than 95% pure nickel. Seat area shall at least 1/2" wide and raised, with the raised surface completely covered with weld to insure that the plug face contacts only nickel.
- E. Plugs shall be solid one-piece castings of ASTM A536 ductile iron. The plug shall have a cylindrical seating surface eccentrically offset from the center of the plug shaft. The plug shall not contact the seat prior to 90% closed. The interference between the plug face and body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in the line under pressure. Plug shall be Chloroprene (CR), or other resilient facing suitable for the application.
- F. Bearings shall have sleeve type metal bearings and shall be of sintered, oil impregnated permanently lubricated type 316 ASTM A743 Grade CF8M stainless steel. Non-metallic bearings shall not be acceptable.
- G. Grit Excluders in the form of PTFE washers at the upper and lower journals shall be provided to prevent the entry of grit and foreign solids into the bearing areas.
- H. Shaft seals shall be of the multiple V-ring type with a packing gland follower or of the "U" cup type in accordance with AWWA C504. Shaft seals shall be self or externally adjustable and repackable without removing the bonnet from the valve.
- I. Pressure ratings shall be 175 psi for sizes 3"-12" and 150 psi for sizes 14"-36". Every valve shall be given a hydrostatic and seat test, with test results being certified when required by the specifications.
- J. Manual valves shall have lever or gear actuators and tee wrenches, extension stems, floorstands, etc., as specified. Valves 6" and larger shall be equipped with worm gear actuators. Non-buried actuators shall clearly indicate valve position.
- K. Worm Gears shall be constructed in accordance with

AWWA C517. Actuators shall be enclosed in a cast iron housing with outboard seals to protect the bearings and other internal components. The actuator shaft and the quadrant shall be supported on permanently lubricated bronze bearings. Input shaft and fasteners shall be made of stainless steel.

- L. Externally adjustable open and closed position stops shall be provided. The adjustable closed position stop shall be used to set closing torque and provide adjustment to compensate for change in pressure differential or flow direction.
- M. Valves and gear actuators for buried or submerged service shall have seals on all shafts and gaskets on the valve and actuator covers to prevent the entry of water. Actuators shall be 90% grease filled. Actuator mounting brackets for buried or submerged service shall be totally enclosed and shall have gasket seals.
- N. Eccentric plug valves shall have a two year warranty from date of shipment. Manufacturers name shall be cast in body of valve and a metal tag containing a serial number shall be riveted to the valve for future parts identification.
- O. Valves and actuators shall be DeZurik PEF, Val-matic 5600R, or Milliken 600Series.

## **2.02 SWING CHECK VALVES**

- A. Check valves shall be swing-type, flanged, with an external hinge arm with outside lever and adjustable weight meeting the requirements of AWWA C508. Double door, torsional-spring, and internal spring type check valves are not acceptable. Check valves shall have a design working pressure of no less than 150 psi.
- B. The outside lever and weight assembly shall be capable of being relocated to the opposite side without requiring modifications to the valve body.
- C. Arms with discs attached shall be hinged at the top of the body and attached to the shaft. Features or devices to limit arm-travel shall be incorporated into the valve body. Utilization of adjacent pipeline flanges to restrict arm travel will not be allowed. For sizes 6" and larger, the ratio of bolt diameter to arm width shall not exceed 0.3 and the ratio of bolt diameter thickness shall not exceed 0.9.
- D. The disc shall clear the inside of the pipe by 1.125" minimum throughout its entire travel.

- E. Valve materials shall be as follows:
  - 1. Body, cover, disc, weight- cast iron, ASTM A126 cl.B.
  - 2. Rubber disc facing, body O-ring, stuffing box O-ring, cover gasket, hinge pin O-rings- ASTM D-2000 rubber.
  - 3. Stuffing box- bronze, ASTM 138
  - 4. Seat ring, clapper arm, retaining washer- bronze, ASTM B584.
  - 5. Stud nut- bronze, ASTM B62
  - 6. Disc stud- bronze, ASTM B21
  - 7. Stuffing Box Hinge Pin- 303 Stainless Steel, ASTM A276
  - 8. Set screw, jam nut- stainless steel, ASTM A194
  - 9. Cover, bolt, nut, test plug- steel, ASTM B18.2.1
  - 10. Weight lever- A36 steel
- F. Valves shall be as manufactured by Mueller, Clow, American, Kennedy, M&H, or approved equal.
- G. When there is no flow, the check valve disc shall hang lightly against its seat in an almost vertical position. When there is flow, the disc shall swing clear of the waterway.
- H. Valves shall be air cushioned to reduce valve slam.
- I. Valves shall be constructed so that the disc and body seat may be removed and replaced without removing the valve from the line.
- J. Swing Check Valve Locations
  - 1. North Pond Reclaimed Water Return Pump Station, 12-inch size
  - 2. Disk Filter Waste Backwash Pump Station, 4-inch size

## **2.03 RESILIENT SEATED GATE VALVES**

- A. Gate valves with 4" - 24" diameters shall be resilient seated, manufactured to meet or exceed the requirements of AWWA C509 of latest revision and in accordance with the following specifications. Valves shall have an unobstructed waterway equal to or greater than the full nominal diameter of the valve. Valves for potable water, reclaimed water and wastewater service shall be epoxy coated.
- B. The valves shall be non-rising stem with the stem made of cast or forged stainless steel, specified in AWWA

C509. Stem seals shall be provided and shall be of the O-ring type, two above and one below the thrust collar. The top two O-rings shall be field replaceable without removing the valve from service. Low friction thrust bearings shall be provided above and below the stem collar.

- C. The sealing mechanism shall consist of a cast iron gate completely encapsulated with a vulcanized synthetic EPDM rubber coating. The resilient sealing material shall be permanently bonded to the cast iron wedge with a rubber tearing bond meeting ASTM D429. The resilient sealing mechanism shall provide zero leakage at 200 psi differential pressure with the line flow in either direction.
- D. The valve body, bonnet, and bonnet cover shall be cast iron ASTM A126, Class B. The stem nut shall be solid bronze. All ferrous surfaces inside and outside shall have a fusion-bonded epoxy coating meeting the requirements of AWWA C550. A handwheel or wrench nut shall be provided for operating the valve. All valves shall be tested in strict accordance with AWWA C509.
- E. Valves shall be equal to the following models: American Series 2500, Clow / Kennedy / M&H; U.S. Pipe Metroseal 5460.
- F. All internal parts shall be removable from the bonnet without removing the body from the pressure main.
- G. Discs of valves shall be operated by methods which will allow operation in any position with respect to the vertical. Valves for interior piping or exposed above grade outside structures, shall be handwheel operated. Valves four inches and larger, buried in earth shall be equipped with 2-inch square operating nuts, extension stems, valve wrenches, valve boxes and covers. Valves shall be fitted with joints suitable for the pipe with which they are to be used. Valves located above grade or in valve vaults shall be OS & Y with flanged joints. All exterior bolts, nuts and washers shall be stainless steel. The direction of opening for all valves shall be to the left (counter-clockwise).
- H. Unless otherwise shown or specified, valves shall be rated at not less than 150 psi cold water, nonshock. The manufacturer's name and pressure rating shall be cast in raised letters on the valve body

## **2.04 AIR RELEASE VALVES**

- A. Automatic Air Release Valves for Reclaimed Water Service Pipelines: Provide and install automatic air release valves for pipelines as shown on the drawings.
1. The air release valve shall be of the simple lever type or float operated, compound lever type, and capable of automatically releasing accumulated air from a fluid system while that system is in operation and under pressure.
  2. Valves shall be manufactured and tested in accordance with AWWA Standard C512. Manufacturers shall have a quality management system certified to ISO 9001:2000. Valves for potable water service shall be NSF 61 approved.
  3. To assure drop tight shut off, a viton orifice button having an adjustable feature shall be used to seal the valve discharge orifice. The orifice diameter shall be sized for use within a given operating pressure range to insure maximum discharge capacity.
  4. The float shall be of all Type 316 stainless steel construction and capable of withstanding a pressure of 1,000 P.S.I. Floats shall be unconditionally guaranteed against failure, including pressure surges. Mechanical linkages shall provide sufficient mechanical advantages so that the valve will open under full operating pressure. Simple lever designs shall consist of a single pivot arm and a resilient orifice button. Compound lever designs shall consist of two levers and an adjustable threaded resilient orifice button.
  5. The valve cover shall be bolted to the valve body and sealed with a flat gasket. Resilient seats shall be replaceable and shall provide drop-tight shutoff to the full valve pressure rating.
  6. The valve body shall be threaded with NPT inlets and outlets. The body inlet connection shall be hexagonal for a wrench connection. The valve shall have two NPT connections for gauges, testing or draining. The air release valve shall have a Type 316 stainless steel isolation ball valve on its inlet.
  7. The body and cover shall be of Type 316 stainless steel construction with all internal trim to be of

Type 316 stainless steel or viton, consistent with the following specifications:

Body and Cover	ASTM A351 Grade CF8M Type 316 Stainless Steel
Float	316 Stainless Steel
Orifice Button	Viton for simple lever and compound valves
Lever Mechanisms	316 Stainless Steel

8. The air release valves shall be manufactured by Val-Matic Corp., Elmhurst, Illinois or approved equal. Valves required for the project include:
  - a. North Pond Reclaimed Water Return Pump Station - 24-inch Discharge Header
  - b. Effluent P.S. Flowmeter Assembly 36" RCW and Reject Pipes
  - c. 36" RCW Low Pressure Transmission Main
  - d. 30" RCW High Pressure Transmission Main
    1. Val-matic Model No 38.2
    2. Quantity: 5
    3. 50,000 GPM Maximum Flow
    4. 150 psi design cold water pressure
    5. 2-inch NPT inlet
    6. ½" NPT outlet
    7. 3/16" orifice

## **2.05 WASTEWATER AIR RELEASE VALVE**

- A. Automatic Air Release Valve for Disk Filter Waste Backwash Pump Station Discharge Pipeline: Provide and install automatic air release valve for pipeline as shown on the drawings.
  1. The air release valve shall be of the simple lever type or float operated, compound lever type, and capable of automatically releasing accumulated air from a fluid system while that system is in operation and under pressure.
  2. Valves shall be manufactured and tested in accordance with AWWA Standard C512. Manufacturer shall have a quality management system certified to ISO 9001:2000. Valves for potable water service shall be NSF 61 approved.
  3. To assure drop tight shut off, a viton orifice button having an adjustable feature shall be used

to seal the valve discharge orifice. The orifice diameter shall be sized for use within a given operating pressure range to insure maximum discharge capacity.

4. The float shall be of all Type 316 stainless steel construction and capable of withstanding a pressure of 1,000 P.S.I. Floats shall be unconditionally guaranteed against failure, including pressure surges. Mechanical linkages shall provide sufficient mechanical advantages so that the valve will open under full operating pressure. Simple lever designs shall consist of a single pivot arm and a resilient orifice button. Compound lever designs shall consist of two levers and an adjustable threaded resilient orifice button.
5. The valve cover shall be bolted to the valve body and sealed with a flat gasket. Resilient seats shall be replaceable and shall provide drop-tight shutoff at the full valve pressure rating of 150 psi.
6. The valve body shall be threaded with NPT inlets and outlets. The body inlet connection shall be hexagonal for a wrench connection. The valve shall have a 2-inch NPT cleanout connection and a 1-inch NPT drain connection. The air release valve shall have a Type 316 stainless steel isolation ball valve on its inlet.
7. The body and cover shall be of Type 316 stainless steel construction with all internal trim to be of Type 316 stainless steel or viton, consistent with the following specifications:

Body and Cover	ASTM A351 Grade CF8M Type 316 Stainless Steel
Float	316 Stainless Steel
Orifice Button	Viton for simple lever valves; Buna-N for compound valves
Lever Mechanisms	316 Stainless Steel

8. Backwash accessories shall be furnished and shall consist of an inlet shut-off valve, a blow-off valve, a clean water inlet valve, rubber supply hose, and quick disconnect couplings. Accessory valves shall be quarter-turn full ported 316 stainless steel ball valves.

9. The air release valve shall be manufactured by Val-Matic Corp., Elmhurst, Illinois or approved equal. Valve required for the project includes:

e. Disk Filter Waste Backwash Pump Station Discharge Header.

1. Val-matic Model No 48A
2. Quantity: 1
3. 200 GPM Maximum Flow
4. 150 psi design cold water pressure
5. 2-inch NPT inlet
6. ½" NPT outlet
7. 3/16" orifice

## **2.06 COMBINATION AIR VALVE**

- A. Combination Air Valves for North Pond Reclaimed Water Return Pump Station Discharge Header: Provide and install air valve for pipeline as shown on the drawings.

1. Combination Air Valves shall be automatic float operated valves designed to exhaust large quantities of air during the filling of a piping system and close upon liquid entry. The valve shall open during draining or if a negative pressure occurs. The valve shall also release accumulated air from a piping system while the system is in operation and under pressure. The valve shall perform the functions of both Air Release and Air/Vacuum Valves and be furnished as a single body type.
2. Valves shall be manufactured and tested in accordance with AWWA Standard C512. Manufacturer shall have a quality management system certified to ISO 9001:2000.
3. Single body valves shall provide a through flow area equal to the nominal size. A resilient bumper shall be provided to cushion the float during sudden opening conditions. The resilient seat shall be replaceable and provide drop tight shut off for the full valve pressure rating.
4. The Air/Vacuum Valve assembly shall have a cover fitted to the valve body by means of a machined register to maintain concentricity between the top and bottom guide bushings at all times. The float shall be double guided with a guide shaft extending through the float to prevent any contact



with the body. The float shall be protected against direct water impact by an internal baffle bolted to the cover or integrally cast in the body. The seat shall be a minimum of ½ inch thick and secured in such a manner as to prevent distortion.

5. Single body combination valves shall have an expanded outlet to provide full flow area around the guide mechanism. The valve shall have a double guided plug on 2 inch and larger sizes, and an adjustable threaded orifice button. The plug shall be protected against direct water impact by an internal baffle. The plug shall have a precision orifice drilled through the center stem.
6. To assure drop tight shut off, a viton orifice button having an adjustable feature shall be used to seal the valve discharge orifice for the air release assembly. The orifice diameter shall be sized for use within a given operating pressure range to insure maximum discharge capacity.
7. The float, guide shafts and bushing shall be of all Type 316 stainless steel construction and capable of withstanding a pressure of 1,000 P.S.I. Floats shall be unconditionally guaranteed against failure, including pressure surges. Mechanical linkages shall provide sufficient mechanical advantages so that the valve will open under full operating pressure. Simple lever designs shall consist of a single pivot arm and a resilient orifice button. Compound lever designs shall consist of two levers and an adjustable threaded resilient orifice button.
8. The valve cover shall be bolted to the valve body and sealed with a flat gasket.
9. The valve body shall be provided with an ANSI B16.1 Class 125 stainless steel flange inlet and an NPT outlet. The valve shall have two additional NPT connections for gauges, testing or draining. The combination valve shall have an isolation ball valve on its inlet.
10. The body and cover shall be of Type 316 stainless steel construction with all internal trim to be of Type 316 stainless steel or viton, consistent with the following specifications:

Body and Cover	ASTM A351 Grade CF8M Stainless Steel
Float	316 Stainless Steel
Orifice Button	Viton for simple lever valves; Buna-N for compound valves
Lever Mechanisms, Guide Shafts, Bushings	316 Stainless Steel

11. The air release valve shall be manufactured by Val-Matic Corp., Elmhurst, Illinois or approved equal. Valve required for the project includes:

f. North Pond Reclaimed Water Return Pump Station, 24-inch Discharge

1. Val-matic Model No. 204C.14
2. Quantity: 1
3. 10,500 GPM Maximum Flow
4. 150 psi design cold water pressure
5. 4 inch ANSI B16.1, 125 lb. flange inlet
6. 4-inch NPT outlet
7. 3/32" orifice
8. 30 SCFS Max Air Flow

## **2.07 CORPORATION STOPS AND SADDLES**

### **A. Corporation Stops**

1. AWWA C800, ASTM B62 red brass, alloy 85-5-5-5, ball type, 300 psi rated working pressure.

### **B. Saddles**

#### **1. Potable Water and Reclaimed Water**

- a) ASTM B62 red brass, alloy 85-5-5-5, Smith-Blair 325 Bronze saddles
- b) Stainless Steel straps, washers and nuts

## **2.08 VALVE BOXES**

- A. All buried valves shall have cast-iron two or three piece valve boxes as required. Valve boxes shall be provided with suitable heavy bonnets to extend to elevations at or slightly above the finished grade surface as directed by the Engineer. The barrel shall

be two or three-piece, screw type, having a 5 1/4-inch inside diameter on the bottom barrel. The bottom barrel shall have a flange at the bottom having sufficient bearing area to prevent settling, valve boxes shall be complete with cast iron covers. Covers shall have "WATER", "SEWER", or 'RECLAIM', as applicable, cast into the top. All valves shall have actuating nuts extended to within 4' of the lid of the valve boxes. Extension stems shall be attached to the valve operating nut with a stainless steel fastener. Reclaimed valve box lids shall be 9 X 9 inches square, load bearing, painted purple and identified as noted above. Grade adjustment risers shall be the same cast iron material as the valve box assemblies. An AFC entering device, Part No. B59434, shall be installed in the valve box. Valve boxes shall be provided with a concrete base and identification disks per the detail on the drawings. The valve boxes shall be Tyler Pipe 6850 Series, Box 461-S through 668-S, Russco 461-S through 668-S or an approved equal.

## **2.09 RESTRAINED FLANGE ADAPTER**

- A. Restrained flange adapters shall be of the size and pressure rating required for each installation and shall be suitable for use on either PVC, Steel, HDPE (with inserts) or ductile iron pipe.
- B. Restrained flange adapters shall be used in lieu of threaded or welded flanged spool pieces. Flange adapters shall be made of ductile iron conforming to ASTM A536, 65-45-12, and have flange bolt circles that are compatible with ANSI/AWWA C110/A21.10.
- C. Restraint for the flange adapter shall consist of a plurality of individual actuated gripping wedges to maximize restraint capability. Torque limited actuating screws shall be used to insure proper initial set of gripping wedges.
- D. The flange adapters shall be capable of deflection during assembly, or permit lengths of pipe to be field cut to allow a minimum 0.6" gap between the end of the pipe and the mating flange without affecting the integrity of the seal. The joints shall be capable of deflecting between 5 degrees for 3-inch pipe and 0.5 degrees for 60-inch pipe.
- E. For PVC pipe, the flange adapter will have a pressure rating equal to the pipe.
- F. For Ductile Iron pipe, the flange adapter shall have a safety factor of 2:1 minimum.

- G. The restrained flange adapter is comprised of two rings. The first is the restraint ring which incorporates wedges around the circumference of the ring to grip the pipe firmly and securely. The wedge style of restraint offers enormous pullout strength when compared to set screw restraints. The resiliency of the wedge style restraint allows the flange adapter to withstand severe moment loads.

The second ring is the gasket ring which separates the seals dedicated to each sealing surface. This ring allows pipe to be cut to lengths in the field at a tolerance of 0.6 inch or more. And the gasket ring also enables the joint to deflect during assembly.

- H. The restrained flange adapter shall be coated with fusion bonded epoxy paint at the factory.
- I. The flange adapter shall be the Series 2100 Megaflange adapter as manufactured by EBAA Iron, Inc., or approved equal.
- J. All flange adapters shall have a sufficient number of factory installed anchor studs to meet or exceed the test pressure rating for this project, 150 psi minimum.

## **2.10 SOLID SLEEVE COUPLINGS**

- A. Solid sleeve couplings shall be used in locations as shown on the Drawings.
  - 1. Solid sleeve type couplings shall be used with all buried piping. The couplings shall be of ductile iron meeting the requirements of ANSI/AWWA C110/A21.10 as manufactured by U.S. Pipe, American Cast Iron Pipe, McWane, or Equal. Solid sleeves shall be furnished with mechanical joint fittings. The solid sleeve coupling shall be provided with 316 stainless steel bolts and nuts unless indicated otherwise.
  - 2. Couplings shall be provided with gaskets of a composition suitable for exposure to the liquid within the pipe.

## **2.11 RESTRAINING CLAMPS**

- A. Restraining clamp assemblies as detailed in the drawings for use at hydrant connections to water mains, or at fittings where shown on the drawings, shall be as manufactured by EBAA Iron Sales, Inc., Eastland, TX, or Equal.

## **2.12 MANUAL VALVE ACTUATORS**

### **A. General**

1. All manual valve actuators shall conform to Section 3.8 of the AWWA C504 Standard Specification and shall be manually operated.
2. Actuators shall be capable of seating and unseating the disc against the full design pressure and velocity, as specified for each class, into a dry system downstream, and shall transmit a minimum torque to the valve. Actuators shall be rigidly attached to the valve body.
3. Valve actuators shall be provided, mounted and tested by the valve manufacturer.

### **B. Manual Actuators**

1. Manual actuators shall have permanently lubricated, totally enclosed gearing with handwheel and gear ratio sized on the basis of actual line pressure and velocities. Actuators shall be equipped with handwheel, position indicator, and mechanical stop-limiting locking devices to prevent over travel of the disc in the open and closed positions. They shall turn counter-clockwise to open valves. Manual actuators shall be of the traveling nut, self-locking type and shall be designed to hold the valve in any intermediate position between fully open and fully closed without creeping or fluttering. Actuators shall be fully enclosed and designed to produce the specified torque with a maximum pull of 80 pounds in the handwheel or chainwheel. Actuator components shall withstand an input of 450 foot pounds for 30" and smaller and 300 foot pounds for larger than 30" size valves at extreme actuator positions without damage. Valves located above grade shall have handwheel and position indicator, and valves located below grade shall be equipped with a two inch (2") square AWWA operating nut located at ground level and a cast iron extension type valve box. Valve actuators shall conform to AWWA C504, latest revision.

## **2.13 TAPPING SLEEVE**

A. Size: 14 through 42 inches

1. Body and Outlet, ASTM A240 type 304/304L stainless steel. Nominal Pipe Size: 14 through 42 inches. Outlet Size: 3 through 24 inches.
2. Bolts and Nuts, 5/8 inch 304 SS, threaded, coated nuts for galling prevention.
3. Gaskets, ASTM D2000 MBA 710 SBR
4. Test Plug, 3/4 inch 304 SS
5. Flange, ASTM A240 type 304SS, AWWA Class D plate flange, ANSI Class 150 drilling, for tapping valves.
6. Manufacturer: Romac Industries, Inc Model STS 420 or approved equal.

B. Size: 4 through 30 inches

1. Body Outlet and Lugs, ASTM A240 type 304 and 304L stainless Steel. Nominal Pipe Size: 4 through 30 inches. Nominal Outlet size: 3 through 12 inches.
2. Bolts, ASTM A193 type 304 stainless steel, 5/8 inch
3. Nuts, ASTM A194 type 304 stainless steel, coated to prevent galling.
4. Gaskets, ASTM D2000, MAA 610 SBR
5. Flange, ASTM A240 type 304SS, for tapping valves
6. Manufacturer: Romac Industries, Inc. Model SST III or approved equal.

## **2.14 SMALL GATE VALVES**

- A. Gate valves 2-1/2-in in diameter and smaller in size, shall have flanged or threaded ends as required; and shall be brass conforming to Federal Specification WW-V-54, Type I or II, solid wedge, rising-stem-type gate valves as manufactured by Jenkins Bros. or equal products as manufactured by Crane, Fairbanks, Kennedy Valve Mfg. Co., or equal.

## **2.15 PVC BALL VALVES**

- A. PVC Ball Valve sizes 1/2" to 4" shall be TYPE 21 and shall be of true union design with two-way blocking capability. All O-rings shall be EPDM or FKM with PTFE seats. PTFE seats shall have elastomeric backing cushion of the same material as the valve seals. Stem shall have double O-rings and be of blowout-proof design. The valve handle shall double as carrier removal and/or tightening tool. ISO mounting pad shall be integrally molded to valve body for actuation. The ball valves shall have a pressure rating of 230 psi for

sizes "1/2" to 3" and 150 psi for 4" at 70 ° F. Type 21 Ball Valves must carry a two-year guarantee, as manufactured by Asahi/America, Inc.

- B. All ball valves used for chemicals prone to "off-gassing" (e.g. sodium hypochlorite, hydrogen peroxide) shall be vented to avoid entrapment of vapors.

## **2.16 BUTTERFLY VALVES**

- A. Butterfly valves (4" thru 48" size) shall conform to the AWWA Standard Specifications for Rubber Seated Butterfly Valves, Designated C504, except as hereinafter specified. Valves shall be Class 150A or B, with a maximum working pressure of 150 psi, except for those butterfly valves downstream of the high service effluent pumps, which shall be Class 250 B with a maximum working pressure of 250 psi. All butterfly valves shall be factory leak tested at a pressure of 200 psi. The Contractor shall supply all of the butterfly valves for this project from one manufacturer. Acceptable manufacturers of the proposed butterfly valves shall include GA Industries, Val-Matic, Henry Pratt Company, DeZurik, Mueller, KOR-FLO or approved equal.
- B. The face-to-face dimensions of flanged end valves shall be in accordance with AWWA Standard Specification C504 for short-body valves. Adequate two-way thrust bearings shall be provided. Flange drilling shall be in accordance with ANSI B16.1. Mechanical Joint end valve dimensions shall be in accordance with AWWA Standard Specification C504.
- C. All Butterfly valves shall have a factory applied fusion bonded epoxy coating inside and outside, in accordance with AWWA C550. The interior and exterior surfaces shall be shown to be holiday free using an electronic holiday test, in accordance with AWWA C550.
- D. Valve seats shall be an EPDM elastomer. Valve seats 24 inches and larger shall be field adjustable and replaceable without dismounting the operator disc or shaft and without removing the valve from the line. All retaining segments and adjusting devices shall be of corrosion resistant material with stainless Nylock or ASTM A276, 316 stainless steel screws, and shall be capable of a 1/8 inch adjustment. Valves 20 inches and smaller shall have bonded or mechanically restrained seats as outlined in AWWA C 504. Where the rubber seat is mounted on the valve body, the mating edge of the valve disc shall be 18-8 stainless steel or ASTM A276, 316 stainless steel. Where the EPDM seat is mounted on

the valve disc, the valve body shall be fitted with an 18-8 stainless steel or ASTM A 276, 316 stainless steel seat offset from the shaft, mechanically restrained and covering 360 degrees of the peripheral opening or seating surface.

- E. The Class 150 A or B valve body shall be constructed of close grain cast iron per ASTM A126, Class B, or ASTM A536, Grade 65-45-12 ductile iron with integrally cast hubs for shaft bearing housings of the through-boss type. Butterfly valves of the "wafer": or "spool" type shall not be accepted.
- F. The Class 150 A or B valve shaft shall be turned, ground, and polished, constructed of 18-8, ASTM A-276, Type 304 stainless steel and designed for both torsional and shearing stresses when the valve is operated under its greatest dynamic or seating torque. The shaft shall be either a one piece unit extending full length through the valve disc and valve bearing or it may be of a stub shaft design. Shaft bearings shall be teflon, self-lubricated type.
- G. Additional materials of construction for Class 150 A or B butterfly valves include:
  - 1. Disc-ASTM A536, Grade 65-45-12 ductile iron.
  - 2. O-Rings-EPDM.
- H. Class 250 butterfly valves shall be constructed from the same materials as the Class 150 A or b butterfly valves noted above except for the following:
  - 1. Body-ASTM A536, Grade 65-45-12 ductile iron.
  - 2. Shaft-Type 17-4 PH, Condition H1150 stainless steel.
  - 3. Bearings - Teflon/Dacron Fabric Liner, fiberglass back-up shell.
  - 4. Torque Screw - Type 17-4 PH, Condition 1100 stainless steel.
  - 5. Tangential Pin - Type 17-4 PH, Condition H1100 stainless steel.
- I. All valves shall be subject to hydrostatic and leakage tests at a pressure of 200 psi at the point of manufacture. The Class 150 valves shall be tested in conformance with AWWA C504. During the hydrostatic test there shall be no leakage through the metal, the end joints or the valve shaft seal. No adjustment of the valve disc will be necessary after the pressure test for normal operation of the valve.



- J. In general, the butterfly valve operators shall conform to the requirements of Section 11 of the AWWA Standard specifications for Rubber Seated Butterfly Valves, Designation C504, insofar as applicable and as herein specified.
- K. Gearing for the operators shall be totally enclosed in a gear case in accordance with the above-mentioned AWWA Standard Specifications.
- L. Operators shall be capable of seating and unseating the disc against the full design pressure of velocity, as specified for each class, into a dry system downstream, and shall transmit a minimum torque to the valve. Operators shall be rigidly attached to the valve body.
- M. All valve operators shall conform to Section 11 of the AWWA Standard Specification and shall be manual unless otherwise shown or specified and shall have permanently lubricated, totally enclosed gearing with handwheels and gear ratios sized on the basis of actual line pressures and velocities. Operators shall be equipped with handwheels, position indicators, and mechanical stop-limiting locking devices to prevent over travel of the discs in the open and closed positions when valves are located above grade. Operators shall turn counterclockwise to open valves. Manual operators shall be of the traveling nut, self-locking type and shall be designed to hold the valve in any intermediate position between fully open and fully closed without creeping or fluttering. Operators shall be fully enclosed and designed to produce the specified torque with a maximum pull of 80 pounds on the handwheel or chainwell when the valve is located above grade. Operator components shall withstand an input of 450 foot pounds for 30" and smaller and 300 foot pounds for larger than 30" size valves at extreme operator positions without damage. Valves located above grade shall have handwheel operators, and valves located below grade shall be equipped with two-inch (2") square AWWA operating nuts located at ground level in cast iron extension type valve boxes. Valve operators shall conform to AWWA C504, latest revision.
- N. The manufacturer shall certify that the required tests on the various materials and on the completed valves have been satisfactory and that the valves conform to all requirements of the specifications and the AWWA standards.
- O. Where indicated on the Drawings, extension stems, floor stands, couplings, stem guides, and floor boxes as required shall be furnished and installed.

## 2.17 PRESSURE REGULATING GLOBE VALVE

- A. The Pressure regulating valve shall be a hydraulically operated, diaphragm actuated, pilot controlled modulating globe valve with anti-cavitation trim devices. The valve shall seal by means of a corrosion-resistant seat and seat disc. These and other parts shall be replaceable in the field without removing the valve from the line. The stem shall be guided top and bottom by integral bushings, guides, and bearings. The diaphragm shall not be used as a seating surface, nor shall pistons be used as an operating means. The pilot system shall be furnished complete and installed on the main valve, and shall include one or two solenoid pilot valves, a strainer, separate opening and closing speed controls, and ball valves for isolating the control system from the main valve.
- B. Where shown on the drawings, a position transmitter shall be installed on the valve and driven by an extension of the valve stem. It shall be a magnetic, non-contact type with analog output, and shall include terminal strips for the communications link to the PLC and for the solenoid pilots, as well as an LED for zeroing purposes. The enclosure shall be weatherproof per NEMA 4. The valve and controls shall be hydrostatically and operationally tested prior to shipment.
- C. The main valve body and cover shall be ductile iron per ASTM A536, Grade 65-45-12. End connections shall be Class 150 flanges per ANSI B16.42 (flat faced), suitable for a valve maximum working pressure of 250 psi. Main valve bonnet studs and nuts shall be stainless steel. Disc retainer and diaphragm washer shall be cast iron per ASTM A216-WCB. All internal ferrous surfaces shall be coated with 10-12 mils dft of NSF61 certified epoxy, Tnemec Series N140 or approved equal. External surfaces shall be coated with 10-12 mils dft of the same epoxy. The main valve stem, nut, and spring; disc guide, seat and cover bearing shall be stainless steel per ASTM A743. Elastomers (diaphragms, resilient seats and O-rings) shall be Buna-N rubber. Diaphragm shall be nylon reinforced Buna-N rubber. The diaphragm shall withstand a Mullins burst test of 600 psi minimum per nylon fabric layer and cycle tested 100,000 times. The main valve cover will have an X101 visual valve position indicator for monitoring the valve position at any time.

- D. The valve shall have 316 stainless steel anti-cavitation trim internals. The seat and disk guide trim components shall feature dual interlocked sleeves containing radial slots that deflect internal flow to impinge upon itself in the center of the flow path, harmlessly dissipating the potential cavitation damages from water flowing from a high pressure zone to a very low pressure zone. The anti-cavitation features of the seat and disk guide detail shall have flow slots equally spaced around their perimeters. The seat slots shall be orientated around the perimeter of the seat so that fluid entering the valve shall flow through the seat slot detail such that the fluid flow converges in the center chamber of the seat allowing potential cavitation to dissipate. The disc guide slots shall be positioned around the perimeter of the disc guide, configured and oriented in an angular direction so that fluid flow exiting through the slots is diverted away from direct impact into pressure boundary surfaces. Flow exiting the disc guide slots is directed in an angular path to increase the distance between the slot geometry and pressure boundary surfaces. If cavitation conditions exist, the increased distance between the slots and pressure boundary surfaces minimizes the potential for damage by allowing the cavitation bubbles to dissipate before they come in contact with pressure boundary surfaces. Anti-cavitation characteristics shall be controlled by the described slotted seat and disc guide components. The disc guide shall slide in the seat and allow controlled flow through the seat slots into the central seat chamber where flow shall continue from the seat chamber and exit through the angularly oriented slots of the disc guide. The seat and disc guide features used together shall provide anti-cavitation characteristics suitable for applications where a large controlled pressure drop is desired.
- E. All speed controls, isolation ball valves, oversized control line tubing, solenoid valves, needle valves, cover bolts, and nuts shall be stainless steel. Solenoid valve assemblies removing water from the top of the diaphragm shall discharge to atmosphere.
- F. A high capacity strainer shall be provided that removes harmful debris from the water supply to protect the pilot control system. The strainer shall have a secondary filter to allow backwashing of the strainer to occur without taking the strainer off line thus providing an uninterrupted supply of filtered water to the pilot system. The strainer shall be provided with a bottom drain stainless steel ball valve with PTFE seals and rated for 400 psi inlet pressure. The stainless

steel mesh shall be 100 microns. The strainer shall be Model F76 as manufactured by Cla-Val or approved equal.

G. Pressure Regulating Valve Controls

1. Size: 36-inch Reduced Port/Quantity 1

- a. The valve shall function as a combination pressure sustaining and solenoid shutoff valve. The valve shall modulate to sustain a minimum backpressure after it is opened by signals from the treatment plant SCADA system. The valve shall be supplied with a solenoid valve energized to open remotely. The valve shall open if electric power is cut off from the solenoid valves.
- b. The pilot control system will consist of a CRL sustaining control and the solenoid electrical control.
  - 1) The CRL sustaining control will monitor inlet pressure and throttle the valve if the inlet drops below some predetermined low set point between 20 and 105 psi.
  - 2) The solenoid control will be a CS3SM solenoid that will override the controls and close the main valve when called to do so. The solenoid shall have a stainless steel body with a weatherproof enclosure per NEMA 4, suitable for operation on 120 VAC, 60 Hertz and be normally closed (energized to open).
- c. The pilot system will also contain isolation valves and gages for startup, setting, adjustment, maintenance and troubleshooting.
- d. The backpressure anti-cavitation control valve shall be Model 100-20KO as manufactured by Cla-Val or Approved Equal.

2. Size: 16 inch Full Port/Quantity 1

- a. The valve shall function as a pressure sustaining valve.
- b. The pilot control system will consist of a CRL sustaining control.
  - 1) The CRL sustaining control will monitor inlet pressure and throttle the valve if the inlet drops below some predetermined low set point.

- c. The pilot system will also contain isolation valves and gages for startup, setting, adjustment, maintenance and troubleshooting.
- d. The backpressure anti-cavitation control valve shall be as manufactured by Cla-Val or Approved Equal.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. All valves and appurtenances shall be installed in the location shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the Engineer before they are installed.
- B. After installation, all valves and appurtenances shall be tested at least two hours at the working pressure corresponding to the class of pipe, unless a different test pressure is specified. If any joint proves to be defective, it shall be repaired to the satisfaction of the Engineer.
- C. Install all floor boxes, brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, the Contractor shall check all plans and figures which have a direct bearing on their location and he shall be responsible for the proper location of these valves and appurtenances during the construction of the structures.
- D. Pipe for use with flexible couplings shall have plain ends as specified in the respective pipe sections in Division 15.
- E. Flanged joints shall be made with high strength, low alloy Corten bolts, nuts and washers. Mechanical joints shall be made with mild corrosion resistant alloy steel bolts and nuts. All exposed bolts shall be painted the same color as the pipe. All buried bolts and nuts shall be heavily coated with two (2) coats of bituminous paint comparable to Inertol No. 66 Special Heavy.
- F. Prior to the installation of sleeve-type couplings, the pipe ends shall be cleaned thoroughly for a distance of

8 inches. Soapy water may be used as a gasket lubricant. A follower and gasket, in that order, shall be slipped over each pipe to a distance of about 6 inches from the end, and the middle ring shall be placed on the substantial completion date unless otherwise requested by the Owner.

- G. Valve boxes with concrete bases shall be installed as shown on the Drawings. Mechanical joints shall be made in the standard manner. Valve stems shall be vertical in all cases. Place a cast iron box over each stem with the base bearing on compacted fill and the top flush with final grade. Boxes shall have sufficient bracing to maintain alignment during backfilling. Knobs on the cover shall be parallel to pipe. Remove any sand or undesirable fill from valve box.

### **3.02        RESTRAINING CLAMPS AND TIE RODS ON PIPE RUN**

- A. Restraining clamps and tie rods shall be used on all pipe runs, as directed by the Engineer and/or shown on the Drawings. Restraining devices shall be JCM Industries, Inc. - Sur-Grip, EBAA Iron, Inc. - Megalug, Romac, or approved equal. Other types shall be submitted to the Owner's Representative for approval.

### **3.03        SHOP PAINTING**

- A. Ferrous surfaces of valves and appurtenances shall receive a coating of rust-inhibitive primer. All pipe connection openings shall be capped to prevent the entry of foreign matter prior to installation.

### **3.04        FIELD PAINTING**

- A. All metal valves and appurtenances specified herein and exposed to view will be painted per Section 09900 with a color appropriate to its usage in accordance with the color code.

### **3.05        INSPECTION AND TESTING**

- A. Completed pipe shall be subjected to a hydrostatic pressure test for two hours at 180 psi pressure. All leaks shall be repaired and lines retested as approved by the Owner's Representative. Prior to testing, the gravity pipelines shall be supported in an approved manner to prevent movement during tests.

**END OF SECTION**

## **SECTION 15102**

### **POWER-ACTUATING DEVICES FOR VALVES**

#### **PART 1 GENERAL**

##### **1.01 DESCRIPTION OF WORK**

- A. This Section includes furnishing and installing power-actuating devices that are externally mounted on valves as shown on the Drawings and as specified herein. Actuator types included are electric-motor type producing a multi-turn rotary motion.
- B. Related Work specified elsewhere:
  - 1. Sections 13300, 13310, 13320, 13330 - Instrumentation and Controls
  - 2. Section 15100 - Valves and Appurtenances
  - 3. Division 16 - Electrical Work

##### **1.02 SUBMITTALS**

- A. Coordinate with Instrumentation and Valve suppliers. Check installation arrangements to prevent conflicts with piping and other equipment. Provide three (3) sets of final Shop Drawings to Engineer for use in observing installation and for record purposes.
- B. All submittals shall be in accordance with Section 01340 - Shop Drawings, Project Data and Samples.
- C. Submit certificates from manufacturer showing compliance with specified requirements and standards.

##### **1.03 QUALITY ASSURANCE**

- A. Power-actuating devices shall conform to the requirements of ANSI/AWWA C540 except as modified in this Section.
- B. Actuators shall be assembled to new valves at the valve manufacturer's factory, bench tested for alignment, and shipped to the job site as a complete assembly.

##### **1.04 ACCEPTABLE MANUFACTURERS**

- A. Subject to complying with specified requirements, manufacturers offering actuators which are acceptable for use on this project are limited to the following:

- 1. Rotork IQ/IQT
- 2. Limitorque MX

#### **1.05 OPERATION AND MAINTENANCE MANUALS**

- A. Operation and Maintenance manuals shall be submitted as outlined in Specification 01730 - Operation and Maintenance Data.

### **PART 2 PRODUCTS**

#### **2.01 GENERAL**

- A. Actuators shall be sized for the required operational characteristics of the valves as listed in the Valve Actuator Data Sheet and for the required torque or thrust, shaft diameter, thread characteristics and keyway dimensions of the valve actually furnished.
- B. Actuators shall be designed for indoor and outdoor service and shall be capable of mounting in any position.
- C. Torque capacity of the actuators shall be sufficient to operate the valves with the maximum pressure differential, as indicated in the Valve Schedule, with a safety factor of 1.5. Actuators in modulating service will be selected such that the required dynamic valve torque is no more than 60% of the electric actuators maximum rated breakaway of torque.
- D. Operating time for full limits of travel shall be not more than 2 seconds per inch diameter of the valve, +/- 50 percent through 20 inches; +/- 30 percent for valves 24 inches and larger. Operating time shall not be less than 30 seconds for all modulating valves.
- E. Actuators shall be capable of operating in ambient temperatures ranging from 0 degrees F to 160 degrees F.
- F. For open/close (non-modulating) actuators, the gearing, motor and contactor shall be capable of up to 60 starts per hour without overheating.
- G. For modulating actuators, the gearing, motor and contactor shall be capable of up to 1200 starts per



hour without overheating. This includes both discrete and analog setpoint modulation.

- H. The actuators shall include, in one integral housing, individual compartments for the motor, gearing, wiring terminals, and control circuits. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal. The inner seal shall protect the motor and all other internal electrical elements of the actuator from entrance of moisture and dust when the terminal cover is removed. Double cartridge shaft seals shall be provided on the hand wheel and output shafts for weatherproof protection. All external fasteners shall be stainless steel. Compartments shall be provided with moisture and dust-proof rigid cast covers meeting NEMA 6, certified to submergence in 6 ft of water for 30 minutes. Actuators located in classified areas shall be suitable for use in Class 1, Division 1, Group D environments.
- I. Gearing shall consist of a worm shaft and worm gear pinion operating in an oil bath. All gearing shall be hardened alloy steel or bronze. The worm gear pinion shall be alloy bronze. Gears shall be rated at twice the output torque of the operator and shall be designed to withstand the stall torque of the motor without failure. Worm gear drive shall be self-locking to prevent creeping of the valve disc in an intermediate position. Heavy-duty grease shall protect gearing and sealed ball bearings of the main shaft for five years without changing. The gearing shall be designed to allow field repair and change in gear ratio. Over-travel of the operator shall be prevented by internal mechanical stops cast into the actuator.
- J. A mechanical dial position indicator shall be furnished to continuously indicate the position of the valve at and between the fully open and fully closed positions. The indicator shall be driven by gearing driven off of the main worm gear pinion and shall operate when the actuator is in either the electrical mode or manual mode.
- K. A handwheel shall be permanently attached for manual operation. A planetary gear assembly shall be provided between the handwheel and the worm shaft if required to reduce the force necessary to operate the handwheel to less than 40 pounds. A positive declutch mechanism shall engage the handwheel when required. When the actuator is set in the declutched position for

handwheel operation, it shall return automatically to electric operation when the actuator motor is energized. The handwheel shall not rotate during electric operation nor shall a fused motor prevent handwheel operation.

## **2.02 ACTUATOR ELECTRIC MOTOR AND ACCESSORIES**

- A. The drive motor shall be specifically designed for actuator service and shall be characterized by high starting torque and low inertia.
- B. Motors shall be 460 volts, three phase, 60 Hz AC reversible squirrel cage induction type motors and shall be specifically designed for modulating service where indicated on the Valve Schedule.
- C. Motors shall be totally enclosed, non-ventilated, with NEMA Class H insulation minimum and a maximum continuous temperature rating of 120 degree C (rise plus ambient). A 120 VAC space heater shall be provided in the motor compartment.
- D. The electric motor shall have a time rating of at least 15 minutes at 104°F (40°C) or twice the valve stroking time, whichever is longer, at an average load of at least 33% of maximum valve torque.
- E. Motor bearings shall be permanently lubricated by premium lubricant. The motor shall have a plug and socket electrical connection to facilitate easy removal and replacement.
- F. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the three-phase power supply connected to the actuator.
- G. The motor shall include single phase protection. A suitable thermal protection device shall be incorporated in the motor or motor starter circuits, connected to a tripping device. Fast acting fuses shall be provided to protect solid state components.
- H. The motor shall be capable of starting against the rated load in either the open or closed direction when voltage to the motor terminals is plus or minus ten (10) percent of nameplate rating.
- I. Open/Close actuators shall be furnished with electro-mechanical reversing starters. Modulating actuators

shall be furnished with solid state reversing starters utilizing thyristors.

- J. Leads from the motor shall be brought to the control circuit (limit switch) compartment without external piping or conduit box. An adequately sized space heater shall be installed in the control circuit compartment to aid in the prevention of damage resulting from condensation. The following items shall be located in the control circuit compartment.
- K. Torque limit switches shall be provided to de-energize the motor control circuit in the event of a stall when attempting to unseat a jammed valve and when torque is exceeded during valve travel. Each actuator shall have an open direction torque switch and a close direction torque switch. The torque switches shall be mechanically operated and able to be set in torque units. Torque switches shall be calibrated prior to the actuator's assembly to the valve.
- L. Travel limit switches shall be provided to de-energize the motor control circuit when the actuator reaches the limits of travel in the open and close directions. The limit switch drive shall be of the counter gear type and "in step'" with the actuator output drive at all times in either the electrical or manual mode of operation. A minimum of eight (8) contacts, four (4) normally open and four (4) normally closed, shall be supplied at each end of valve travel (total of 16 contacts). Limit switches shall be fully adjustable when power is applied to the actuator.
- M. The electrical terminals shall be housed in a double sealed terminal compartment isolated from the rest of the actuator components. All control terminations shall have plug and socket connections such that removal of the terminal compartment cover simultaneously disconnects all wiring in the compartment. The actuators shall be designed to operate from a single 480VAC, 3-phase source. The actuators shall be furnished with fuses inside the terminal compartment. A quantity of two -  $\frac{3}{4}$  inch NPT conduit entries shall be furnished.
- N. Motor enclosures shall be as listed in the Valve Actuator Data Sheet.

## 2.03

### ACTUATOR CONTROLS

- A. Modulating actuators shall have a position feedback potentiometer mounted directly to the valve actuator gearing inside the gearing compartment. The potentiometer shall provide a 4-20 mA signal corresponding to valve position. Modulating valve actuators shall be designed to respond to either a 4-20 mA DC analog signal or a digital pulse signal as specified herein or as required to coordinate with the requirements of Section 13100.
- B. Modulating valve actuators designed to respond to a 4-20 mA DC signal shall be provided with a valve positioner, which shall position the valve proportional to an externally generated 4-20mADC signal. The valve positioning control circuitry shall position the valve by comparing the command signal with the present valve position as indicated by the feedback potentiometer. The positioner shall be field adjustable to fail to the "open," "closed," or "last" position on loss of 4-20 mA DC command signal.
- C. Modulating valve actuators designed to respond to "pulse" open/close signals shall operate the valve during the time the open or close pulse signal is high. Modulating actuators designed to respond to "pulse" open/close signals shall have the latching circuitry described for open/close actuators disabled.
- D. Actuators shall contain wiring and terminals for the following control functions. All dry contacts shall be rated for 5A at 250VAC.
  - 1. Open, Close, and Stop commands from external dry contacts (utilizing internal 24VDC power supply) and/or from an external signal of 12V to 120V. The inputs for the open, close, stop signals shall be field selectable to respond to either maintained or momentary remote signals. In momentary mode, the actuator shall have internal latching circuitry that causes the operator to drive the valve to its limit of travel upon receipt of the momentary contact signal unless a stop signal is received.
  - 2. Remote Local-Off-Remote selector switch, Open/Close pushbuttons, and Open/Closed pilot lights for a remote manual control station (see below). The remote Local-Off-Remote selector switch and Open/Close pushbuttons shall be a dry

contact input to the actuator control circuitry. The Open/Closed pilot lights shall be powered from the valve actuator control power.

3. Four (4) unpowered contacts shall be provided which can be selected to indicate valve "Opened" and "Closed" position, "Remote" status of the actuator, and fail status of the actuator. The fail status contacts shall activate upon motor overtemperature and actuator overtorque as a minimum.
4. Terminals for 4-20mADC position command and 4-20mADC position feedback as described above for modulating actuators.

#### E. Local Controls

1. Actuators shall be furnished with a Local-Off-Remote selector switch; Open, Close, and Stop pushbuttons for local control; a red lamp indicating closed and a green lamp indicating open. L-O-R switch shall be padlockable in any of the three positions.
2. When the LOR is in the "Local" position, open/close control shall be by the open and close pushbuttons on the actuator. The stop push button shall stop the actuator travel.
  - a) When the LOR is in the "Off" position, the actuator shall not operate.
  - b) When the LOR is in the "Remote" position, the actuator shall be controlled by remote inputs from the PLC or from the remote manual controls station.
3. The local controls shall be arranged so that the direction of travel can be reversed without the necessity of stopping the actuator.

#### F. Remote Manual Control Station

1. Where indicated in the Valve Schedule, manual actuator controls shall be furnished in a separate NEMA 4X stainless steel enclosure (NEMA 7 if located in a classified area). Manual control station controls shall include Hand-Off-Auto Selector switch; Open, Stop, and Close

pushbuttons; a red lamp indicating closed and a green lamp indicating open.

- a) When the HOA is in the "Hand" position, open/close control shall be by the open and close pushbuttons on the remote manual control station. The stop push button shall stop actuator travel.
- b) When the HOA is in the "Off" position, the actuator shall not operate.
- c) When the HOA is in the "Auto" position, the actuator shall be controlled by remote inputs to the valve actuator from the PLC.

## **2.04 PAINTING AND COATINGS**

- A. Actuators shall be painted in accordance with the requirements of the specified Standard with finish coats and colors conforming to the requirements of Section 09900 - Painting and Coatings.

## **PART 3 EXECUTION**

### **3.01 SHIPPING, HANDLING AND STORAGE**

- A. Assembled actuators and valves shall be packaged, shipped and stored in accordance with the requirements of the specified Standard.

### **3.02 INSTALLATION**

- A. Install new actuators and valves as specified for valve installations. Make necessary piping, electrical and instrumentation connections.

### **3.03 TESTING**

- A. After installation, test valves and actuators in accordance with the requirements of Section 15100 - Valves and Appurtenances.

## VALVE ACTUATOR DATA SHEET

### DATA SHEET NOTES

1. Valve Designation Number
2. Quantity of valves on this project.
3. Nominal diameter of valve.
4. Type of valve: Gate, Ball, Plug, Butterfly, Motorized Check, V-port Ball.
5. Maximum differential pressure across closed valve at time of actuation.
6. Stroking time: Time for full travel operation of valve.
7. Available Voltage.
8. Maximum flow rate through the fully open valve at time of actuation.
9. Type of valve operation required: Open-Close; Throttle; Modulate.
10. Electric enclosure required: NEMA 4 (Water-tight); NEMA 6 (Submersible); NEMA 7 (Hazardous).

	1	2	3	4	5	6	7	8	9	10
Location	Valve No.	Valve Qty	Valve Diam	Valve Type	Max Diff Pres	Stroking Time	Voltage	Max Flow Rate	Type of Oper	Elec Enc.
Effluent Flowmeter	BFV-101	1	36	Butterfly	150 psi	90 seconds	480 volts - 3 Phase	36 MGD	Open/Close	Nema 4
RCWR P.S.	BFV-102	1	24	Butterfly	150 psi	90 seconds	480 volts - 3 Phase	15 MGD	Open/Close	Nema 4
RCWR	BFV-	1	12	Butterfly	150 psi	90 Seconds	480 volts - 3 Phase	15 MGD	Open/Close	Nema 4

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END OF SECTION



## **SECTION 15141**

### **PIPE SUPPORT SYSTEMS**

#### **PART 1 GENERAL**

##### **1.01 DESCRIPTION OF WORK**

###### **A. General**

1. Furnish all labor, materials, tools, equipment and services for all pipe support and anchor systems, in accordance with the provisions of the Contract Documents.
2. Completely coordinate with work of all other trades.
3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.
4. The layout of pipe supports is the responsibility of the Contractor, and must take into consideration pipe material, joint type, location, and other requirements of these specifications.

##### **1.02 QUALITY ASSURANCE**

###### **A. Reference Standards:**

1. American National Standards Institute (ANSI)
2. American Society of Mechanical Engineers (ASME)
3. American Society for Testing and Materials (ASTM)
4. ASTM A575 Merchant Quality Hot-Rolled Carbon Steel Bars
5. American Welding Society (AWS)
6. Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS)
7. MSS SP-58 (Latest Edition) Pipe Hangers and Supports - Materials and Design

8. MSS SP-69 (Latest Edition) Pipe Hangers and Supports - Selection and Application
9. National Bureau of Standards (NBS)
10. NBS Handbook H-28

### **1.03 SUBMITTALS**

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples.
- B. Submit itemized list of wall sleeves, anchors, support devices and all other items related to pipe support system.
- C. Submit scaled drawings showing guides, hangers, supports, anchors, structural members and appurtenances to describe the pipe support system.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. All structural steel angles, rods, channels and special devices integral to pipe support systems shall be fabricated from ASTM-A-276 Type 304 stainless steel. Locate supports and accessories to support pipe system at concentrated loads and in accordance with minimum suggested by MSS SP-69-66.

### **2.02 PIPE SADDLES**

- A. Provide ASTM-A-276 Type 304 Stainless Steel pipe support saddles for pipe supported from the floor, unless otherwise indicated on the drawings. Pipe saddles equal to B-Line Figure B3092, or equal.
- B. Use Schedule 40 ASTM-A-276 Type 304 stainless steel support pipe risers and floor plate recommended by saddle manufacturer.

### **2.03 WALL BRACKETS**

- A. Provide ASTM-A-276 Type 304 stainless steel wall bracket supports for pipe located near walls, including all horizontal pipe and all vertical pipe 8-feet or more above floor elevation or as indicated on the

drawings. Provide wall brackets at all changes of direction and as shown on drawings.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install supports capable of supporting the pipe for all service and testing conditions. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.
- B. Install pipe support system in accordance with highest industry practices, and in full accordance with manufacturer's recommendations. Adjust supports and hangers to allow for proper pitch of pipes.
- C. Ensure design, materials of construction, and installation of pipe hangers, supports, guides, restraints, and anchors for chemical and waste piping are in accordance with ANSI B31.3, and MSS Standard SP-58 and SP-69, except where modified by this specification.
- D. Check all physical clearances between piping, support system, and structure. Provide for vertical adjustment after erection.
- E. Provide piping system exhibiting pulsation, vibration, swaying, or impact with suitable constraints to correct the condition. Movements from trap discharge, water hammer, and similar internal forces are included in this requirement. No system will be accepted until the adequacy and safety of the system is assured under all anticipated conditions of operation.
- F. Weld supports in accordance with the requirements of AWS Code D1.1 Structural Welding.
- G. Locate piping and pipe supports so as to not interfere with open accesses, walkways, platforms, and with maintenance or disassembly of equipment.
- H. After erection of piping systems, and prior to pipe testing and flushing, inspect for adequacy of clearance for piping and supports.

- I. Support pipes for lateral movement with clamps or brackets.
- J. Provide 20-gauge ASTM-A-276 Type 304 stainless steel pipe saddle for fiberglass and plastic support points to insure minimum contact width of 4 inches.

### 3.02 SUPPORT SPACING

- A. General: Locate pipe supports at maximum spacing scheduled unless indicated otherwise on the drawings. Provide at least one support for each length of pipe, at each change of direction and at each valve.
- B. Steel, stainless steel, cast-iron, and ductile iron support schedule:

<u>Pipe Size - Inches</u>	<u>Maximum Span - Feet</u>
1-1/2 and less	5.0
2 thru 4	10.0
5 thru 8	15.0
10 and greater	20.0

- C. Schedule 40 PVC Pipe, Temperature 100° or Less:

<u>Pipe Size - Inches</u>	<u>Maximum Span - Feet</u>
1	5.0
1.5	5.5
2	6.0
3	7.0
4	7.5
6	9.0
8	9.5
10	10.0
12	10.5
14	11.0

- D. Schedule 80 CPVC Pipe, Temperature 140° or Less:

<u>Pipe Size - Inches</u>	<u>Maximum Span - Feet</u>
1	5.0
1.5	5.5
2	6.0
3	7.0
4	7.5
6	8.0
8	9.0

10  
12

9.5  
10.5

### **3.03 WELDING**

- A. Identify welding rods clearly identified meeting the requirements of ASTM and American Welding Society Standards.
- B. Integral attachments include welded-on ears, shoes, plates, and angle clips. Ensure material for integral attachments is of good weldable quality. Have preheating, welding, and postheat treating in accordance with Chapter V of ANSI B31.3.

### **3.04 PAINTING**

- A. All stainless steel items shall not be painted. Painting for all other materials shall comply with Section 09900 - Painting and Coatings.

**END OF SECTION**



## **SECTION 15465**

### **SUMP PUMP**

#### **PART 1 GENERAL**

##### **1.01 DESCRIPTIO OF WORK**

- A. This Section includes furnishing and installing sump pumps in valve vaults as shown on the Plans.

##### **1.02 QUALITY ASSURANCE**

- A. Available Manufacturers: Subject to compliance with requirements, provide a sump pump from one of the following:
  - 1. Goulds Model LSP03
  - 2. Ebara Model EPPD-3Sa1
  - 3. Or Approved Equal

##### **1.03 SUBMITTALS**

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples.

##### **1.04 OPERATIONS AND MAINTENANCE MANUALS**

- A. Operations and Maintenance Manuals shall be submitted as outlined in Specification 01730 - Operation and Maintenance Data.

##### **1.05 WARRANTY**

- A. Per General Condition Article 9, the Contractor shall provide a 3 year warranty from substantial completion.

#### **PART 2 - MATERIALS AND EQUIPMENT**

##### **2.01 SUMP PUMP**

- A. Provide a 3500-RPM, 1/3 HP, 115 Volt, 60 Hz, single phase sump pump capable of displacing at least 15 GPM at 17' TDH. Minimum shut off head shall be 21 feet. Minimum discharge pipe diameter shall be 1.25 inches.
- B. Each sump pump shall be equipped with a built in float, and total width requirements shall be compatible with the sump provided in the valve vault.

- C. Each sump pump shall be provided with 10 foot minimum power cord to be field hot-wired.
- D. Each sump pump shall be UL listed and CSA approved.
- E. Each sump pump shall have a 304 SS housing

## **2.02 PIPE AND VALVES**

- A. Discharge pipe shall be 1-½-inch Schedule 80 PVC. Provide one 1-½-inch PVC ball valve on discharge piping. If the sump pump is not provided with a built in check valve, a PVC ball check valve shall also be provided on the discharge piping prior to the ball valve to prevent water from draining back into the sump.

## **3.01 INSTALLATION**

- A. Install sump pump in accordance with the manufacturer's recommendations.

**END OF SECTION**



## SECTION 16010

### ELECTRICAL BASIC REQUIREMENTS

#### PART 1 GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish all labor, materials, equipment and incidentals required for a complete electrical installation for the Work associated with the Contract Documents, as hereinafter specified and shown on the Contract Drawings.
- B. Provide functioning systems in compliance with manufacturer's instructions, performance requirements specified or shown on the Contract Drawings and modifications resulting from reviewed shop drawings and field coordinated drawings.
- C. The work, apparatus and materials which shall be furnished under these Specifications and accompanying Contract Drawings shall include all items listed hereinafter and/or shown on the Contract Drawings. Certain equipment will be furnished as specified in other sections of these Specifications which will require wiring thereto and/or complete installation as indicated. All materials necessary for the complete installation shall be furnished and installed by the Contractor to provide complete power, lighting, communication systems, instrumentation, wiring, and control systems as indicated on the Contract Drawings and/or as specified herein.
- D. Provide complete bonding and/or grounding systems for all equipment as specified herein, shown on the contract documents, and as required for specific pieces of equipment per manufacturer.
- E. The Contractor shall furnish and install the necessary cables, transformers, motor control centers, protective devices, conductors, exterior electrical system, etc., to serve motor loads, lighting loads and miscellaneous electrical loads as indicated on the Contract Drawings and/or as specified hereinafter.
- F. The work shall include complete testing of all equipment and wiring at the completion of the work and making any connection changes or adjustments necessary for the proper functioning of the system and equipment.

- G. Mount and wire control panels and process instruments furnished under other Divisions of these Specifications unless specifically stated otherwise. Mount and make all field connections to process instrument panels and other control panels furnished under other Divisions of these Specifications. For process instrumentation, furnish and install all conduit, wire and interconnections between primary elements, transmitters, local indicators, surge protection devices and receivers.
- H. Mount and wire isolation transformers, operator's stations, and power conversion equipment for all variable speed drive systems furnished under other Divisions of these specifications.
- I. Install and wire all thermostats, aqua-stats and other devices furnished under other Divisions of this Specification directly controlling HVAC equipment or fan motors.
- J. Mount and wire electric heaters, and heat tracing furnished under other Divisions of this Specification.
- K. The scheduling and duration of any power or control interruption for the removal of existing equipment or the installation of new equipment shall be coordinated in advance with the Owner.
- L. It is the intent of these Specifications that the electrical system shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Section shall be furnished at no extra cost.
- M. Provide all temporary power as required to facilitate the Contract phased construction plan.

#### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Related Sections include but are not necessarily limited to:
  - 1. Division 1 - General Requirements
  - 2. Section 02050 - Demolition
  - 3. Section 03300 - Cast-in-Place Concrete
  - 4. Division 11 - Equipment
  - 5. Division 13 Special Construction

### **1.03 AREA CLASSIFICATIONS**

- A. Outdoor locations may contain wet, corrosive and hazardous areas.
  - 1. Corrosive and hazardous areas are identified on the Contract Drawings. Areas not identified as such shall be considered wet.
- B. Indoor locations may contain unclassified, damp, wet, corrosive and hazardous areas.
  - 1. Damp, wet, corrosive and hazardous areas are identified on the Contract Drawings. Areas not identified as such, but provided with heating shall be considered unclassified. Areas not identified as such, but provided without heating shall be considered damp.
- C. Hazardous Locations
  - 1. Hazardous locations shall be as defined in NFPA 70 NEC, NFPA 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities, and other applicable standards or codes governing the classification of a particular type of facility or location. In addition, areas are classified as shown on Contract Drawings and as follows:
    - a) Class I Division 1
    - b) Class I Division 2
    - c) Class II Division 1
    - d) Class II Division 2

### **1.04 DEFINITIONS**

- A. Outdoor Areas
  - 1. Those locations on the Project site where the equipment is normally exposed to wind, dust, rain, etc. Outdoor areas include areas protected by a roof or rain/sun shields but not enclosed within a structure.
- B. Indoor Areas
  - 1. Those locations on the Project site where the equipment is normally protected from wind, dust, rain, etc.

## 1.05      **QUALITY ASSURANCE**

### A.      Referenced Standards

1.      American Iron and Steel Institute (AISI)
2.      American National Standards Institute (ANSI)
  - a)      C2, National Electrical Safety Code.
3.      American Society for Testing and Materials (ASTM)
4.      Factory Mutual System (FM)
  - a)      A Guide to Equipment, Materials and Services.
5.      Institute of Electrical and Electronics Engineers (IEEE)
  - a)      141, Recommended Practice for Electrical Power Distribution for Industrial Plants.
  - b)      242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
6.      National Electrical Contractors Association (NECA)
  - a)      NECA 1, Good Workmanship in Electrical Construction
  - b)      NECA 200, Recommended Practice for Installing and Maintaining Temporary Electrical Power at Construction Sites.
7.      National Electrical Manufacturers Association (NEMA)
  - a)      250, Enclosures for Electrical Equipment (1000 V Maximum)
  - b)      ICS 6, Enclosures for Industrial Control and Systems
8.      National Fire Protection Association (NFPA)
  - a)      70, National Electrical Code (NEC).
  - b)      70E, Standard for Electric Safety in the Workplace

- c) 79, Electrical Standard for Industrial Machiner
  - d) 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities
- 9. Underwriters Laboratories, Inc (UL)
  - a) 508, Industrial Control Equipment
  - b) 508A, Industrial Control
  - c) 698, Industrial Control Equipment for Use in Hazardous Locations.
- B. When a specific code or standard has not been cited, the applicable codes and standards of the following code-making authorities and standards organizations shall apply.
  - 1. American Association of State Highway and Transportation Officials (AASHTO)
  - 2. American Iron and Steel Institute (AISI).
  - 3. American National Standard Institute (ANSI).
  - 4. American Society for Testing and Materials (ASTM).
  - 5. ETL Testing Laboratories, Inc (ETL).
  - 6. Insulated Cable Engineers Association (ICEA).
  - 7. Institute of Electrical and Electronic Engineers (IEEE).
  - 8. Illuminating Engineering Society of North America (IES).
  - 9. Instrument Society of America (ISA).
  - 10. Lightning Protection Institute (LPI).
  - 11. National Electrical Manufacturers Association (NEMA).
  - 12. National Fire Protection Association (NFPA).
  - 13. Occupational, Health and Safety Administration (OSHA).

14. Underwriters Laboratories Inc (UL).

- C. In case of conflict or disagreement between codes, standards, laws, ordinances, rules, regulations, drawings and specifications, or within either document itself, the more stringent condition shall govern.

#### **1.06 SUBMITTALS**

- A. Shop Drawings - All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples.

1. Shop drawings shall be arranged and labeled according to specification section and Contract Drawing.
2. Submit shop drawings prior to purchase or fabrication of equipment. See individual Division 16 sections for additional specific requirements.
3. Prior to submittals of shop drawings, coordinate electrical equipment, particularly motor control equipment, control panels, and instrumentation, with all applicable equipment and systems interfacing with that equipment.
4. Submittals shall be made in the following combinations:
  - a) Conduits, raceways, cable trays, ductbank details, wire and cable 600V and below, medium voltage cable, boxes and fittings.
  - b) Medium voltage switchgear, medium voltage motor starters, distribution transformers and secondary substations.
  - c) Motor control centers and control equipment, low voltage switchboards, safety switches, dry-type (specialty) transformers, panelboards, power factor correction capacitors, grounding.
  - d) Lamps, interior lighting, exterior building lighting, site lighting.
  - e) Wiring devices.

- f) Alarm systems, communication systems and telephone systems.
  - g) Provide a wire or cable identification schedule for all power, control, signal, process and protective circuits. The schedule shall be submitted in an electronic spreadsheet type Excel compatible file format and include the following information:
    - (1) Wire or Cable tag number.
    - (2) Number of conductors.
    - (3) Conductor size and type.
    - (4) Wire or Cable usage description.
    - (5) Conduit tag number
    - (6) Conduit routing (to and from).
    - (7) Conduit size and type.
    - (8) Additional notes
5. For each product, clearly identify manufacturer by name. When general data sheets are provided as part of the submittal, specifically identify the products to be used on this Project. Provide manufacturer's technical information on products to be used, including:
- a) Product descriptive bulletin.
  - b) Electrical data pertinent to the Project and necessary to assure compliance with Specifications and Contract Drawings.
  - c) Equipment dimensions, where applicable.
  - d) Evidence that the products submitted meet the requirements of the standards referenced.
  - e) Specify part number with explanation of options selected.
6. Ensure that all submittals clearly indicate the equipment is UL or ETL listed.
7. For all equipment, provide manufacturer's installation instructions.
- B. When a quality standard has been established by identification of a specific manufacturer or catalog number, submittals for proposed alternates and substitutions shall include:

1. Alternate and substitute equipment cross-referenced to the equipment it is replacing. Submittal shall be marked to show how differences will be accommodated.
2. Calculations and other detail data to allow determination of alternate and substitute equipment equivalency to the equipment it is replacing. Data supplied shall allow detailed comparison of all significant characteristics upon which the design equipment is based.
3. Dimensioned drawings, of the same or larger scale as the Contract Drawings, for all alternate and substitute equipment, which differs in size, configuration, service accessibility or in any significant way from the equipment it is replacing.
  - a) Complete system layout, except that portion which is identical to the Contract Drawings.
  - b) Redesign and modifications to all work required by the alternate or substitute equipment.

C. Operation and Maintenance Manuals.

**1.07 DELIVERY, STORAGE, AND HANDLING**

- A. The Contractor shall unload and handle materials using methods, rigging, and equipment that will prevent damage to the materials. Care shall be used to prevent damage to painted and galvanized surfaces.
  1. Bare wire rope slings shall not be used for unloading and handling materials and equipment, except with the specific written permission of the Engineer.
- B. Equipment and materials, in accordance with the manufacturer's recommendations, shall be stored, supported and protected to prevent damage.
  1. Stored materials and equipment shall not be allowed to contact the ground.
  2. Equipment and materials which incorporate electrical equipment or which have finished painted



surfaces, and other items which would be damaged by outdoor exposure, shall be stored indoors.

- a) Provide covering and shielding for all equipment to protect from damage.
  - b) When such storage would present an unreasonable building space or volume requirement, the equipment or materials may, when acceptable to the Engineer, be stored under weatherproof coverings on shoring or platforms.
3. All small loose items that could be easily lost, stolen, broken, or misused shall not be stored on open platforms or shoring.
  4. All storage methods and schedules shall be acceptable to the Engineer.
- C. Ensure that equipment is not used as steps, ladders, scaffolds, platforms, or for storage-either inside or on top of enclosures.
- D. Protect nameplates on electrical equipment to prevent defacing.
- E. Repair, restore or replace damaged, corroded and rejected items at no additional cost to the Owner.
- F. Record Drawings
1. The Contractor shall maintain a marked up set of Document Drawings showing actual installed circuit numbers, conduit sizes, cable tray routing, number of conductors, conductor sizes (other than #12AWG) and all other deviations from the design drawings.
  2. All underground conduit and concealed items shall be dimensioned on the Document Drawings from permanent, visible, building features. Depths to the top of ductbanks shall be recorded.
  3. Provide actual motor size, starter size, and heater size, along with all other protective equipment for all motor circuits as part of the one-line record drawings.
  4. Revise all wire/cable identification schedules to indicate as installed conditions.

5. Revise all panelboard schedules to indicate as installed conditions.

## **PART 2 PRODUCTS**

### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Refer to related Division 16 sections. All equipment of a similar type shall be by one manufacturer unless otherwise noted in the Specifications.

### **2.02 MATERIALS**

- A. Trade names and catalog numbers may be used in the Contract Drawings or Specifications to establish quality standards and basics of design.
  1. Other listed manufacturers in the applicable specification sections with equal equipment may be acceptable.
  2. If no other manufacturer is listed then any manufacturer of equal equipment may be acceptable.
- B. Listed: Where UL test procedures have been established for the product type, electrical equipment shall be approved by UL or ETL and shall be provided with the UL or ETL label.

### **2.03 FABRICATION**

- A. When equipment is shop fabricated for the Project, the electrical devices and enclosures utilized shall be UL or ETL listed and labeled or shall be UL recognized.
- B. Shop or Factory Finishes: Interiors of other painted equipment shall be white.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Equipment shall be installed in accordance with the requirements of the NEC.
- B. Enclosures for use with electrical equipment unless specifically shown or specified elsewhere in the Contract Documents:
  1. NEMA 1/12

- a) Acceptable in unclassified indoor locations.
- 2. NEMA 3/3R
  - a) Acceptable in damp or wet indoor/outdoor non-corrosive locations
- 3. NEMA 4X
  - a) Use in wet indoor/outdoor corrosive locations.
  - b) Enclosures shall be 304-Stainless-Steel minimum. Enclosures constructed of 316-Stainless Steel may be required in extremely corrosive areas as shown on the Contract Drawings
  - c) Nonmetallic enclosures shall not be used in areas subject to physical damage or sunlight. Nonmetallic enclosures may be used in interior locations.
- 4. NEMA 6P
  - a) Use in "Accidental Submergence" locations.
- 5. NEMA 7
  - a) Use in all Class I, Division 1, 2, Group A, B, C, D locations.
  - b) Unless other enclosures are approved and UL listed for the application.
- 6. NEMA 9
  - a) Use in all Class II, Division 1, 2, Group E, F, G and Class III, Division 1, 2 locations.
  - b) Unless other enclosures are approved and UL listed for the application.
- 7. Exceptions
  - a) As modified in other Division 16 sections.
  - b) As otherwise indicated on the Contract Drawings.

- C. Coordinate the installation of electrical equipment with other trades.
  - 1. Arrange for the building in of equipment during structure construction.
  - 2. Where equipment cannot be built-in during construction, arrange for sleeves, box-outs, openings, etc., as required to allow installation of equipment after structure construction is complete.
- D. Verify that equipment will fit support layouts indicated.
- E. Equipment Dimensions and Clearances
  - 1. Equipment shall fit in the locations shown on the Contract Drawings.
  - 2. Do not use equipment or arrangements of equipment that reduce required clearances or exceed the space allocation.
- F. Install equipment in accordance with the manufacturer's instructions.
- G. Equipment Access
  - 1. Install equipment so it is readily accessible for operation and maintenance.
  - 2. Equipment shall not be blocked or concealed.
  - 3. Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.
- H. Equipment shall be installed plumbed, square and true with the building construction and shall be securely fastened.
- I. Outdoor wall-mounted equipment and indoor equipment mounted on earth or water bearing walls shall be provided with corrosion-resistant spacers to maintain 1/4 IN separation between the equipment and the wall.
- J. Screen or seal all openings into outdoor equipment to prevent the entrance of rodents and insects.

- K. Equipment fabricated from aluminum shall not be placed in direct contact with earth or concrete.
- L. Provide all necessary anchoring devices and supports.
  - 1. Use supports as detailed on the Drawings and as specified. Where not detailed on the Drawings or specified, use supports and anchoring devices rated for the equipment load and as recommended by the manufacturer.
  - 2. Supports and anchoring devices shall be rated and sized based on dimensions and weights verified from approved equipment submittals.
  - 3. Hardware shall be malleable type, corrosion resistant and shall be supported by heavily plated machine screws or brass, bronze or stainless steel bolts.
  - 4. Do not cut, weld to, or modify building structural members without written approval by the Engineer of record.
  - 5. Do not mount safety switches and external equipment to other equipment enclosures, unless enclosure-mounting surface is properly braced to accept mounting of external equipment.
- M. Contractor shall verify exact rough-in location and dimensions for connection to electrical items to be installed under this Contract.
  - 1. Shop drawings shall be secured from those furnishing the equipment.
  - 2. Proceeding without proper information may require the Contractor to remove and replace work that does not meet the conditions imposed by the equipment supplied.
  - 3. Provide sleeves wherever openings are required through new concrete or masonry members. Place sleeves accurately and coordinate locations with the Engineer.
  - 4. Should any cutting and patching be required on account of failure of the Contractor to coordinate penetrations, such cutting and patching shall be done at the expense of the Contractor.

- a) Contractor shall not endanger the stability of any structural member by cutting, digging, chasing, or drilling and shall not, at any time, cut or alter the work without the Engineer's written consent.
    - 1) Provide additional reinforcing if required.
    - 2) Cutting shall be done neatly using proper tools and methods.
  - b) Subsequent patching to restore walls, ceilings, or floors to their original condition shall be done by workmen skilled in their particular field.
- N. Provide concrete foundations or pads required for electrical equipment as indicated or specified.
- 1. Floor-mounted equipment shall be mounted on a 4IN high concrete housekeeping pad. Pad shall be poured on top of the finished floor or slab.
- O. Material that may cause rusting or streaking on a building surface shall not be used.
- P. Perform excavation and backfill in accordance with Section 02200 - Earthwork.
- Q. Contractor shall coordinate the installation of the conduit and wire associated with the HVAC equipment supplied under this Contract.
- R. Enclosed electronic equipment located outdoors shall be provided with sun/rain shields and oriented to minimize sun exposure.
- S. Device Mounting
- 1. Dimensions are to top of item unless otherwise indicated.
  - 2. Mounting heights as indicated below unless otherwise indicated on the Contract Drawings
    - a) Light switch: 48IN.
    - b) Receptacle in offices and other finished areas: 16IN.

- c) Receptacle in all other locations: 48IN.
- d) Telephone outlet for desk-mounted phone: 16IN.
- e) Telephone outlet for wall-mounted phone: 64IN.
- f) Bracket light above lavatory: 80IN to bottom of fixture.
- g) Disconnect / Safety-Switch: 64IN to top of enclosure.
- h) Panelboard: 72IN to top of enclosure.
- i) Motor starter: 64IN to top of enclosure.
- j) Pushbutton motor control station: 48IN to top of enclosure.

### **3.02 IDENTIFICATION**

- A. Identify all major items of equipment including controls, panels, switches, contactors, motor starters/controllers, junction boxes and metering by permanent nameplates, with wording approved by the Engineer. Secure nameplates to equipment with stainless-steel screws or rivets. Adhesives may be used in conjunction with mechanical fasteners.
- B. Nameplates after installation shall be easily visible and shall bear notations corresponding to those shown on the Record Drawings.
- C. All conduits shall be identified with a stamped stainless-steel tag system. Conduit tags shall be permanently attached to each exposed end of conduit runs such as in manholes, pull boxes, panels, motor control centers, junction boxes, etc., and at each point of entry into a structure or building. Each tag shall be stamped with the appropriate conduit number per the conduit and cable schedules.
- D. Each instrument shall be identified with a stamped stainless-steel tag system. Instrument tags shall be permanently attached to each individual instrument and stamped with the appropriate tag number per the instrument specification section.
- E. Each cable shall be identified with a heat-shrinkable polyolefin label printing system. Instrumentation cables

shall be labeled with the appropriate instrument tag (Example: FIT-200-1). Multiplex cables, power and control cables shall be labeled with the appropriate cable tag number per the equipment tag number (Example: PP1-CKT-9).

F. All motor control centers, power panels, lighting panels, control panels, control cabinets, etc., shall be identified with permanently mounted nameplates.

G. All power and lighting panels shall have matte-finish plastic laminated typed schedules mounted on panel doors.

H. Identification Types

1. Equipment Nameplates

a) Phenolic Resin or Thermoplastic Elastomer

- 1) Thickness: 3/32IN minimum.
- 2) Size: As required by text.
- 3) Letters: White letters on Black background.
- 4) Mount with stainless-steel screws.

2. Wire and Cable Labels

a) Heat shrinkable Polyolefin

- 1) Size: As required by wire or cable.
- 2) Letters: Black letters on White background.
- 3) Heat-shrink after termination.
- 4) Replace damaged or illegible labels.

3. Raceway Tags

- a) Material: Stainless-Steel
- b) Size: As required by text.
- c) Attach with stainless-steel wire and permanent crimp sleeve

4. Instrument Tags

- a) Material: Stainless-Steel
- b) Size: As required by text.
- c) Attach with stainless-steel wire and permanent crimp sleeve

5. UNDERGROUND WARNING TAPE



- a. Manufacturers: Brady Company, Seton or as approved.
- b. Description: 2-inch wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines.

### **3.03 FIELD QUALITY CONTROL**

- A. Do not remove or damage fireproofing materials.
  - 1. Install hangers, inserts, supports, and anchors prior to installation of fireproofing.
  - 2. Repair or replace fireproofing removed or damaged.
- B. Make all penetrations through roofs prior to installation of roofing.
- C. All penetrations required after installation of roofing, shall be completed by an authorized roofer to maintain the roof warranty.
- D. Make all penetrations of electrical work through walls water and weather-tight.
- E. Equipment furnished under this Contract for use on future work and all concealed equipment, including conduits, shall be dimensioned, on the Record Drawings, from visible and permanent building features.
- F. After installation, all equipment shall be tested as recommended by the manufacturer.
- G. Verify all components are operational.
- H. Perform ground-fault performance testing as required by NEC Article 230-95(c).
- I. Test Equipment Interface
  - 1. Verify systems coordination and operation.
- J. Set all adjustable trip protective devices as required for system protection and coordination.
- K. Verify all system and equipment ground continuity.
- L. Adjust installed equipment for proper operation of all electrical and mechanical components.
- M. Replace equipment and systems found inoperative or defective and re-test.

1. If equipment or system fails re-test, replace it with products that conform to Contract Documents.
  2. Continue remedial measures and re-tests until satisfactory results are obtained.
  3. Remedial measures and re-tests will be done at no cost to the Owner.
- N. The Engineer shall be notified of tests and Engineer may witness individual tests.
- O. Required certificates of testing and test reports shall be presented to the Engineer upon completion of the tests.
- P. At Completion of Installation
1. Test to ensure all equipment is free of short circuits and improper grounds.
  2. Test to ensure all equipment is operational.

#### **3.04 CLEANING**

- A. Clean dirt and debris from all interior and exterior surfaces.
- B. Apply touch-up paint as required to repair scratches, etc.
- C. Replace nameplates or wire and cable markers damaged during installation.
- D. Thoroughly vacuum the interior of all enclosures to remove dirt and debris. Do NOT use pressurized air systems to blow out dirt and debris.

#### **3.05 DEMONSTRATION**

- A. Demonstrate equipment in accordance with Contract Requirements.

**END OF SECTION**

## **SECTION 16050**

### **MATERIALS AND METHODS**

#### **PART 1 GENERAL**

##### **1.01 RELATED WORK SPECIFIED ELSEWHERE**

- A. In addition to the requirements specified in this section, the requirements of specification Section 16010 - Electrical, Basic Requirements and the sections referenced therein shall be applied.
- B. Specification Section 03300 - Cast-in-Place Concrete
- C. Specification Section 09900 - Painting and Coatings

##### **1.02 SUBMITTALS**

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples.
- B. In accordance with the procedures and requirements set forth in the Contract requirements, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable Specification Section.
- C. Shop drawings shall include but not be limited to:
  - 1. Equipment specifications and product data sheets identifying all materials used and methods of fabrication.
  - 2. Complete assembly, layout, installation, and foundation drawings with clearly marked dimensions.

##### **1.03 QUALITY ASSURANCE**

- A. Manufacturers: Firms regularly engaged in manufacture of products for electrical related work of sizes, types, ratings, and materials required, whose products have been in satisfactory use in similar service for not less than three (3) years.

##### **1.04 PROJECT CONDITIONS**

- A. Protect property from any and all damage that might result from excavating and backfilling.

- B. Protect persons from injury at excavations, by barricades, warnings and illumination.
- C. Coordinate excavations with weather conditions, to minimize possibility of washouts, settlements and other damages and hazards.

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION**

**3.01 EXCAVATING FOR ELECTRICAL WORK**

- A. General: Do not excavate for electrical work until the work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimized.
- B. Excavate with vertical-sided excavations to greatest extent possible, except where otherwise indicated. Where necessary, provide sheeting and cross-bracing to sustain sides of excavations. Remove sheeting and cross-bracing during backfilling wherever such removal would not endanger the work or other property. Where not removed, cut sheeting off at sufficient distance below finished grade to not interfere with other work.
- C. Depth for sub-base Support: Unless otherwise noted, provide installation of sub-base material(s). Excavate for installation of sub-base material in depth indicated or, if not otherwise indicated, 6IN below bottom of work to be supported.
- D. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.
  - 1. Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.
  - 2. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.
- E. Excavate trenches to the uniform dimensions required for the particular item(s) to be installed and provide sufficient working clearances. Dig trenches to

- approximate depth and hand grade bottom to accurate elevation as required.
- F. Where rock is encountered, carry excavation 6IN below required elevation and backfill with a 6IN layer of sand prior to installation of conduit.
  - G. Where soil conditions at bottom of indicated excavation are unsatisfactory, excavate additional depth as directed to reach satisfactory soil-bearing condition. Backfill with sub-base material compacted as directed, to indicated excavation depth.
  - H. Unless otherwise noted in the Contract Drawings, store excavated material (temporarily) near excavation, in manner that will not interfere with or damage excavation or other work. Do not store under trees (within drip-line).
  - I. Retain excavated material that complies with requirements for backfill material.
  - J. Dispose of excess or unsatisfactory excavated material(s) as directed by the Contract requirements and site conditions.
  - K. Refer to the Contract requirements and site conditions for removal of large subsurface materials.

### **3.02 DEWATERING**

- A. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
- B. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.
- C. Maintain dry excavations for electrical work, by removing water. Protect excavations from inflow of surface water. Pump minor inflow of ground water from excavations; protect excavations from major inflow of ground water, by installing temporary sheeting and waterproofing. Provide adequate barriers that will protect other excavations and below-grade property from being damaged by water, sediment or erosion from or through electrical work excavations.

### **3.03 BASE PREPARATION**

- A. Install subbase material to receive electrical work, and compact by tamping to form a firm base for the work.
- B. Provide finely-graded subbase material for equipment to be buried.
- C. Tamp fill to uniform compacted density.
- D. Where conduit crosses over areas which have been previously excavated to depths greater than required for conduit installation, provide suitable support that comply with details shown and Contract requirements.

### **3.04 BACKFILLING**

- A. Backfill with approved backfill materials.
- B. Backfill with finely-graded subbase material to 6IN above equipment to be buried. Backfill materials shall be soil materials free of clay, rock or gravel larger than 3/4IN, debris, waste, frozen materials, vegetation and other deleterious matter.
- C. Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to required densities. Do not backfill with frozen soil materials.
- D. Backfill simultaneously on opposite sides of electrical work, and compact simultaneously; do not dislocate the work from installed positions.
- E. Backfill excavations in 8IN high courses of backfill material, uniformly compacted to the following densities (% of maximum density, ASTM D 1557), using power-driven hand-operated compaction equipment.
- F. When backfilling excavations for electrical work, backfill to elevations matching finished grades.
- G. Backfill trenches with concrete where trench excavations pass within 18IN of column or wall footings and which are carried below bottom of such footings, or which pass under wall footings. Place concrete to level of bottom of adjacent footing.

- H. Do not backfill trenches until tests and inspections have been made and backfilling authorized by the Engineer. Use care in backfilling to avoid damage or displacement of conduit systems.

### **3.05        INSTALLATION OF CONCRETE WORK**

- A. Refer to Specification Section 03300 - Cast-in-Place Concrete
- B. Miscellaneous Concrete Work
  - 1. Concrete Grouting: Grout openings and recesses as indicated on the Contract Drawings and around all electrical work and other work that penetrates or adjoins all concrete work. Provide formwork where required, and tamp, screed and trowel surfaces. Cure grout as specified for concrete work.
  - 2. Refer to Specification Sections for grouting of equipment base plates on foundations (with high-strength, non-shrinking grout), and similar grouting requirements not defined herein.
- C. Clean-Up: Upon completion of work, clean excess concrete and grout from adjacent areas and surfaces. Remove excess concrete and grout by proper methods of removal, using care not to scratch or otherwise damage finished surfaces.

### **3.06        SUPPORT AND FASTENERS**

- A. The Contractor shall furnish and install structural supports and fasteners for mounting and installing all electrical, lighting, alarm systems, instrumentation, communications and other equipment furnished under this Contract.
- B. Where the weight of equipment exceeds 75LBS and is supported from walls, ceilings, columns and/or beams, such structural supports, methods, and locations shall be approved in writing by a professional engineer currently registered in the State of the projects location.
- C. Concrete or Masonry Inserts
  - 1. The Contractor shall be responsible for the furnishing and installation of all conduit sleeves, anchor bolts, masonry inserts, and similar devices

required for installation of equipment furnished under this Contract.

2. The Contractor shall furnish leveling channels for all switchgear, switchboards, motor control centers, and similar equipment spanning 60IN, in any direction, along the floor. The leveling channels shall be provided for installation into the equipment supporting pads. Coordination of the installation of these channels within the concrete pad is essential and required. Pad height shall be as required to maintain coverage of the reinforcement bars while not exceeding the maximum mounting heights requirements of the NEC.

D. Support Fastening and Locations

1. All equipment fastened to structural steel; columns, beams, and trusses shall be made by approved clamps or welded. No holes shall be drilled in structural steel.
2. Where supports or hangers are required for heavy electrical equipment units exceeding 75LBS, the structural engineer of record shall check the structural members. Where required, additional sections shall be provided for a safe installation.
3. All holes in hung ceilings for support rods, conduits, and other equipment shall be made adjacent to ceiling supports where possible, to facilitate removal of ceiling panels.
4. For interior dry areas, a bracket and channel type support of galvanized steel construction shall be provided wherever required for the support of starters, switches, panels, and miscellaneous equipment.
5. For outdoor service or in indoor damp/wet process areas, the support system shall be made of either stainless steel, PVC coated rigid galvanized steel, aluminum or as indicated on the Contract Drawings.
6. All fastening hardware (bolts, nuts, washers, etc.) shall be approved stainless steel materials or as indicated on the Contract Drawings.
7. All supports shall be rigidly bolted together and braced to make a substantial supporting framework.



Where possible, control equipment shall be grouped together and mounted on a single framework. Wherever this occurs, a provision shall be made for ready access to the wiring for connections to the equipment by means of boxes with screw covers.

8. Aluminum support members shall not be installed in direct contact with concrete. Stainless steel or non-metallic "spacers" shall be used to prevent contact of aluminum with concrete.
9. The Contractor is responsible for the design of supporting structures and shall submit design details to the Engineer for acceptance before proceeding with the fabrication and installation.
10. Wherever dissimilar metals come into contact, the Contractor shall isolate these metals as required with nylon washers, 9MIL polyethylene tape, or gaskets.

**END OF SECTION**



## **SECTION 16111**

### **CONDUIT AND RACEWAY**

#### **PART 1 GENERAL**

##### **1.01 THE REQUIREMENT**

- A. The Contractor shall furnish all labor, materials, tools and equipment necessary for furnishing, installing, connecting, testing and placing into service all raceway to include all conduits, conduit fittings, wireway, supports, etc. as required for a complete electric installation as specified herein and indicated on the Contract Drawings.
  - 1. Conduit home runs for lighting, receptacle and other misc. circuits are not necessarily indicated on the Contract Drawings; however, the circuit numbers are shown. Conduit shall be furnished and installed for these circuits.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. In addition to the requirements specified in this section, the requirements of specification Section 16010 - Electrical Basic Requirements, and the sections referenced therein shall be applied.
  - 1. Additional raceway from what is shown on the Contract Drawings may be required. Coordinate with the requirements of equipment provided under other Divisions of the specifications.

##### **1.03 CODES AND STANDARDS**

- A. Raceway shall comply with the following applicable codes and standards as well as any others within the specifications and drawings. In the event of any conflict between these codes, regulations, standards, and Contract Documents, the most restrictive shall apply.
  - 1. American National Standards Institute (ANSI)
    - a) C80.4 Fittings for Rigid Metal Conduit and Electrical Metallic Tubing.
    - b) C80.5 Electrical Rigid Aluminum Conduit.

2. American Society for Testing and Materials (ASTM):
  - a) A36, Standard Specification for Structural Steel.
  - b) A153, Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  - c) A307, Carbon Steel Externally Threaded Standard Fasteners.
  - d) A563, Standard Specification for Carbon Steel Nuts.
  - e) A569, Steel Carbon, Hot-Rolled Sheet and Strip, Commercial Quality.
  - f) A570, Hot-Rolled Sheet and Strip, Structural Quality.
  - g) A575, Merchant Quality Hot-Rolled Carbon Steel Bars.
  - h) A635, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot-Rolled.
  - i) D1784, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
  - j) D1788, Standard Specification for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Plastics.
  - k) D2564, Solvent Cements for (PVC) Plastic Pipe, Tubing, and Fittings.
  - l) F512, Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation.
3. ETL Testing Laboratories, Inc (ETL).
4. National Electric 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-6, PVC and ABS Plastic Utilities Duct for Underground Installation.
- 5. National Electric Contractors Association
  - a) NECA 1: Standard Practices for Good Workmanship in Electrical Construction
- 6. National Fire Protection Association (NFPA)
  - a) 70, National Electric Code (NEC)
  - b) 79, Electrical Standard for Industrial Machinery
- 7. Underwriters Laboratories Inc (UL)
  - a) 1, Flexible Metal Conduit
  - b) 6A, Electrical Rigid Metal Conduit - Aluminum
  - c) 209, Cellular Metal Floor Raceways and Fittings
  - d) 360, Liquid-Tight Flexible Steel Conduit
  - e) 467, Grounding and Bonding Equipment
  - f) 514, Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
  - g) 514B, Conduit, Tubing and Cable Fittings
  - h) 651, Schedule 40 and 80 Rigid PVC Conduit
  - i) 870, Wireways, Auxiliary Gutters, and Associated Fittings
  - j) 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
  - k) 1242, Intermediate Metal Conduit
  - l) 1660, Liquid-Tight Flexible Non-Metallic Conduit

#### **1.04 SUBMITTALS**

- A. Shop Drawings - All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples.
  - 1. Proposed routing of all site conduits including direct buried, concrete encased, and long run above ground conduits.
  - 2. Proposed routing of conduits buried under floor slabs.
  - 3. Proposed routing and details of construction, including conduit and rebar, of conduits embedded in floor slabs, columns, etc.
  - 4. Operation and Maintenance Manuals shall be submitted as outlined in Specification 01730 - Operation and Maintenance Data.

#### **PART 2 PRODUCTS**

##### **2.01 GENERAL REQUIREMENTS**

- A. The material covered by this Specification is intended to be standard material of proven performance as manufactured by reputable firms. Raceways and appurtenances shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. All equipment shall be UL listed and labeled for its intended service.
- C. Subject to compliance with the Contract Documents, the listed manufacturers are acceptable.

##### **2.02 RIGID ALUMINUM CONDUIT (RAC)**

- A. Acceptable Manufacturers
  - 1. Allied Tube and Conduit Corporation
  - 2. Western Tube and Conduit Corporation
  - 3. Wheatland Tube Company
- B. RAC and associated fittings shall be manufactured from

6063 aluminum alloy in temper designation T-1.

C. RAC shall be installed for all above ground conduit installations indoor or outdoor unless otherwise noted on the contract drawings.

D. Standards

1. ANSI C80.5

## **2.03 PVC-COATED RIGID GALVANIZED STEEL CONDUIT (PVC-RGS)**

A. Acceptable Manufacturers

1. Thomas & Betts

2. Perma-Cote

3. Rob-Roy Ind.

B. PVC-RGS shall have a minimum 40MIL polyvinyl chloride exterior coating. The coating shall be bonded to hot-dipped galvanized rigid steel conduit conforming to ANSI C80.1. The bond between the polyvinyl chloride coating and the conduit surface shall be greater than the tensile strength of the coating. PVC-RGS shall have a nominal 2MIL, minimum, urethane interior coating and a urethane coating on threads. The PVC-RGS conduit shall have an epoxy prime coating prior to application of polyvinyl chloride and urethane coatings.

C. Female ends shall have a plastic sleeve extending a minimum of 1 pipe diameter or 2 inch, whichever is less beyond the opening. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used with it.

D. Standards

1. ANSI C80.1

2. NEMA RN-1

## **2.04 RIGID POLYVINYL CHLORIDE CONDUIT (PVC)**

A. Acceptable Manufacturers

1. Allied Tube and Conduit Corporation

2. Carlon

3. Cantex

- B. PVC shall be either Schedule 40 or Schedule-80. The polyvinyl-chloride plastic compound shall meet, as a minimum, ASTM D1784 cell classification PVC 12233-A, B, or C. PVC shall be rated for direct sunlight exposure, 90°C wire, and fire retardant with low smoke emission.
- C. Schedule 40 PVC conduit shall be installed in concrete encased underground conduit installations. Schedule 80 PVC conduit shall be installed in direct buried installations.
- D. Standards
  - 1. ANSI C33.91
  - 2. NEMA TC-2
  - 3. UL 651

**2.05 LIQUID-TIGHT FLEXIBLE METAL CONDUIT (LFMC)**

- A. Acceptable Manufacturers
  - 1. Anamet, Inc.
  - 2. Electri-Flex Company
  - 3. International Metal Hose Company
- B. LFMC shall have a core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked, contain an interwoven copper strip suitable as a grounding means, and have an extruded vapor and liquid tight polyvinyl chloride outer jacket positively locked to the steel core.
- C. Standard
  - 1. UL 360

**2.06 WIREWAY**

- A. Acceptable Manufacturers
  - 1. E.M. Wiegmann and Company, Inc.
  - 2. Hoffman Engineering Company
  - 3. Stahlin



4. Square D

B. Wireway shall have a minimum wall thickness of 0.040 inch, be furnished without knockouts, be designed for continuous grounding, and suitable for lay-in conductors. Provide Solid and non-removable covers when passing through partitions and solid hinged covers with captive screw fasteners when accessible.

C. Wireway shall not be smaller than 4-inch x 4-inch unless otherwise indicated on the Contract Drawings.

D. Types

1. NEMA-1: Wireway shall be steel, finished with rust inhibiting phosphatizing coating and gray baked enamel finish on interior and exterior surfaces.

2. NEMA-3/3R/12: Wireway shall be steel, finished with rust inhibiting phosphatizing coating and gray baked enamel finish on interior and exterior surfaces. Cover shall be fully gasketed and provided with captive clamp type latches.

3. NEMA- 4/4X: Wireway shall be type 304 stainless steel for interior or exterior corrosive areas. Cover shall be fully gasketed and provided with captive external screw type clamps.

4. NEMA- 4/4X: Fiberglass or PVC may be utilized for interior corrosive areas only where specifically shown on the Contract Drawings.

E. Standards

1. NFPA 79

2. UL 870

**2.07 CONDUIT FITTINGS AND ACCESSORIES**

A. Acceptable Manufacturers

1. Appleton

2. Carlon

3. Crouse-Hinds

4. Killark

5. OZ Gedney Company
6. Perma-Cote
7. RACO
8. Rob-Roy Ind.
9. Steel City
10. Thomas and Betts
11. Western Plastics Company

B. Fittings for Use with RAC

1. Materials: Following minimum requirements unless otherwise noted.
  - a) Body: Copper-free aluminum with aluminum lacquer or aluminum enamel finish.
  - b) Covers: Copper-free aluminum and gasketed.
  - c) Gaskets: Neoprene or PVC.
  - d) Insulators-phenolic, thermosetting: minimum 105 Deg C UL rating.
  - e) Grounding saddles tin-plated copper or bronze suitable for use with copper and aluminum conductors.
  - f) Bonding jumpers: Tinned copper flexible braid.
  - g) Locknuts: Malleable iron, zinc plated.
2. All fittings: Threaded unless otherwise noted.
3. Conduit Hubs shall be cast aluminum with insulated throat.
4. Straight couplings: Same material and finish as the conduit with which they are used.
5. Mogul pulling elbows and tees:
  - a) Die cast copper free aluminum
  - b) Rain tight

6. Conduit seals

- a) Drain and breather: Stainless steel or brass
- b) Fiber and sealing compound: UL listed for use with the sealing fitting

7. Standards

- a) UL 467
- b) UL 514B

C. Fittings for Use with PVC

1. Fittings shall be of the same material, thickness, and construction as the conduits with which they are used.

- a) Standards
  - 1) UL 651
  - 2) NEMA TC-2-1978

2. Solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.

- a) Shall not be more than 1 year past date of manufacture.
- b) Standard: ASTM D2564

D. Fittings for Use with LFMC

1. Fittings shall meet the following minimum requirements unless otherwise noted:

- a) Body: Malleable iron, zinc-plated
- b) Ferrule: Steel, zinc-plated
- c) Locknuts and compression nuts: Malleable iron, zinc-plated
- d) Sealing ring: Neoprene

2. Fittings shall be compression type

3. Standard: UL 514

## **2.08        STRUT CHANNEL SUPPORT SYSTEMS**

- A.    Acceptable manufacturers:
  - 1.    Allied Power-Strut Products
  - 2.    B-Line Systems
  - 3.    Rob-Roy Industries
  - 4.    Thomas & Betts
  - 5.    Unistrut Building Systems
- B.    All strut-channel, clamps, fittings and fastener materials shall conform to the following unless otherwise noted on the Contract Drawings.
  - 1.    Indoor Wet/Dry Areas:
    - a)    Aluminum 6063-T6
  - 2.    Indoor Corrosive Areas:
    - a)    Fiberglass (ASTM D-4385)
    - b)    Stainless Steel Type-316 (ASTM A240)
    - c)    PVC Coated Hot-Dipped Galvanized Steel (ASTM D1151, D2247)
  - 3.    Outdoor Wet Areas:
    - a)    Stainless Steel Type-304 (ASTM A240)
    - b)    Aluminum 6063-T6
  - 4.    Outdoor Corrosive Areas:
    - a)    Stainless Steel Type-316 (ASTM A240)
    - b)    PVC Coated Hot-Dipped Galvanized Steel (ASTM D1151, D2247)
- C.    Strut-channel shall not be bent, drilled, cut or otherwise modified to produce fittings, braces or brackets for conduit and equipment supports.
- D.    Manufactured strut-channel braces, brackets, fittings and post-bases shall be provided and installed with

associated hardware and fasteners as a complete system for conduit and equipment supports.

**PART 3 EXECUTION**

**3.01 DELIVERY, STORAGE, AND HANDLING**

- A. All conduit, raceway, wireway and associated fittings shall be stored in accordance with the manufacturer recommendations and shall not be stored exposed to sunlight or other UV rays.

**3.02 INSTALLATION**

- A. The Contractor shall plan the layout of conduit and raceway systems so that when the work is complete it will exhibit good workmanship practices in accordance with NECA-1.
- B. Routing of Conduits and Raceways
  - 1. Conduit and Raceway runs, where shown, indicate the preferred location. Site conditions may affect actual routing. Contractor shall coordinate routing and measurement with other trades and with equipment suppliers.
  - 2. Shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.
  - 3. Wherever possible avoid routing conduits and raceways through areas of high ambient temperature or radiant heat.
- C. Size of Conduits and Raceways
  - 1. The size of conduits and raceways are normally shown on the Contract Drawings. If a size is not shown on the Contract Drawings, or if a minimum size is not stated in the Specifications, then the size of conduits and raceways shall be in accordance with the NEC.
  - 2. Conduits shall not be smaller than 1 inch for underground installations and 3/4 inch elsewhere, unless otherwise shown on the Contract Drawings.
- D. Types of Conduits and Raceways

1. Shall be installed as defined in the Contract Drawings.
  2. As required by NFPA.
  3. Flexible Conduit
    - a) Install as the final conduit to motors, electrically operated valves, primary elements (instrumentation), and electrical equipment that is liable to vibrate.
    - b) Shall not be used as a conduit run:
    - c) Maximum length shall not exceed:
      - (1) 36 inch to motors.
      - (2) 24 inch to all other equipment.
  4. PVC-RGS
    - a) Contractor shall use tools, clamps, dies, equipment, etc. designed specifically for the cutting, bending and threading of PVC-RGS.
    - b) Contractor shall follow the recommendations and methods of the manufacturer for installing PVC-RGS.
- E. Provide openings in walls, floors, and ceilings for all required raceway penetrations.
1. Sleeves and block outs: Set in masonry walls during erection.
  2. Sleeves and block outs: Set in concrete during forming.
    - a) Material: Not harmful to the concrete.
    - b) Not considered to replace structurally the displaced concrete.
- F. Conduit Runs
1. All conduits within a structure shall be installed concealed unless otherwise noted on the Contract Drawings.
  2. Total of Bends in a Conduit Run

- a) Less than 270 degrees.
- b) Provide pull boxes, conduits, or pulling elbows or tees as needed.
- 3. Run in straight lines parallel to or at right angles to structural members or building lines.
- 4. Maintain minimum 2-inch separation between all conduits.
- 5. Maintain minimum 6-inch separation between instrumentation and power conduits.
- 6. Maintain minimum 12-inch separation from process, gas, air and water pipes.
- 7. Conduits and accessories embedded in concrete:
  - a) Shall not be larger in outside diameter than one-third the thickness of the slab, column or beam.
  - b) Place conduit and accessories after reinforcing steel has been laid.
  - c) Shall not displace the reinforcement steel.
  - d) Provide a minimum of 1-1/2 inches of concrete cover around conduit.
  - e) Do not run against reinforcing steel.
  - f) Provide 2 inch minimum of spacing between conduits.
  - g) Install expansion/deflection fittings wherever conduit spans structural or expansion joint.

#### G. Field Bending of Conduits

- 1. Utilize tools, equipment, methods and recommendations by the manufacturer to make all field bends.
- 2. The internal diameter of conduit shall not be reduced or distorted.

#### H. Field Cutting and Threading Conduits

1. Utilize tools, equipment, methods and recommendations by the manufacturer to field cut and thread conduit.
2. All field cut conduit shall be smooth and evenly chamfered on the inside.
3. All field threaded conduit shall be clean and degreased before applying a zinc rich paint.

#### I. Terminating Conduits

1. NEMA 1 enclosures
  - a) Top: Locknuts and insulated bushings.
  - b) Side: Locknuts and insulated bushings.
  - c) Bottom: Locknuts and insulated bushings.
2. NEMA 2/12/12K enclosures
  - a) Top: Sealing locknuts and insulated bushings.
  - b) Side: Locknuts and insulated bushings.
  - c) Bottom: Locknuts and insulated bushings.
3. NEMA 3/3R/3S/13 enclosures
  - a) Top: Threaded conduit hubs with insulated throats.
  - b) Side: Sealing locknuts and insulated bushings.
  - c) Bottom: Locknuts and insulated bushings.
4. NEMA 4/4X enclosures
  - a) Top: Threaded conduit hubs with insulated throats or approved cable gland fittings.
  - b) Side: Threaded conduit hubs with insulated throats or approved cable gland fittings.
  - c) Bottom: Threaded conduit hubs with insulated throats or approved cable gland fittings.
5. NEMA 5 enclosures
  - a) Top: Sealing locknuts with insulated throats.



- b) Side: Sealing locknuts and insulated bushings.
- c) Bottom: Locknuts and insulated bushings.

6. NEMA 6/6P enclosures

- a) Top: Threaded conduit hubs with insulated throats or approved cable gland fittings.
- b) Side: Threaded conduit hubs with insulated throats or approved cable gland fittings.
- c) Bottom: Threaded conduit hubs with insulated throats or approved cable gland fittings.

7. NEMA 7/8/9 enclosures

- a) Enclosures shall be provided with integral conduit hubs

J. Conduit Seal Installation

- 1. In each conduit entering or leaving a Class I area.
- 2. In each conduit in a Class I Division 1 area entering or leaving an enclosure containing switches, circuit breakers, fuses, relays, resistors or other apparatus which may produce arcs, sparks or high temperature.
- 3. In each conduit 2-inch or larger in a Class I Division 1 area entering or leaving an enclosure containing terminals, splices and taps.
- 4. In each conduit in a Class I Division 2 area entering or leaving an enclosure required to be approved for use in Class I environments.
- 5. In each conduit in a Class II location between an enclosure required to be dust ignition-proof and an enclosure that is not required to be dust ignition-proof.
- 6. In each conduit in a corrosive area entering or leaving that area and entering or leaving an electrical equipment enclosure in that area.
- 7. So that the filler plug and drain is accessible.
- 8. Complete with approved sealing fiber and compound.

K. Conduit Moisture Sealing

1. All conduits terminated into enclosures located outdoors or routed from interior to exterior locations shall have non-hardening conduit sealing putty packed into and around conductors within each conduit opening.

L. Conduit Coatings

1. The protective coating of metallic conduits, fittings, and accessories shall be maintained.
  - a) Repair PVC-RGS utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the conduit.
    - (1) The total nominal thickness: 40 MIL.
  - b) Repair surfaces that will be inaccessible after installation prior to installation.
2. All metallic raceways installed in direct contact with concrete, masonry or soils shall be:
  - a) PVC-RGS
  - b) Installed with 40 MIL minimum coating of cured coal-tar bitumastic paint.
3. All metallic raceway transitions through concrete, masonry or soils shall be:
  - a) PVC-RGS
  - b) Installed with heavy-wall heat-shrink polyolefin tubing extending 6-inch minimum on each side of transition.
  - c) Installed with 40 MIL minimum coating of cured coal-tar bitumastic paint.

M. Power Cable Pulling Preparation

1. Remove water and debris from conduit prior to installation of power cables.
2. Pull mandrel with diameter nominally 1/4 inches smaller than the interior of the conduit, to ensure circular cross-section and removal of obstructions.

3. Swab conduit by pulling a clean, tight-fitting rag through the conduit.
4. Tightly plug ends of conduit with manufactured pipe plugs or plastic conduit inserts until power cables are pulled.
5. Only nylon or polyethylene rope shall be used to pull power cables in rigid non-metallic conduit systems.

**END OF SECTION**



## **SECTION 16115**

### **UNDERGROUND CONDUIT**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section Includes manholes; handholes; pull-boxes; and underground power, control, and instrumentation conduits and ductbanks.
- B. In addition to the requirements specified in this section, the requirements of specification Section 16010 - Electrical, Basic Requirements and the sections referenced therein shall be applied.

##### **1.02 QUALITY ASSURANCE**

- A. Referenced Standards
  - 1. American Association of State Highway & Transportation Officials (AASHTO).
  - 2. American Society for Testing Materials (ASTM):
    - a) A536, Standard Specification for Ductile Iron Castings.
  - 3. National Fire Protection Association (NFPA):
    - a) NFPA 70, National Electrical Code (NEC), 2008 Edition.
- B. Miscellaneous
  - 1. Contract Drawings indicate the intended location of manholes, handholes and pull-boxes; and routing of ductbanks and direct buried conduit. Field conditions may affect actual routing.

##### **1.03 DEFINITIONS**

- A. Direct-buried conduit means individual (single) underground conduits without concrete encasement.
- B. Direct-buried ductbank means multiple underground conduits, in a common trench, without concrete encasement.

- C. Concrete encased ductbank means any underground conduit or combination of underground conduits encased in a common concrete envelope.

#### **1.04 SUBMITTALS**

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples and 16010 - Electrical Basic Requirements.
- B. Fabrication and layout drawings
  - 1. Provide cross-sectioned sketch of each ductbank.
    - a) Dimension spacing between conduits
    - b) Dimension concrete envelope and reinforcing, where applicable
  - 2. Provide ductbank and direct-buried conduit profile.
    - a) Dimension from grade to ductbank and direct buried conduit
    - b) Dimension from ductbank and direct buried conduit to other utilities in the route
  - 3. Certifications
  - 4. Test reports
- C. Operation and Maintenance Manuals
  - 1. Operation and Maintenance Manuals shall be submitted as outlined in Specification 01730 - Operating and Maintenance Data.

#### **PART 2 PRODUCTS**

##### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  - 1. Precast manholes, handholes and pull-boxes
    - a) Carolina Precast Concrete, Inc.
    - b) Oldcastle Precast
    - c) Utility Vault Co.
  - 2. Manhole and handhole covers

- a) Neenah
  - b) Utility Vault Co.
- 3. Cable racks
  - a) Unistrut
  - b) B-Line
  - c) Condux International, Inc.
  - d) Underground Devices, Inc.
- 4. Cable pulling irons
  - a) Condux International, Inc.
- 5. Ground rods and grounding equipment
  - a) See Section 16450 - Grounding and Bonding
- 6. Ground wire
  - a) See Section 16450 - Grounding and Bonding
- 7. Duct terminators
  - a) Carlon
  - b) Condux International, Inc.
- 8. Conduit
  - a) See Section 16111 - Conduit and Raceway
- 9. Duct spacers
  - a) Underground Devices, Inc.
  - b) Condux International, Inc.
- 10. Warning Tape
  - a) W. H. Brady Company
  - b) Seton Nameplate Company

## **2.02 MATERIALS**

### **A. Handholes and Pull-Boxes**

- 1. Pre-Cast steel reinforced concrete
  - a) Boxes are required to meet ASTM C 858 with 4,000 PSI minimum compressive strength concrete and designed for AASHTO H-20 loading unless otherwise noted on the Contract Drawings.

- b) Tongue-and-grove double sealed joints on mating edges of pre-cast components. The joints shall firmly interlock adjoining components and provide waterproof junctions and adequate shear transfer. Joints shall be sealed with approved watertight joint sealant as prescribed in the manufacturer's installation specifications and conforming to AASHTO M198, Type B. Sealing material shall be installed in strict accordance with manufacturer's printed instructions.
- c) Knockout panels or pre-cast individual conduit openings may be used. Blockout panels are not acceptable.
- d) Cover
  - (1) Heavy-duty type frames and covers made of cast iron, suitable for H-20 loading, and having machined bearing surfaces shall be used.
  - (2) The covers shall be of indented type with solid top design.
  - (3) The upper side of each cover shall have the letters "Electrical", "Control", or "Communication" cast in integral letters no less than 2-inches high as indicated on the Contract Drawings.

## 2. Cast-In-Place

- a) Comply with Section 03300 - Cast-In-Place Concrete unless otherwise specified herein.
- b) Constructed as detailed on the Contract Drawings.
- c) Cover
  - (1) Heavy-duty type frames and covers made of cast iron, suitable for H-20 loading, and having machined bearing surfaces shall be used.
  - (2) The covers shall be of indented type with solid top design.



- (3) The upper side of each cover shall have the letters "Electrical", "Control", or "Communication" cast in integral letters no less than 2-inches high as indicated on the Contract Drawings.
- d) Shall have an AASHTO live load rating of H-20, unless otherwise noted in the Contract Drawings or Specifications.

## B. Manholes

### 1. Pre-Cast Steel Reinforced Concrete

- a) Boxes are required to meet ASTM C 858 with 4,000 PSI minimum compressive strength concrete and designed for AASHTO H-20 loading unless otherwise noted on the Contract Drawings.
- b) Tongue-and-grove double sealed joints on mating edges of pre-cast components. The joints shall firmly interlock adjoining components and provide waterproof junctions and adequate shear transfer. Joints shall be sealed with approved watertight joint sealant as prescribed in the manufacturer's installation specifications and conforming to AASHTO M198, Type B. Sealing material shall be installed in strict accordance with manufacturer's printed instructions.
- c) Knockout panels or pre-cast individual conduit openings may be used. Blockout panels are not acceptable.
- d) Minimum interior dimensions shall be 4 feet wide x 4 feet long x 6 feet tall
- e) Cover
  - (1) Minimum access opening dimensions
    - (a) Rectangular 26-inch x 22-inch
    - (b) Round 26-inch Diameter
  - (2) Heavy-duty type frames and covers made of cast iron, suitable for H-20 loading, and having machined bearing surfaces shall be used.

- (3) The covers shall be of indented type with solid top design.
- (4) The upper side of each cover shall have the letters "Electrical", "Control", or "Communication" cast in integral letters no less than 2-inch high as indicated on the Contract Drawings.

2. Cast-In-Place

- a) Comply with Section 03300 - Cast-In-Place Concrete unless otherwise specified herein.
- b) Constructed as detailed on the Contract Drawings.
- c) Shall have an AASHTO live load rating of H-20, unless otherwise noted on the Drawings.
- d) Minimum interior dimensions shall be 4-feet wide x 4-feet long x 6-feet tall.
- e) Cover
  - (1) Minimum access opening dimensions
    - (a) Rectangular 26-inch x 22-inch
    - (b) Round 26-inch Diameter
  - (2) Heavy-duty type frames and covers made of cast iron, suitable for H-20 loading, and having machined bearing surfaces shall be used.
  - (3) The covers shall be of indented type with solid top design.
  - (4) The upper side of each cover shall have the letters "Electrical", "Control", or "Communication" cast in integral letters no less than 2-inches high as indicated on the Contract Drawings.
- f) Cable Racks
  - (1) Hot-dipped galvanized hot-rolled steel; or Lexan.
  - (2) 120 Lbs. minimum loading capacity.

- (3) Three-point locking to resist twisting.
- g) Cable Pulling Irons
  - (1) Hot-dipped galvanized steel
  - (2) 6,000 Lbs. minimum pulling load
- h) Ground Rods and Grounding Equipment
  - (1) See Section 16450 - Grounding and Bonding
- i) Ground Wire
  - (1) See Section 16120 - Wire and Cable: 600 Volt and Below
- j) Duct Terminators
  - (1) Window type
  - (2) ABS plastic
  - (3) Provide for conduit entrance
  - (4) Designed for installation into manhole, handhole or pull-box walls for a watertight seal.
  - (5) Sufficient space between terminator walls to allow for placement of rebar and concrete.
- k) Conduit
  - (1) See Section 16111 - Conduit and Raceway
- l) Duct Spacers
  - (1) High density polyethylene or high impact polystyrene.
  - (2) Interlocking
  - (3) Provide 2-inch minimum spacing between conduits.
- m) Warning Tape
  - (1) Material: Polyethylene
  - (2) Thickness: 3.5 MIL

- (3) Tensile strength: 1,750 PSI
- (4) Size: 6-inches wide (minimum)
- (5) Legend: Preprinted and permanently imbedded:
  - (a) Message continuously printed.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

#### **A. General**

- 1. Install products in accordance with manufacturer's instructions.
- 2. Comply with Section 16050 - Materials and Methods for trenching, backfilling and compacting.
- 3. Buried conductor warning tape
  - a) See Section 16010 - Electrical Basic Requirements.

#### **B. Manholes, Handholes and Pull-Boxes**

- 1. Shape: Manholes, handholes and pull-boxes may be either square or rectangular.
- 2. Size
  - a) Manholes shall have minimum interior dimensions of 48-inch x 48-inch with a minimum interior height of 72-inches unless other dimensions are detailed on the Contract Drawings.
  - b) Handholds shall be sized for the number of conduits entering unless other dimensions are detailed on the Contract Drawings.
    - (1) Minimum interior dimensions shall be 24-inch x 17-inch with a minimum depth of 36-inches.
  - c) Pull-Boxes shall be sized for the number of conduits entering unless other dimensions are detailed on the Contract Drawings.

#### **3. Precast or Cast-In-Place**

- a) Optional unless otherwise noted in the Contract Drawings or Specifications.
- 4. Precast manholes, handholes and pull-boxes shall be installed in accordance with the manufacturer's instructions for "subject to occasional heavy vehicles."
- 5. For cast-in-place construction, comply with Section 03300-Cast-In-Place Concrete.
- 6. Provide minimum 12-inches of tamped crushed rock or gravel prior to setting manhole, handhole or pull box.
- 7. Construct manholes, handholes and pull-boxes approximately where shown on the Contract Drawings. Determine the exact locations after careful consideration has been given to location of other utilities, grading, and paving.
  - a) Locations are to be approved by the Engineer prior to excavation and construction of manholes, handholes and pull-boxes.
- 8. Grout or seal all joints
  - a) For precast construction, comply with the manufacturer's instructions.
  - b) For cast-in-place construction, comply with Section 03300 - Cast-In-Place Concrete.
- 9. Set frames and covers
  - a) For manholes, handholes and pull-boxes located in roadways, paint with two coats asphaltic paint before setting and set top of covers flush with finished surface of paving.
  - b) For manholes, handholes and pull-boxes not located in roadways, set top of covers 2-inches above finished grade. Slope surrounding grade away from edge to insure water drains away from opening.
  - c) Install sufficient number of concrete extensions between top of manhole, handhole or pull-box frame as required to elevate cover to existing grade level.

10. Support cables on walls by cable racks
  - a) Equip cable racks with adjustable hooks
    - (1) Quantity of hooks as required by the number of conductors
    - (2) Minimum of two (2) cable hooks per rack
  - b) Install a minimum of two (2) racks on each wall in each manhole, handhole and pull-box.
  - c) Space cable racks so that both ends of cable splices will be supported horizontally.
  - d) In manholes, install one (1) spare hook on each rack.
  - e) Install a cable-pulling iron in each wall opposite each ductbank entrance.
11. Grounding: In each manhole, drive copper ground rod into the earth and extend ground rod approximately 6-inches above finished floor.
  - a) In precast structures, drill openings in floor for ground rod.
  - b) Connect all metallic conduits, racks, and other metallic components to ground rod by means of #8AWG minimum tinned copper wire and approved grounding clamps.
12. Provide an 18-inch diameter sump in the bottom of each manhole and handhole.
13. After installation is complete, backfill and compact soil around manholes and handholes.

C. Underground Conduits

1. Concrete encased ductbank
  - a) Provide electrical duct system consisting of conduits completely encased in a minimum of 2-inches of concrete.
  - b) For circuits 600V and below, install so that top of concrete encased duct, at any point, is not less than the minimum depths established by the NEC (Table 300-5 and exceptions):

- (1) RGS conduit: 24-inch
  - (2) PVC sch-40 conduit: 24-inch
  - (3) Under areas subject to vehicular traffic
    - (a) All applications: 24-inch
  - (4) Unless a greater depth is detailed on the Contract Drawings.
- c) Under traffic areas (roadways, parking lots, etc.) and for a distance 10 feet either side of the traffic area, and elsewhere as defined on the Contract Drawings or specified, the concrete shall be reinforced in accordance with Section 03300-Cast-In-Place Concrete.

2. Direct-buried ductbank

- a) Provide electrical duct system consisting of conduits directly buried in earth.
- (1) Lay conduits on minimum 2-inch sand base completely encased by 2-inch of selected backfill containing no stones or other hard material larger than 1/2-inch diameter.
- b) For circuits 600V and below, install so that the top selected backfill at any point, is not less than the minimum depths established by the NEC (Table 300-5 and exceptions).
- (1) RGS conduit: 24-inch
  - (2) PVC sch-80 conduit: 24-inch
  - (3) Under areas subject to vehicular traffic
    - (a) All applications: 24-inch
  - (4) Unless a greater depth is detailed on the Contract Drawings.

3. Direct-buried conduit

- a) Provide electrical duct system consisting of conduits directly buried in earth.
- (1) Lay conduit on minimum 2-inch sand base completely encased by 2-inches of

selected backfill containing no stones or other hard material larger than 1/2-inch diameter.

- b) For circuits 600V and below, install so that top of the selective backfill, at any point, is not less than the minimum depths established by the NEC (Table 300-5 and exceptions).

- (1) RGS conduit: 24-inch

- (2) PVC sch-80 conduit: 24-inch

- (3) Under areas subject to vehicular traffic

- (a) All applications: 24-inch

- (4) Unless a greater depth is detailed on the Contract Drawings.

- 4. Underground conduits and ductbanks shall comply with the following:

- a) Minimum grade shall be 4-inches per 100 feet or as detailed on the Contract Drawings.

- (1) Low point shall be at one end of the conduit run.

- b) During construction and after conduit installation is complete; plug the ends of all conduits.

- c) Provide conduit supports and separators of concrete, plastic, or other suitable nonmetallic, non-decaying material designed for that purpose.

- (1) Concrete encasement supports shall provide a uniform minimum clearance of 2 inches between the bottom of the trench and the bottom row of conduit.

- (2) Separators shall provide a uniform minimum clearance of 2-inches between conduits.

- (3) Place supports and separators for PVC conduit on maximum centers as indicated for the following trade sizes:



- (a) 1 inches and less: 2 feet
  - (b) 1-1/4 to 3 inches: 4 feet
  - (c) 3-1/2 to 6 inches: 6 feet
- (4) Place supports and separators for RGS conduit on maximum centers as indicated for the following trade sizes:
  - (a) 1-inch and less: 8 feet
  - (b) 1-1/4 to 2-1/2 inches: 10 feet
  - (c) 3-inches and larger: 12 feet
- (5) Securely anchor conduits to supports and separators to prevent movement during placement of concrete or soil.
- (6) Do not place concrete or soil until conduits have been observed by the Engineer.
- d) Stagger conduit joints at intervals of 6-inches horizontally.
- e) Make conduit joints watertight and in accordance with manufacturer's recommendations.
  - (1) Make plastic conduit joints by uniformly brushing a plastic solvent cement on inside of plastic coupling fitting and outside of conduit ends. Slip conduit and fitting together with a quick one-quarter turn twist to set joint tightly.
  - (2) Accomplish changes in direction of runs exceeding a total of 5 degrees by long sweep bends having a minimum radius of 25-inches.
  - (3) Sweep bends shall be made up of one curved section.
- f) Furnish manufactured bends at end of runs.
  - (1) Minimum radius of 18-inches for conduits less than 3-inch trade size and 36-inches for conduits 3-inch trade size and larger.

- g) After the conduit run has been completed, pull a standard flexible mandrel having a length of not less than 12-inches and a diameter approximately 1/4-inch less than the inside diameter of the conduit through each conduit. Then pull a brush with stiff bristles through each conduit to remove any foreign material left in conduit.
- h) Pneumatic rodding may be used to draw in pull-cords.
  - (1) Install a 1/8-inch polypropylene pull-cord free of kinks and splices in all unused new ducts.
  - (2) Extend pull-cord 3-feet beyond ends of conduit and fasten to prevent loss of pull-cord in conduits.
- i) Transition from PVC to RGS conduit with a minimum of 3-feet prior to entering a structure or going above ground.
  - (1) Unless otherwise indicated on the Contract Drawings.
  - (2) PVC conduit may be extended directly to pull, junction and transformer boxes; manholes and handholes.
- j) Where conduits enter transformer boxes; manholes and handholes:
  - (1) Terminate PVC conduits in end bells.
  - (2) Terminate RGS conduits in insulated bushings.

B. Warning Tape

- 1. Place warning tape in trench directly over ductbanks, direct-buried conduit, and direct-buried wire and cable.
  - a) 6-inches below finished grade where conduit or ductbank is 12-inches or more below finished grade.

- b) 3-inches below finished grade where conduit or ductbank is less than 12-inches below finished grade.

2. Provide warning tape as follows:

- a) Electrical trenches and ductbanks or directly buried conduit
  - (1) Legend: "CAUTION CAUTION CAUTION" (1st line), "BURIED ELECTRIC LINE" (2nd line).
  - (2) Letters: 1-1/4-inch minimum
  - (3) Interval: Continuous
  - (4) Color: Red and black letters.
- b) Trenches and direct-buried or conduit encased telephone lines:
  - (1) Legend: "CAUTION CAUTION CAUTION" (1st line), "BURIED TELEPHONE LINE" (2nd line).
  - (2) Letters: 1-1/4-inch minimum
  - (3) Interval: Continuous
  - (4) Color: Orange with black letters
- c) Trenches with direct-buried or conduit encased computer or SCADA system communications lines:
  - (1) Legend: "CAUTION CAUTION CAUTION" (1st line), "BURIED COMPUTER LINE" (2nd line).
  - (2) Letters: 1-1/4-inch minimum
  - (3) Interval: Continuous
  - (4) Color: Orange with black letters

**3.02 MAINTENANCE**

- A. Provide the Owner with two (2) sets of manhole cover, underground pull-box cover or precast cable trench cover removal tools.

**END OF SECTION**



## **SECTION 16120**

### **WIRE AND CABLE: 600 VOLT AND BELOW**

#### **PART 1 GENERAL**

##### **1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, install, connect, test, and place in satisfactory operating condition, ready for service, all cables and wires indicated on the Contract Drawings and as specified herein or required for proper operation of the installation, with the exception of internal wiring provided by electrical equipment manufacturers. The work of connecting cables to equipment, machinery, and devices shall be considered a part of this Section. All hardware, junction boxes, bolts, clamps, insulators, and fittings required for the installation of cable and wires system shall be furnished and installed by the Contractor
- B. The Contractor shall submit Shop Drawings and other material required to substantiate conformance with the requirements set forth on the Contract Drawings and in Section 16010 - Electrical Basic Requirements, and Section 01340 - Shop Drawings, Project Data and Samples. Shop drawings shall include, but not be limited to, detailed specifications and product data sheets for the power, control, and instrumentation cable required for this project.
- C. The wire and cable to be furnished and installed for this project shall be the product of manufacturers who have been in the business of manufacturing wire and cable for a minimum of ten (10) years.
- D. Reference Section 16010 - Electrical Basic Requirements.

##### **1.02 SUBMITTALS**

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples, the Contractor shall obtain from the wire and cable manufacturer and submit the following:
  - 1. Shop Drawings
  - 2. Reports of Certified Shop and Field Tests
  - 3. Wiring Identification Methods.

Each submittal shall be identified by the applicable specification section.

### **1.03 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed material's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible Submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  - 1. Material specifications and product data sheets identifying all materials used and methods of fabrication
  - 2. Cable and wire identification methods and materials

### **1.04 IDENTIFICATION**

- A. Each cable or wire shall be identified as specified in Section 16010 - Electrical Basic Requirements.

## **PART 2 PRODUCTS**

### **2.01 600V POWER WIRE AND CABLE**

- A. All 600V rated power wire and cable shall consist of stranded, copper conductor with insulation type XHHW-2, 90°C.
- B. Circuits within the interior spaces of buildings may utilize 600V rated insulation, type THHN/THWN, 75°C.
- C. Conductors shall be stranded copper per ASTM-B8, B-33 and B-189, Class B or C stranding contingent on the size unless otherwise specified. Minimum size wire shall be #12AWG.
- D. 600V rated individual or multi-conductor power wire and cable shall be manufactured by the Okonite Company, BICC Industrial Cable Company or approved equal.

### **2.02 600V CONTROL CABLE**

- A. All 600V rated control cable shall consist of stranded, copper conductor with insulation type XHHW-2, 90°C.
- B. Control circuits within the interior spaces of buildings may utilize 600V rated insulation, type THHN/THWN, 75°C.
- C. The individual conductors of the multiple conductor cable shall be color coded for proper identification. Color coding shall be equal to ICEA S-68-514, Table K-1. Cables shall meet requirements of IEEE-383.
- D. Conductors shall be stranded copper per ASTM B-8, B-33 and B-189, Class B or C stranding contingent on the size unless otherwise specified. Minimum wire size shall be #14AWG.
- E. 600V rated individual or multi-conductor control wire shall be manufactured by the Okonite Company, BICC Industrial Cable Company or approved equal.

**2.03      600V SHIELDED MOTOR POWER CABLE FOR VARIABLE FREQUENCY DRIVES**

- A. Where indicated on the Contract Drawings, the power connection between the variable frequency drive (VFD) and the associated motor shall utilize a shielded three-conductor plus ground conductor VFD output cable.
- B. Shielded motor power cables with #2AWG and smaller conductors shall have an overall polyvinyl chloride jacket, utilize XLPE conductor insulation with 100 percent rated ground conductor, overall foil shield, 85% TC braid and drain wire.
- C. Shielded motor power cables with #1AWG and larger conductors shall have an overall polyvinyl chloride jacket, utilize XLPE conductor insulation with three-symmetrical BC grounds, two spiral copper tape shields.
- D. Shielded Motor cable shall meet the following requirements:
  - 1. Utilize high-strand tined copper conductors
  - 2. Lower capacitance suitable for longer runs
  - 3. Sunlight and oil resistant
  - 4. Suitable for Class I and II; Division 2 hazardous locations

5. Rated for 90°C temperature for wet or dry locations
6. Pass UL 1685 vertical tray flame test
- E. All VFD cables shall be terminated with approved VFD cable connectors and/or termination kits.
- F. 600V rated shielded motor power cable shall be:
  1. Belden: 29500 Series Cable
  2. General Cable: CVTC VFD Cable
  3. Service Wire Company: ServiceDrive ASD/VFD Cable
  4. Southwire Armor-X VFD Cable
  5. Approved equal

**2.04 600V POWER CABLE, MULTICONDUCTOR ALUMINUM INTERLOCKED ARMOR.**

- A. Aluminum interlocked armor cable shall consist of XHHW insulated compressed or compact stranded copper conductors, non-hygroscopic fillers, interlocked aluminum armor, and outer PVC jacket.
- B. Multiconductor interlocked power cable shall be rated for 90 deg. C for wet or dry locations. Power cable shall be listed for cable tray installation
- C. Multiconductor Aluminum Interlocked 600V power cable shall be OKONITE type MC (XHHW-2), or equal

**2.05 LIGHTING AND RECEPTACLE WIRE AND CABLE**

- A. All exterior lighting and receptacle branch circuit wire and cable shall consist of stranded, copper conductors with 600v rated insulation, type XHHW-2, 90°C.
- B. Interior lighting and receptacle branch circuit wire and cable may utilize stranded, copper conductors with 600v rated insulation, type THHN/THWN 75°C.
- C. Conductors shall be stranded copper per ASTM-B8, B-33 and B-189, Class B or C stranding contingent on the size unless otherwise specified. Minimum size wire shall be #12AWG.



- D. Lighting and receptacle cables and wire shall be manufactured by the General Cable Company, Southwire Cable Company or approved equal.

## **2.06 INSTRUMENTATION SIGNAL CABLE (STP)**

- A. The instrumentation cable for analog signals shall be individually shielded twisted pair cable (STP) or individually shielded twisted multi-pair cable (M#STP, where # = number of pairs). Conductors shall be tin or alloy coated, soft, annealed copper, #16AWG minimum with a minimum of 19 strands with 600V rated insulation for 75°C. Pairs shall have 100% coverage foil shields with a #18AWG tinned copper drain wire. Outer jackets shall be chromed polyvinyl chloride.
- B. The instrumentation cable shall be Belden, Okonite or approved equal for single and multiple pair applications or approved equal.
- C. Instrumentation cables shown on the Contract Drawings to be direct buried shall be UL labeled for direct buried service.

## **2.07 TELEPHONE/DATA CABLE (CAT-6)**

- A. All interior telephone/data cables shall be ANSI/TIA/EIA 568 (Category 6e), #24AWG copper, plenum rated and ETL Type-CMP.

## **PART 3 EXECUTION**

### **3.01 600V CABLE INSTALLATION**

- A. The cable and wires shall be installed as specified herein and shown on the Contract Drawings.
- B. The cables shall be terminated in accordance with the cable and/or termination product manufacturer's instructions for the particular type of cable.
- C. To minimize oxidation and corrosion, wire and cable shall be terminated using an oxide-inhibiting joint compound recommended for "copper-to-copper" connections. The compound shall be Penetrox E as manufactured by Burndy Electrical, or approved equal.
- D. Splices are normally not permitted in the underground duct, manhole and handhole systems. If splices are required, the Contractor shall obtain approval in writing from the Engineer prior to splicing.

1. Splicing material shall be a two-part insulating and encapsulating resin.

B. Cable and Wire Sizes

1. The sizes of cable and wire shall be as shown on the Contract Drawings, or if not shown, as approved by the Engineer. If required due to field routing, the size of conductors and respective conduit shall be shall be coordinated with and approved by the Engineer.
2. Minimum wire size within control panels, motor control centers, switchboards and similar equipment shall be #12AWG for power and #14AWG for control.

C. Number of Wires

1. The number of wires indicated on the Contract Drawings for the various control, indication, and metering circuits were determined for general schemes of control and for particular indication and metering systems.
2. The actual number of wires installed for each circuit shall, in no case, be less than the number required; however, the Contractor shall add as many wires as may be required for control and indication of the actual equipment selected for installation at no additional cost to the Owner. The addition of conductors shall be coordinated with and approved by the Engineer.

D. Wiring Identification

1. Wiring Identification shall meet the requirements of Section 16010 - Electrical Basic Requirements.

E. Cable Installation

1. All interior cable not protected by a compartment enclosure shall be run in conduit.

F. Training of Cable

1. The Contractor shall furnish all labor and material required to train cables around cable vaults within buildings and in manholes in the outdoor underground duct system. Sufficient length of cable shall be provided in each manhole and vault so that the cable can be trained and racked in an approved

manner. In training or racking, the radius of bend of any cable shall be not less than the manufacturer's recommendation. All manhole cables shall be arc and fire-proofed. The training shall be done in such a manner as to minimize chaffing.

G. Connections at Control Panels, Limit Switches, and Similar Devices

1. Where stranded wires are terminated at panels, and/or devices, connections shall be made by solderless lug, crimp type ferrule or solder dipped.
2. Where enclosure sizes and sizes of terminals at limit switches, solenoid valves, float switches, pressure switches, temperature switches, and other devices make 7-strand, #12AWG, wire terminations impractical, the Contractor shall terminate external circuits in an adjacent junction box of proper size and shall install #14AWG stranded wires from the device to the junction box in a conduit. The #12 AWG field wiring shall also be terminated in the same junction box to complete the circuit.

H. Pulling Temperature

1. Cable shall not be flexed or pulled when the temperature of the insulation or of the jacket is such that damage will occur due to low temperature embrittlement. When cable will be pulled with an ambient temperature within a three day period prior to pulling of 40°F or lower, cable reels shall be stored during the three day period prior to pulling in a protected storage area with an ambient temperature not lower than 55°F and pulling shall be completed during the work day for which the cable is removed from the protected storage.

I. Color Coding

1. Unless otherwise noted on the Contract Drawings, conductor insulation shall be color coded as follows:
  - a) 480V AC Power
    - (1) Phase A - BROWN
    - (2) Phase B - ORANGE

- (3) Phase C - YELLOW
    - (4) Neutral - GREY
  - b) 120/208V or 120/240V AC Power
    - (1) Phase A - BLACK
    - (2) Phase B - RED
    - (3) Phase C - BLUE
    - (4) Neutral - WHITE
  - c) 120VAC Control
    - (1) Ungrounded conductors - RED
    - (2) Ungrounded conductors, foreign source - YELLOW.
  - d) 24VAC Control
    - (1) All wiring - ORANGE
  - e) 24VDC Power
    - (1) Positive Lead - RED
    - (2) Negative Lead - BLACK
  - f) 24VDC Control
    - (1) Ungrounded conductors - BLUE
    - (2) Grounded conductors - BLUE w/WHITE stripe
  - g) Equipment Grounding Conductor:
    - (1) All wiring - GREEN
2. Conductors #4AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables shall be coded by the use of colored tape.

### **3.02 INSTRUMENTATION / TELEPHONE / DATA CABLE INSTALLATION**

- A. Grounding of cable shield shall be accomplished at one end point only.
- B. Raceways exceeding 5 feet and containing instrumentation / telephone / data cable shall be installed to provide the following clearances:
  - 1. Raceway installed parallel to raceway conductors energized at 480 through 208V shall be 18 inch and 208/120V shall be 12 inch.
  - 2. Raceway installed at right angles to conductors energized at 480V or 120/208V shall be 6 inch.
- C. Where practical, raceways containing instrumentation / telephone / data cable shall cross raceway containing conductors of other systems at right angles.
- D. Where instrumentation / telephone / data cables are installed in panels, etc., the Contractor shall arrange wiring to provide maximum clearance between cables and other conductors. Instrumentation / telephone / data cables shall not be installed in same bundle with conductors of other circuits.
- E. Additional pullboxes shall be furnished and installed for ease of cable pulling and the cable manufacturer's recommended conduit fill factor shall be followed.
- F. All cable, insulation and jacket shall have adequate strength to allow for it to be pulled through the conduit systems. Sufficient conductors shall be installed to provide space and serve future equipment where shown and specified. All conductors shall be color coded and all wires shall be suitably tagged with permanent markers at each end.

### **3.03 TESTING**

- A. All testing shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
  - 1. Shop Test
    - a) Prior to the first shipment of each size of power, control, and telephone / data cable to be furnished and installed under this Contract, samples of each size of cable shall be subjected to complete physical and electrical factory production tests at the

manufacturer's plant. Other cable and wiring shall be tested in accordance with the applicable ICEA Standards. Six copies of certified test data sheets shall be submitted to the Engineer for approval prior to installation at the site. Subsequent shipment of each size of wire shall be covered by certificates of compliance which shall list Contractor's name, point of delivery, reel numbers, size of wire, length of wire, and date of shipment. Certificates shall attest the wires and cables comply with specification requirements and that wires and cables are equal in every respect to wires and cables which have been successfully tested.

- b) All test data or certificates shall be notarized and submitted.

## 2. Field Tests

- a) Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and Section 16010-Electrical-Basic Requirements.
- b) After installation, all wires and cables shall be tested for insulation levels and continuity. Insulation resistance between conductors of the same circuit and between conductor and ground shall be tested. Testing for insulation levels shall be as follows:
  - (1) For 600V rated power and control cable, apply 1,000VDC from a Megaohmmeter for all 600V wires and cables installed in lighting, control, power, indication, alarm and motor feeder circuits. Testing for continuity shall be "test light" or "buzzer".
  - (2) 600V rated instrumentation signal cable shall be tested from conductor to conductor, conductor to shield, and conductor to ground using a 260 volt-ohmmeter, or approved equal. The resistance value shall be 200 megaohms or greater.

- B. Low voltage wires and cables shall be tested before being connected to motors, devices or terminal blocks.

- C. Voltage tests shall be made successively between each conductor of a circuit and all other conductors of the circuit grounded.
- D. If tests reveal defects or deficiencies, the Contractor shall make the necessary repairs or shall replace the cable as directed by the Engineer, without additional cost to the Owner.
- E. All tests shall be made by and at the expense of the Contractor who shall supply all testing equipment.

**END OF SECTION**





## **SECTION 16130**

### **OUTLET PULL AND JUNCTION BOXES**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes:
  - 1. Outlet pull and junction boxes
- B. Related Sections include but are not necessarily limited to:
  - 1. Contract and Bidding Requirements
  - 2. Section 16010 - Electrical Basic Requirements

##### **1.02 QUALITY ASSURANCE**

- A. Referenced Standards
  - 1. Refer to Section 16010 - Electrical Basic Requirements

##### **1.03 SUBMITTALS**

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples, Shop Drawings
- B. Operation and Maintenance Manuals shall be submitted as outlined in Specification 01730 - Operation and Maintenance Data.

##### **1.04 DELIVERY, STORAGE, AND HANDLING**

- A. see Section 16010 - Electrical Basic Requirements

#### **PART 2 PRODUCTS**

##### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  - 1. Galvanized Steel Boxes

- (a) Appleton Electric Co.
  - (b) Steel City
  - (c) Raco
- 2. Corrosion-Resistant Boxes
  - (a) Hoffman Engineering Co.
  - (b) Crouse-Hinds
- 3. Hazardous Location Boxes (Class I, II & III)
  - (a) Appleton Electric Co.
  - (b) Crouse-Hinds
  - (c) Killark
  - (d) O-Z/Gedney
- 4. Raintight and Watertight Boxes
  - (a) Appleton Electric Co.
  - (b) Crouse-Hinds
- 5. Terminal Boxes
  - (a) Hoffman Engineering Co.
- 6. Exposed Switch and Receptacle Boxes
  - (a) Appleton Electric Co.
  - (b) Crouse-Hinds
  - (c) Killark

## **2.02 MATERIALS**

- A. Pull and Junction Boxes (smaller than 100 cubic inch)
  - 1. Wet Areas
    - (a) Material: Malleable-Iron or 14 gage steel with polyester powder coating inside and out over phosphatized surfaces.
    - (b) 14 gage steel

- (1) Continuously welded seams, ground smooth, no conduit punch-outs
- (2) Stainless steel clamps on four sides
- (3) Flat cover with oil resistant gasket
- (4) NEMA 4 classification
- (5) UL listed

2. Corrosive Areas:

- (a) Material: Nylon, PVC or fiberglass reinforced polyester material.
  - (1) Neoprene door gasket
  - (2) Grounding bushing(s)
  - (3) NEMA 4X classification
  - (4) UL listed

3. Hazardous Areas

- (a) Material: Cast gray iron alloy or copper-free cast aluminum
- (b) Drilled and tapped openings or tapered threaded hub equipped
- (c) Flat bolted-down or threaded cover with neoprene gasket
- (d) Stainless steel hex head screws
- (e) Explosion-proof, UL listed for Class 1 Groups C and D

B. Large Pull and Junction Boxes (100CU-IN and larger)

1. Wet and Corrosive areas

- (a) NEMA 4X with stainless steel screws
  - (1) Type 304 L welded stainless steel
  - (2) Continuously welded seams, ground smooth, no conduit punch-outs

(3) Rolled lip around all sides

(b) Termination Boxes

(1) Galvanized 16 GA steel box provided with plain blank screw cover, subpanel, and terminal points.

(2) Terminal blocks shall be screw-cage barrier-type with white marker strip.

(3) Refer to Contract Drawings for dimensions, number of terminals and ratings.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Use listed and labeled boxes with threaded conduit hubs for use in hazardous areas.
- C. Use malleable iron Type FS and FD boxes in wet areas and where exposed rigid steel conduit is required.
- D. Use stainless steel, fiberglass, nylon or PVC boxes for corrosive areas.
- E. Fill unused punched, tapped, or threaded hub openings with insert plugs of like material to maintain enclosure NEMA rating.
- F. Use boxes sized to accommodate the quantity of conductors and devices enclosed.
- G. Set all outlet pull and junction boxes plumb and vertical to the finish floor or grade.
- H. Provide and install pull boxes or junction boxes in conduit runs as required to facilitate pulling of wires or making connections.
- I. Make covers of boxes accessible.
- J. Install pull boxes or junction boxes rated for the area classification.

- K. Install all conduits squarely into all outlet pull and junction boxes.
- L. Terminate all conduits as required in Specification **Section 16111-Conduit and Raceway**.
- M. Large pull and junction boxes shall NOT be mounted to hand-rail or safety rail.
- N. Do not install "back-to-back" boxes anywhere within this Project.
- O. Support outlet boxes for lighting fixtures and other ceiling-mounted devices in lay-in acoustical tile ceilings by bar hangers anchored to ceiling construction members which do not interfere with tile removal.

**END OF SECTION**



## **SECTION 16140**

### **WIRING DEVICES**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

A. Section Includes:

1. Light switches, receptacles, device plates, dimmers, plug-in strips.

B. Related Sections include but are not necessarily limited to:

1. Division 1 - General Requirements
2. Section 16010 - Electrical Basic Requirements

##### **1.02 QUALITY ASSURANCE**

A. Referenced Standards

1. Refer to Section 16010 - Electrical Basic Requirements

##### **1.03 SUBMITTALS**

A. Shop Drawings

1. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples and 16010 - Electrical Basic Requirements.

#### **PART 2 PRODUCTS**

##### **2.01 ACCEPTABLE MANUFACTURERS**

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Light switches (except explosion-proof)
  - a) Hubbell
  - b) Slater

- c) P&S
  - d) Arrow Hart
  - e) General Electric
  - f) Leviton
2. Explosion-proof light switches
- a) Crouse-Hinds
  - b) Appleton Electric Co.
  - c) Killark
3. Door switches
- a) General Electric
  - b) Slater
  - c) P&S
  - d) Arrow Hart
  - e) Micro-switch
4. Receptacles (except explosion-proof)
- a) Hubbell
  - b) Slater
  - c) P&S
  - d) Arrow Hart
  - e) General Electric
  - f) Leviton
5. Explosion-proof Receptacles
- a) Crouse-Hinds
  - b) Appleton Electric Co.
  - c) Killark
6. Dimmers



- a) Lutron
  - b) General Electric
  - c) P&S
7. Plug-in Strip
- a) Wiremold
  - b) Walker

## **2.02 MATERIALS**

### **A. Light Switches for Unclassified Areas**

- 1. Toggle type, quiet action, and specification grade with grounding terminal
- 2. Back and side wired
- 3. Solid silver cadmium oxide contacts
- 4. One-piece switch arm rated 20A, 120/277VAC
- 5. UL listed
- 6. Color: Ivory
- 7. Wall plate: Type 304 stainless steel
- 8. Type: As indicated on Contract Drawings

### **B. Receptacles for Unclassified Areas**

- 1. Straight blade, grounding type, specification grade
- 2. Back and side wired with Wrap-around Bridge
- 3. Rated 20A, 125 VAC
- 4. UL listed
- 5. Color
  - a) For use on normal power: IVORY
  - b) For use on UPS systems: RED
  - c) For use on isolated ground systems: ORANGE

6. Wall plate: Type 304 stainless steel
  7. Type: As indicated on Contract Drawings
- C. Light Switches for Wet Areas
1. Press-switch type, quiet action, specification grade, with grounding terminal
  2. Back and side wired
  3. Solid silver cadmium oxide contacts
  4. One-piece switch arm rated 20A, 120/277VAC
  5. UL listed
  6. Color: IVORY
  7. Wall plate: GREY weatherproof press-switch type
  8. Type: As indicated on Contract Drawings
- D. Receptacles for Outdoor and Wet Areas
1. Straight blade, grounding type, GFIC specification grade
  2. Back and side wired with wrap around bridge
  3. Rated 20A, 125VAC
  4. UL listed
  5. Color: IVORY
  6. Wall plate: Weatherproof, cast aluminum, UL listed "IN USE" cover
  7. Type: As indicated on Contract Drawings
- E. Ground Fault Circuit Interrupter (GFCI) Receptacles
1. Straight blade, grounding type, specification grade
  2. Rated 20A, 125VAC
  3. UL listed
  4. Test and reset buttons

5. Wall plate: Indoor or weatherproof "IN USE" as required
6. Feed-thru type

F. Light Switches for Corrosive Areas

1. Corrosion-resistant NEMA 4X enclosure with switch consisting of:
  - a) Fiberglass reinforced polyester enclosure
  - b) Fiberglass reinforced polyester gasketed wall plate with built-in toggle lever switch with stainless steel shaft
  - c) Grounding bushing
  - d) Rated 20A, 125VAC
  - e) UL listed
  - f) Type: As indicated on Contract Drawings
  - g) Color: YELLOW
2. Optional: Corrosion-resistant enclosure and switch consisting of:
  - a) Cast copper-free aluminum "FS" or "FD" ridge type hub box
  - b) Toggle type, quiet action, and specification grade with grounding terminal
  - c) Rated 20A, 125VAC with solid silver cadmium oxide contacts
  - d) UL listed
  - e) Neoprene gasket
  - f) Cast aluminum cover with stainless steel screws and lever to activate switch
  - g) Type: As indicated on Contract Drawings
  - h) Color: YELLOW

G. Receptacles for Corrosive Areas

1. Corrosion-resistant straight blade, grounding type, specification grade
  2. Back and side wired with Wrap-around Bridge
  3. Rated 20A, 125VAC
  4. UL listed
  5. Color: YELLOW
  6. Box: "FS" or "FD" ridge type cast hub box of copper-free aluminum
  7. Gasket: Neoprene
  8. Wall plate: Weatherproof, cast aluminum, UL listed "IN USE" cover
  9. Type: As indicated on Contract Drawings
- H. Explosion-proof Light Switches for Use in Hazardous Areas:
1. Explosion-proof, UL listed for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.
  2. EDS factory sealed
  3. Malleable iron body and cover
  4. Aluminum sealing chamber
  5. Front operated handle with stainless steel shaft
  6. Rated 20A, 125VAC
  7. With grounding screw
  8. Type: As indicated on Contract Drawings
- I. Explosion-proof Receptacles for Use in Hazardous Areas
1. Explosion-proof, UL listed for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2, Groups F and G
  2. Factory-sealed malleable iron receptacle with spring-loaded cover

3. Malleable iron mounting box
  4. Rated 20A, 125VAC
  5. "Dead-front" construction requiring plug to be inserted and rotated to activate receptacle
  6. Type: As indicated on Contract Drawings
- J. Plug-In Strip: Surface steel raceway plug-in strip with single 15A, 125VAC, 3 wire grounding-type receptacles spaced 18 inch on center.
1. Pre-wired with two #12 TW and one #12 TW green insulated ground
  2. Minimum 1-1/4 inch wide x 3/4 inch deep
  3. Suitable fittings and snap-in cover
  4. Finish
    - a) Stainless steel
  5. Receptacle color
    - a) For use on normal power: Ivory
    - b) For use on UPS systems: Red
    - c) For use on isolated ground systems: ORANGE
- K. Door Switches
1. Rated 5A, 120VAC
  2. Mode of operation: Door open - lights on
  3. UL listed
- L. Lighting Dimmers
1. Electronic solid state type, rated for load, 120 and 277VAC
  2. Circuit design: Silicon symmetrical gate to provide full wave dimming and withstand current and inverse voltage surges
  3. Controls: Linear slide with positive off

4. Provide built-in filter to minimize noise interference in nearby audio lines
  5. Rated 100°F maximum, ambient
  6. UL listed
  7. Finish: IVORY or WHITE
- M. Pedestal-Type Floor-Mounted or Counter-Mounted Duplex Receptacles
1. Straight blade, grounding type, specification grade
  2. Back and side wired with Wrap-around Bridge
  3. Rated 15A, 125VAC
  4. Horizontal design housing with threaded conduit fittings in base with satin chromium finish
  5. Install on adjustable 4-inch flush floor box
  6. Color
    - a) For use on normal power: IVORY
    - b) For use on UPS systems: RED
    - c) For use on isolated ground systems: ORANGE
- N. Thermostats
1. Contacts close on falling temperature to cycle unit heater on rising temperature to cycle exhaust fan motor
  2. Rated 20A, 120VAC
  3. Range: 46-84 Degrees F scale.
  4. Switch: AUTO/OFF/ON
  5. Provide sub-base and mounting plate.
  6. Provide standard outlet box for mounting thermostat

### **PART 3 EXECUTION**

- A. Installation

1. Install products in accordance with manufacturer's instructions.
2. Mount devices where indicated on the Contract Drawings.
3. Surface-mount receptacles and light switches in concrete construction.
4. In masonry and metal stud construction, recess-mount receptacles and light switches unless device precludes recessed mounting or unless otherwise noted on the Contract Drawings.
5. Where more than one receptacle is installed in a room, they shall be symmetrically arranged.
6. Set all wiring devices including covers plumb and vertical to the floor.
7. Set recess-mounted switches and receptacles flush with face of walls.
8. Do not connect dimmers to loads in excess of 80 percent of the rating of the dimmer.
9. Provide blank plates for empty outlets.
10. Securely attach top to ceiling grid and base to mating surface.

**END OF SECTION**





## **SECTION 16150**

### **MOTORS**

#### **PART 1 GENERAL**

##### **1.01 THE REQUIREMENT**

- A. The Contractor shall furnish all labor, materials, tools and equipment necessary for furnishing, installing, connecting, testing and placing into service all Motors as specified herein and indicated on the Contract Drawings.
- B. All Motors shall be sufficient size for the duty to be performed and shall not exceed their full rated load when the driven equipment is operating at specified capacity. Unless otherwise noted, motors driving pumps shall not be overloaded at any head or discharge condition of the pump.

##### **1.02 CODES AND STANDARDS**

- A. Motors shall comply with the following applicable codes and standards as well as any others within the Specifications and Contract Drawings. In the event of any conflict between these codes, regulations, standards, and Contract Documents, the most restrictive shall apply.
  - 1. American National Standards Institute (ANSI/NEMA)
    - a) MG1-2006, REV 1 2007 - Motors and Generators
  - 2. National Fire Protection Association (NFPA)
    - a) 70, National Electric Code (NEC)
    - b) 79, Electrical Standard for Industrial Machinery

##### **1.03 SUBMITTALS**

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples.
- B. The Motor manufacturer shall submit to the Engineer certified dimensional drawings showing nameplate data and outline dimensions.
- C. Guarantee: All motors and associated equipment furnished and installed under this Section shall be guaranteed

against defects of workmanship, materials and improper installation for a period of three years from date of acceptance. All such motors, equipment or parts proven defective, due to the above noted causes, shall be replaced and installed by the Contractor at no expense to the Owner.

- D. Operation and Maintenance Manuals shall be submitted as outlined in Specification 01730 - Operation and Maintenance Data.

## **PART 2 PRODUCTS**

### **2.01 RATINGS**

- A. All three-phase motors shall be "premium efficiency" type.
- B. Unless otherwise noted, all Motors shall be of the low voltage type (600V or less). All Motors 2HP through 100HP shall be rated 230/460VAC, 3-PH, 60Hz. All Motors 125HP through 300HP shall be rated 460VAC, 3-PH, 60Hz. Motors below 2HP shall be rated 115/230VAC, 1-PH, 60Hz.
- C. All Motors controlled by a Variable Frequency Drive (VFD) shall indicate on the motor nameplate that it is suitable for the intended application (inverter duty rated) and shall be provided with an integral temperature switch that opens on high temperature. All Motors operated by a VFD shall meet the requirements of ANSI/NEMA MG1 Class II Part 32.

### **2.02 CONSTRUCTION**

- A. General
  - 1. Unless otherwise noted in these Specifications, all motors shall be totally enclosed fan cooled (TEFC).
  - 2. TEFC motors shall be provided with condensate drain hole and epoxy coated motor windings to protect against moisture.
  - 3. All motors shall have 1.15 service factor unless otherwise noted.
  - 4. The output shaft shall be suitable for mechanical connection as required.
  - 5. Space heaters shall be provided on motors 25 HP and larger for moisture control. Space heaters shall

operate at 120 VAC, single-phase with leads brought out to terminal blocks enclosed within a NEMA-12 accessory box. Motors shall be provided with a metallic or plastic warning plaque, permanently fixed to motor casing, with red background and white letters which has the following legend:

WARNING-ELECTRICAL SHOCK HAZARD  
Motor Equipped with Strip-Heaters  
Strip-Heater remains Energized when Local  
Disconnect is OFF

B. Three-Phase Motors

1. Motors shall be of the squirrel-cage induction type, NEMA design B. Horizontal, vertical solid shaft, vertical hollow shaft, normal thrust and high thrust types shall be furnished as specified herein. All Motors shall be built in accordance with current NEMA, IEEE, ANSI and AFBMA standards where applicable. Motors shall be of the type and quality described by these Specifications, fully capable of performing in accordance with manufacturer's nameplate rating, and free from defective material and workmanship.
2. Motors shall have normal or high starting torque (as required), low starting current (not to exceed 600 percent full load current), and low slip.
3. Motors shall have a Class B non-hygroscopic insulation system. Class F insulation may be used but shall be limited to Class B temperature rise.
4. All machine surfaces shall be coated with rust inhibitor for easy disassembly.
5. All Motors shall have a final coating of chemical resistant corrosion and fungus protective epoxy fortified enamel finish sprayed over red primer over all interior and exterior surfaces. Stator bore and rotor of all motors shall be epoxy coated.
6. Motors installed outdoors shall be mill and chemical duty suitable for operation in moist air with hydrogen sulfide gas present.
7. All fittings, bolts, nuts, and screws shall be 316 stainless steel. Bolts and nuts shall have hex heads.

8. Nameplates shall be stainless steel. Lifting lugs or "O" type bolts shall be supplied on all frames 254T and larger. Enclosures will have stainless steel screen and motors shall be protected for corrosion, fungus and insects.
9. Conduit boxes shall be gasketed. Lead wires between motor frame and conduit box shall be gasketed.
10. Three-Phase Motors shall be manufactured by Baldor, General Electric, U.S. Motors, Westinghouse or approved equal.

C. Fractional Horsepower Motors

1. Fractional Horsepower Motors shall be rigid, welded-steel, designed to maintain accurate alignment of Motor components and provide adequate protection. End shields shall be reinforced, lightweight die-cast aluminum. Windings shall be of varnish-insulated wire with slot insulation of polyester film, baked-on bonding treatment to make the stator winding strongly resistant to heat, aging, moisture, electrical stresses and other hazards.
2. Motor shaft shall be made from high-grade, cold-rolled shaft steel with drive-shaft extensions carefully machined to standard NEMA dimensions for the particular drive connection.
3. For light to moderate loading, bearings shall be quiet all-angle sleeve type with large oil reservoir that prevents leakage and permits motor operation in any position.
4. For heavy loading, bearings shall be carefully selected precision ball bearings with extra quality, long-life grease, and large reservoir providing 10 years' normal operation without relubrication.

D. Integral Horsepower Motors

1. Motor frames and end shields shall be cast iron or heavy fabricated steel of such design and proportions as to hold all Motor components rigidly in proper position and provide adequate protection for the type of enclosure employed.

2. Windings shall be adequately insulated and securely braced to resist failure due to electrical stresses and vibrations.
3. The shaft shall be made of high-grade machine steel or steel forging of size and design adequate to withstand the load stresses normally encountered in Motors of the particular rating. Bearing journals shall be ground and polished.
4. Rotors shall be made from high-grade steel laminations adequately fastened together, and to the shaft. Rotor squirrel-cage windings may be copper or bar-type construction with brazed end rings.
5. Motors shall be equipped with vacuum-degassed antifriction bearings made to AFBMA Standards, and be of ample capacity for the Motor rating. The bearing housing shall be large enough to hold sufficient lubricant to minimize the need for frequent lubrication, but facilities shall be provided for adding new lubricant and draining out old lubricant without Motor disassembly. The bearing housing shall have long, tight, running fits or rotating seals to protect against the entrance of foreign matter into the bearings, or leakage of lubricant out of the bearing cavity.
6. Bearings of high thrust Motors will be locked for momentary upthrust of 30% downthrust. All bearings shall have a minimum B10 life rating of 100,000 hours in accordance with AFBMA life and thrust values.
7. Vertical hollow-shaft motors will have non-reverse ratchets to prevent backspin.

E. Single-Phase Motors

1. Single-Phase Motors shall be split-phase and capacitor-start induction types rated for continuous horsepower at the RPM as called for on the Contract Drawings. Motors shall be rated 115/230VAC, 1-PH, 60Hz, TEFC with temperature rise in accordance with NEMA Standards for Class B insulation.
2. TEFC Motors shall be designed for severe-duty.
3. Motors shall have corrosion and fungus protective

finish on internal and external surfaces. All fittings shall have corrosion-protective plating.

4. Mechanical characteristics shall be the same as specified for Fractional Horsepower Motors.

## **PART 3 EXECUTION**

### **3.01 DELIVERY, STORAGE, AND HANDLING**

- A. All Motors and associated equipment shall be stored in accordance with the manufacturer recommendations and shall not be stored exposed to weather.

### **3.02 INSTALLATION**

- A. The Contractor shall plan the layout of the raceway systems so that when the work is complete it will exhibit good workmanship practices.
- B. All Motors and their peripheral devices shall be connected to the raceway system by means of a short section of flexible conduit, 18IN minimum and 60-inch maximum, unless otherwise indicated on the Contract Drawings.
- C. The Contractor shall install a grounding conductor in the conduit and terminate at the Motor Controller with an approved grounding clamp for all motor connections.
- D. Connection to Motor leads shall be made with high-compression type lugs with heat-shrinkable insulating boots.
- E. Phase rotation corrections shall be made within the Motor connection box.

### **3.03 TESTING**

- A. The Contractor shall check each Motor for correct clearances and alignment and for correct lubrication, and shall lubricate, if required, in accordance with manufacturer's instructions.
- B. The Contractor shall utilize a 1000V meg-ohmmeter to test each Motor winding before energizing the Motor. If the Motor insulation resistance is at or below the manufacturer's allowable limit, the Contractor shall notify the Engineer and shall not energize the Motor. The Contractor shall confirm the direction of rotation of all Motors with a phase rotation meter and reverse the

connections, as required, at the Motor connection box.

**END OF SECTION**





## **SECTION 16163**

### **DISTRIBUTION SWITCHBOARDS**

#### **PART 1 GENERAL**

##### **1.01 SCOPE**

- A. Work covered by this section includes furnishing all labor, equipment, and materials required to install or Modify distribution switchboards where indicated. Distribution switchboards shall be dead front type, completely metal enclosed, self-supporting structures independent of wall supports.

##### **1.02 SHOP DRAWINGS AND ENGINEERING DATA**

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples.

##### **1.03 STORAGE AND PROTECTION**

- A. The Contractor shall store and protect switchboards in accordance with the manufacturer's recommendations.

##### **1.05 OPERATION AND MAINTENANCE MANUALS**

- A. Operations and Maintenance Manuals shall be submitted as outlined in Specification 01730 - Operation and Maintenance Data.

#### **PART 2 PRODUCTS**

##### **2.01 GENERAL**

- A. Voltage rating shall be as indicated on the drawings. Switchboards shall consist of the required number of vertical sections bolted together to form one rigid unit. The sides and rear shall be covered with removable screw-on plates. All edges of front covers or hinged front panels shall be formed.
- B. Equipment shall comply with the latest applicable standards of NEMA PB2 & U.L. 891. Equipment shall be UL labeled and Service Entrance shall be labeled where required.
- C. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required.

All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips.

- D. Switchboard shall be provided with adequate lifting means and shall be capable of being rolled or moved into installation position and provided with contractor supplied floor sills to be set level.
- E. Furnish cable pull sections or top cable pull boxes where shown on the drawings complete with cable tie-down supports. Where cable pull section or pull boxes contain utility service cables provide utility acceptable sealing means.
- F. Switchboard shall be manufactured by Square D, Cutler-Hammer, or GE.

## **2.02 BUSSING**

- A. All bus bars shall be plated copper with bolted connections at joints. The switchboard(s) shall bear a UL integrated equipment rating as shown on the drawings. Main horizontal bus bars shall be mounted with all 3 phases arranged in the same vertical plane. Provide full capacity neutral where a neutral is indicated on the drawings.
- B. A ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard. An incoming ground lug shall be furnished. Other ground lugs for feeder circuits shall also be supplied as shown in the schedules on the drawings.
- C. All hardware used on conductors shall be high-tensile strength and zinc plated. All terminals shall be of the anti-turn solderless type suitable for CU or AL cable of sizes indicated.

## **2.03 SWITCHBOARD TYPE**

- A. Front Accessible Panel Mounted Feeder Devices
  - 1. All sections of the switchboard shall be 24-inches deep or greater. All sections of the switchboard shall align so that the back of the complete structure may be placed flush against a wall.
  - 2. Construction shall allow maintenance of incoming line terminations, main device connections and all

main bus bolted connections to be performed without rear access. The feeder or branch devices shall be removable from the front and shall be panel mounted with the necessary device line and load connection front accessible.

#### **2.04 OVERCURRENT DEVICES**

- A. Feeder protective devices shall be molded case circuit breaker type with frame and trip ratings as shown on the drawings and have additional characteristics as specified.
- B. Devices shall be manually operated (MO), unless electrically operated (EO) is indicated on the Drawings.

#### **2.05 SPECIFIC OVERCURRENT DEVICE SPECIFICATIONS**

- A. The following specification paragraphs elaborate on the devices selected and determined by the notes and comments in the schedules and on the contract drawings.

##### **1. Molded Case Breakers**

- a) Protective devices as shown shall be molded case circuit breakers, built, tested and UL labeled per UL 489.
- b) Breakers 100-ampere through 400-ampere frame shall be thermal-magnetic trip with inverse time current characteristics. Breakers 225-ampere through 400-ampere shall have continuously adjustable magnetic pick-ups of approximately five to ten times trip rating.
- c) Breakers 600-ampere frame and above shall be complete with built-in current transformers, trip unit and flux transfer shunt trip. Breakers shall have trip rating plugs with ratings as indicated on the drawings. Rating plugs shall be interlocked so they are not interchangeable between frames and interlocked such that a breaker cannot be latched with the rating plug removed.

Breakers shall have built-in test points for testing long delay, instantaneous and ground fault functions of the breaker by means of a test kit.

- d) Supply where shown on the drawings, limiters or current limiting mechanisms.
- 2. Nameplates: Engraved nameplates shall be furnished for all mains and feeder circuits including control fuses and also for all indicating lights and instruments. Nameplates shall give item designation and circuit number as well as frame size and appropriate trip rating. Furnish Master Nameplate giving switchboard designation, voltage, ampere rating, short circuit rating, manufacturer's name, general order number and item number.
- 3. Finish: All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be manufacturer's standard and use the manufacturer's standard process.
- 4. Indoor Enclosure
  - a) Panel or group-mounted device structures shall have hinged wireway covers allowing easy access to load terminations.
  - b) Individually mounted feeder devices shall have bolted covers providing a dead front cover, yet allowing the device operating mechanism to extend through the cover for visual trip indication and operation.

## **PART 3 EXECUTION**

### **3.01 TESTS**

- A. After assembly, the manufacturer's standard tests, including any NEMA standard tests, shall be performed. Witnessed tests shall be carried out when specified on the data sheet or purchase order.
- B. A functional test shall be performed on all metering, control, and protective relay circuits and devices. This shall be accomplished by introducing operating and tripping currents and voltages at the secondary terminals of the instrument transformers. The purchaser shall be notified before this test is performed.

### **3.02 MARKING AND SHIPPING**

- A. Each separate component of the equipment shall be identified by the purchaser's requisition sheet number and item number by means of a metal tag securely wired to the component.
- B. Each housing enclosure for equipment such as circuit breakers, switches, and motor starters shall be provided with a permanently attached nameplate of laminated bakelite or a similar approved material. The name plate shall indicate the tagging or nomenclature shown in the equipment list, and shall be permanently mounted on the face of the enclosure where it will be clearly visible. Lettering shall be white on a black background and shall be at least ¼ inch high.
- C. Equipment shall be packed to prevent damage to it during shipment. Movable parts such as contactors, relays, etc. shall be wedged to prevent movement. Small parts shall be shipped, bagged, boxed or otherwise protected against damage or loss.
- D. Each package, case, etc. as shipped shall, in addition to the address, be marked with the purchaser's requisition sheet and item number. Containers shall be marked to show the contents thereof.

### **3.03 REJECTION**

- A. Equipment or parts thereof and material entering therein, indicating irremediable or injurious defects, improper fabrication, excessive repairs, or that it is not in accordance with the requirements of this specification, shall be subject to rejection. They shall also be subject to rejection if such conditions are discovered after acceptance of the item at the manufacturer's plant.

**END OF SECTION**



## **SECTION 16450**

### **GROUNDING AND BONDING**

#### **PART 1 GENERAL**

##### **1.01 THE REQUIREMENTS**

- A. The Contractor shall furnish and install grounding systems complete in accordance with the minimum requirements established by Article 250 of the NEC. Article 250 of the NEC shall be considered as a minimum requirement for compliance with this Specification.
- B. Grounding of all instrumentation and control systems shall be furnished and installed in accordance with the manufacturer/system requirements and IEEE 1100-92, Powering and Grounding of Sensitive Electronic Equipment. Conflicts shall be promptly brought to the attention of the Engineer.
- C. In addition to the NEC requirements, building structural steel columns shall be permanently and effectively grounded.
- D. Reference Section 16010 - Electrical Basic Requirements.
- E. Additional requirements for grounding are shown on the Contract Drawings.

##### **1.02 CODES AND STANDARDS**

- A. All grounding components and the completed system shall comply with the following codes and standards as well as within the Specifications or as shown on the Contract Drawings:
  - 1. American National Standards Institute (ANSI/IEEE)
    - a) C2, National Electrical Safety Code (NESC)
  - 2. Institute of Electrical and Electronic Engineers (IEEE)
    - a) IEEE 81, Guide for Measuring Earth Resistivity.
    - b) IEEE 142, Recommended Practice for Grounding of Industrial and Commercial Power Systems.

3. National Fire Protection Association (NFPA)
  - a) NFPA 70, National Electric Code (NEC)
4. Underwriters Laboratories Inc (UL)
  - a) 588, Grounding Equipment

#### **1.03 SUBMITTALS**

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples.
- B. In accordance with the procedures and requirements set forth in the General Conditions and Division 1, the Contractor shall obtain from the equipment manufacturer and submit the following:
  1. Shop Drawings
  2. Reports of certified field tests. Each submittal shall be identified by the applicable Specification section.

#### **1.04 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  1. Equipment specifications and product data sheets identifying all materials used and methods of fabrication.
  2. Drawings and written description of how the Contractor intends to furnish and install the grounding system.

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURERS**



- A. The equipment covered by these specifications shall be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Contract Drawings.

## **2.02 GROUNDING CONDUCTOR**

- A. A green, insulated equipment grounding conductor, which shall be separate from the electrical system neutral conductor, shall be furnished and installed for all circuits. Equipment grounding conductors shall be furnished and installed in all conduits. Use of conduits as the NEC required equipment grounding conductor is not acceptable.
- B. Where specified or shown a 3-inch strap shall be furnished and installed as the grounding conductor.

## **2.03 EQUIPMENT GROUND CONDUCTOR**

- A. Equipment ground conductors shall be solid and continuous from a connection at earth to all distribution panelboards. Ground connections at panelboards, outlets, equipment, and apparatus shall be made in an approved and permanent manner.

## **2.04 BONDING FITTINGS**

- A. Grounding connections to equipment shall be bolted. Cable end connections may be made by use of the crucible weld process or bolted type connectors. Bolted type connectors for this application shall consist of corrosion resistant copper alloy with silicone bronze bolts, nuts and lock-washers which are designed for this purpose.

## **2.05 GROUND RODS**

- A. Ground rods shall be rolled to a commercially round shape from copper-clad steel manufactured by the molten-welding process or by the electro-formed process (molecularly bonded). They shall have an ultimate tensile strength of 75,000 PSI and an elastic limit of 49,000 PSI. The rods shall be not less than 3/4-inch diameter by 20 feet in length; and the proportion of copper shall be uniform throughout the length of the rod. The copper shall have a minimum wall thickness of 0.013 inch at any point on the rod.

- B. The maximum resistance to ground of a driven ground rod shall not exceed 10-OHM under normally dry conditions. Where the resistance obtained with one (1) ground rod exceeds 10-OHM, additional ground rods shall be coupled, by exothermic welds. Except where specifically indicated otherwise, all exposed non current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductors in nonmetallic raceways and neutral conductors of wiring systems shall be grounded.

The ground connection shall be made at the main service equipment and shall be extended to the point of entrance of the metallic water service. Connection to the water pipe shall be made by a suitable ground clamp or lug connection to a plugged tee. If flanged pipes are encountered, connection shall be made with the lug bolted to the street side of the flanged connection. If there is not suitable metallic water service to the facility, the ground connection shall be made to the driven ground rods on the exterior of the building.

Where ground fault protection is employed, care shall be taken so that the connection of the ground and neutral does not interfere with the correct operation of the ground fault protection system.

## **2.06        GROUNDING GRID**

A grounding grid shall be provided for each structure and interconnected between structures. The grounding grid shall be installed such that the ground resistance does not exceed 5-OHM. The grounding grid shall be interconnected by bare copper conductors sized to the largest service entrance ground, spliced and connected to ground rods by exothermic welds. The grounding conductors shall be installed after the excavations for the building have been completed and prior to the pouring of concrete for the footings, mats, etc. Copper "pigtailes" shall be connected to the grounding grid system; shall enter the buildings and structure from the outside; and shall be connected to steel structures and equipment as described in this Section and as shown on the Contract Drawings.

## **PART 3        EXECUTION**

### **3.01        INSTALLATION**

- A. Metal surfaces where grounding connections are to be made shall be clean and dry. Steel surfaces shall be ground or filed to remove all scale, rust, grease, and dirt.

Copper and galvanized steel shall be cleaned with emery cloth to remove oxide before making connections.

- B. Grounding conductors shall be continuous between points of connection; splices shall not be permitted.
- C. Where conductors are exposed and subject to damage from personnel, traffic, etc., conductors shall be installed in PVC sch-80 raceway.
- D. Mechanical connections shall be permitted to ground rods in "Ground Test Wells" and shall be exposed to permit maintenance and inspection for continuity and effectiveness of grounding system.
- E. Where subsurface conditions do not permit use of driven ground rods to obtain proper ground resistance, rods shall be installed in a trench or plate electrodes shall be provided, as applicable and necessary to obtain proper values of resistance.
- F. Conduit
  - 1. Conduit that enters equipment such as motor control centers, switchboards, switchgear, variable frequency drives, instrument and control panels, and similar equipment shall be bonded to the ground bus, where provided, and as otherwise required by the NEC.

### **3.02 TESTING**

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
  - 1. Witnessed Shop Tests: None required
  - 2. Field Tests
    - a) Ground resistance shall be measured with a three-point, fall of potential instrument.
    - b) All ground rods shall be tested after being driven and prior to connection to the grounding system. Where test results show resistance-to-ground is greater-than 10-OHM, additional ground rods shall be driven by coupling with exothermic welds. The compliance shall be demonstrated by retesting ground rod.

- c) Upon completion of installation of the grounding and bonding system, the entire system shall be tested at the ground test well(s), as indicated on the Contract Drawings. The completed system shall have less-than 5-OHM of ground resistance.

3. Documentation

- a) All tests shall be completely documented indicating time of day, date, temperature, weather conditions, measuring instrument and all pertinent test information.
- b) All required documentation of readings indicating non-compliance, shall be submitted to the Engineer prior to and required for final acceptance of the project.

**END OF SECTION**

## SECTION 16460

### DRY TYPE TRANSFORMERS

#### PART 1 GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, and test transformers for power and lighting distribution systems as described herein, as shown on the Contract Drawings, and as required to complete the electrical installations.
- B. All equipment specified in this Section shall be furnished by the transformer manufacturer who shall be responsible for the suitability and compatibility of all included equipment.
- C. Reference Section 16010 - Electrical Basic Requirements, and Section 09900 - Painting and Coatings.

##### 1.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
  - 1. Witnessed Shop Tests: None required
  - 2. Certified Shop Tests
    - a) The transformers shall be given routine factory tests in accordance with the requirements of the ANSI and NEMA standards. Temperature rises may be certified from basic design.
    - b) As a minimum, the following tests shall be made on all transformers:
      - (1) Ratio tests on the rated voltage connection and on all tap connections
      - (2) Polarity and phase-relation tests on the rated voltage connection
      - (3) Polarity and phase-relation tests on the rated voltage connection
      - (4) Applied potential tests

(5) Induced potential tests

(6) No-load and excitation current at rated voltage on the rated voltage connection

3. Field Tests

a) Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and Section 16010 - Electrical Basic Requirements.

b) After installation, the transformers shall be subjected to routine insulation resistance tests. The tests shall be made by the Contractor who shall also furnish the required testing equipment.

**1.03 SUBMITTALS**

A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples. The Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings
2. Operation and Maintenance Manuals
3. Spare Parts List
4. Special Tools List
5. Reports of Certified Shop Tests

B. Each submittal shall be identified by the applicable specification section.

**1.04 SHOP DRAWINGS**

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein, and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Equipment specifications and product data sheets identifying all materials used and methods of fabrication

2. Drawings showing clearly marked dimensions for each transformer
  3. Sample equipment nameplate diagram
- D. The submittal information shall reflect the specific equipment identification number as indicated on the Contract Drawings.
  - E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

#### **1.05 OPERATION AND MAINTENANCE MANUALS**

- A. Operations and Maintenance Manuals shall be submitted as outlined in Specification 01730 - Operation and Maintenance Data.

#### **1.06 TOOLS, SUPPLIES AND SPARE PARTS**

- A. The transformers shall be furnished with all special tools necessary to disassemble, service, repair and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.
- B. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same parts number.

#### **1.07 IDENTIFICATION**

- A. Each transformer shall be identified with the equipment tag number indicated on the Contract Drawings and the accepted shop drawings. A nameplate shall be securely affixed in a conspicuous place on each transformer. Nameplates shall be as specified in Section 16010 - Electrical Basic Requirements.

## **PART 2      PRODUCTS**

### **2.01      MANUFACTURERS**

- A.    The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Contract Drawings.
- B.    Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  - 1.    Square-D
  - 2.    Cutler-Hammer
  - 3.    General Electric
  - 4.    Siemens-ITE
  - 5.    Virginia Transformer

### **2.02      DRY TYPE TRANSFORMERS**

- A.    Furnish and install single-phase and three-phase general purpose, dry-type transformers, as specified herein and indicated on the Contract Drawings. The transformers shall be 60Hz, self-cooled, quiet-design insulated of the two winding type.
- B.    The transformers shall be Underwriters Laboratories, Inc. listed and shall bear the UL label.
- C.    The primary windings shall be rated 480VAC for use on 3-phase, 3-wire systems and connected delta unless indicated otherwise on the Contract Drawings. KVA ratings shall be as shown on the Contract Drawings. Furnish taps for transformers as follows:
  - 1.    1 PH, 25 KVA and below: Two 5% FCBN
  - 2.    3 PH, 15 KVA and below: Two 5% FCBN
  - 3.    3 PH, 30 KVA and above: Two 2.5% FCAN and four 2.5% FCBN
- D.    All taps shall be full capacity rated.
- E.    The ratings of the secondary windings shall be as indicated on the Contract Drawings.



- F. Transformers shall be designed for continuous operation at rated KVA, 24 hours a day, 365 days a year, with normal life expectancy as defined in IEEE 65 and ANSI C57.96. This performance shall be obtainable without exceeding 150 degrees Celsius average temperature rise by resistance or 180 degrees Celsius hot spot temperature rise in a 40 degrees Celsius maximum ambient and 30 degrees Celsius average ambient. The maximum coil hot spot temperature shall not exceed 220 degrees Celsius. All insulating materials shall be flame retardant and shall not support combustion as defined in ASTM Standard Test Method D 635. All insulating materials shall be in accordance with NEMA ST 20 Standard for a 220 degrees Celsius UL component recognized insulation system.
- G. Transformer coils shall be of the continuous wound copper construction and shall be impregnated with nonhydroscopic, thermosetting varnish.
- H. Transformers shall have copper windings.
- I. All cores are to be constructed of high grade, nonaging, grain-oriented silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point. The core laminations shall be tightly clamped and compressed with structural steel angles. The completed core and coil shall then be bolted to the base by means of vibration-absorbing mounts to minimize sound transmission. There shall be no metal-to-metal contact between the core and coil assembly and the enclosure.
- J. Indoor non-classified enclosures shall be made of heavy gauge steel and shall be degreased, cleaned, primed, and finished with a baked, weather-resistant enamel. See painting requirements specified in this section. Outdoor enclosures or enclosures within a corrosive area shall be constructed of stainless steel and rated NEMA 4X.
- K. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring. The maximum temperature of the enclosure shall not exceed 90 degrees Celsius. Transformers shall be furnished with lugs of the size and quantity required and suitable for termination of the field wiring.
- L. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable NEMA, IEEE, and ANSI standards.

- M. Transformers shall be mounted on neoprene-rubber isolation pads. The transformers shall not exceed the following ANSI sound levels:

1. 0 to 9 kVA 40dB
2. 10 to 50kVA 45dB
3. 51 to 150kVA 50dB
4. 151 to 300kVA 55dB
5. 301 to 500kVA 60dB
6. 501 to 700kVA 62dB
7. 701 to 1000kVA 64dB
8. 1001 to 1.5MVA 65dB

## **2.03 PAINTING**

- A. The exteriors of the transformer enclosures shall be painted as follows:
1. Factory painting: Surfaces shall be cleaned carefully and given a priming basic lead chromate. This shall be followed by two coats of an approved paint applied by brushing.
  2. Field painting: After delivery and installation, but before transformers are placed in service, all factory-painted surfaces shall be carefully cleaned and all abrasions shall be repaired.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. The transformers shall be furnished and installed as shown on the Contract Drawings and as recommended by the equipment manufacturer.
- B. Conduit routed to and from the transformer shall be arranged for easy removal of the transformer.

**END OF SECTION**

## **SECTION 16470**

### **PANELBOARDS**

#### **PART 1 GENERAL**

##### **1.01 THE REQUIREMENT**

- A. The Contractor shall furnish and install panelboards of voltage and current ratings as shown on the Contract Drawings. Panelboards shall be furnished with circuit breaker ratings, number of breakers, number of poles and locations conforming to the panelboard schedules on the Contract Drawings.
- B. Reference Section 16010 - Electrical Basic Requirements.

##### **1.02 STANDARDS**

- A. Panelboards shall conform to all applicable Federal, UL, and NEMA standards. Materials and components shall be new and conform to grades, qualities and standards as specified herein and shown on the Contract Drawings.
- B. Panelboards shall comply with the following industry standards:
  - 1. UL Listing/ Approval
  - 2. Standards
    - a) UL 50 - Cabinets and Boxes
    - b) UL 67 - Panelboards
    - c) NEMA - PB1
    - d) NFPA 70 - National Electrical Code

##### **1.03 TESTING**

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
  - 1. Witnessed Shop Tests: None Required
  - 2. Field Tests:
    - a) Field testing shall be done in accordance with the requirements specified in the General

Conditions, Division 1, and Section 16010 -  
Electrical Basic Requirements.

**1.04 SUBMITTALS**

- A. All submittals shall be in accordance with Specification 01340-Shop Drawings, Project Data and Samples. The Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings
  - 2. Reports of Certified Shop Tests
  - 3. Spare Parts List
  - 4. Operation and Maintenance Manuals shall be submitted as outlined in Specification 01730 - Operation and Maintenance Data.
- B. Each submittal shall be identified by the applicable specification section.

**1.05 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  - 1. Material specifications and product data sheets identifying all materials used and methods of fabrication.
  - 2. Complete assembly, layout, and installation drawings with clearly marked dimensions for each panelboard.
  - 3. Complete panelboard schedules indicating circuit designations and connected loads as shown on the Contract Drawings for each panelboard.

- D. The submittal information shall reflect the specific equipment identification as indicated on the Contract Drawings.

#### **1.06 TOOLS, SUPPLIES AND SPARE PARTS**

- A. The panelboards and accessories shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment. For each panelboard, the Contractor shall furnish to the Owner all spare parts as recommended by the equipment manufacturer including two (2) molded case circuit breakers of each type, size, and rating used.
- B. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same parts number.

#### **1.07 IDENTIFICATION**

- A. Each panelboard shall be identified with the identification tag number indicated on the Contract Drawings and the accepted shop drawings. A nameplate shall be securely affixed in a conspicuous place on each panelboard.

### **PART 2 PRODUCTS**

#### **2.01 GENERAL**

- A. The Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Contract Drawings.

#### **2.02 CONDUCTORS (MAIN BUS AND BRANCH CONNECTORS)**

- A. All main bus shall be copper sized in accordance with UL standards to limit the temperature rise on any current carrying part to a maximum of 50 degrees C above a maximum ambient temperature of 40 degrees C.

#### **2.03 LIGHTING PANELBOARDS**

A. General

1. The Lighting Panelboards, as defined by NEC or noted on the Contract Drawings, shall be dead-front type with automatic trip-free, non-adjustable, thermal-overload, branch circuit breakers. Panelboards shall be of the configuration and rating as specified herein and indicated on the Contract Drawings. Panelboards shall be listed and labeled by Underwriter's Laboratories, Inc.
2. The Lighting Panelboards shall be equipped with a main breaker or main lugs complete with branch circuit breakers, as shown on the Contract Drawings. The panelboards shall be enclosed in a cabinet suitable for flush or surface mounting. Some panelboards shall be furnished and installed within motor control center structures as shown on the Contract Drawings.
3. Lighting Panelboards shall be fully rated and shall have a short circuit rating of 22kA symmetrical, minimum. In the event the results of the Contractor's short circuit fault analysis, as accepted by the Engineer, indicate that a higher short circuit rating of the panelboards is required, furnish complete panelboards with that higher rating.
4. Lighting Panelboards shall be furnished with transient voltage surge suppression (TVSS) and filtering equipment as required in Specification Section 16671-Transient voltage Surge Suppression and indicated on the Contract Drawings. The TVSS devices shall be UL labeled.
5. Subject to compliance with specifications Lighting Panelboards shall be:
  - a) Square-D Company
  - b) Eaton/Cutler-Hammer Electric Corporation
  - c) General Electric
  - d) Approved equal

B. Cabinets

1. Except for lighting panelboards installed in motor control centers, the cabinet shall be NEMA 12

(minimum) constructed of #12 U.S.S. code gauge galvanized steel. The door shall be fastened to the cabinet with concealed brass hinges and shall be equipped with flush-type catches and locks. All locks shall be keyed alike. The cabinet shall have wiring gutters on sides and shall be at least 20-inches wide and 5-3/4-inches deep. The Contractor shall provide an engraved nameplate for the panelboard. The nameplate shall include the panelboard designation, voltage, phase, wires, and bus rating.

2. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the cabinet.

#### C. Bus Work

1. Main bus bars shall be of ample size so that a current density of not more than 1000A per square inch of cross section will be attained. This current density shall be based on the application of the full load connected to the panel plus approximately 25% of the full load for spare capacity. The main bus shall be full capacity as based on the preceding for the entire length of the panel so as to provide full flexibility of circuit arrangement.
2. Solid neutral bus bars are required. Ratings shall be in accordance with applicable standards.
3. A separate ground bus shall be provided with lugs for termination of equipment grounding conductors.
4. Branch bus work shall be rated to match the maximum branch circuit breaker which may be installed in the standard space.
5. All bus shall be plated copper.

#### D. Circuit Breakers

1. Circuit breakers shall be bolt-on, molded-case type conforming to NEMA Standard AB 1. Trip elements of circuit breakers shall be 20A unless otherwise shown on the Contract Drawings. Minimum branch circuit breaker shall be 100A frame for 60A and above except where shown otherwise on the Drawings or where a larger frame size is standard for the continuous current rating required. Breakers shall have an interrupting rating of 22kA symmetrical at

240VAC, minimum. All breakers shall have quick-make, quick-break, toggle mechanism for manual as well as automatic operation. Tandem or half-size breakers are not acceptable.

2. Where indicated, or where required by Code, circuit breakers for receptacle circuits shall be equipped with integrally mounted ground fault interrupters complete with "TEST" push button and shall be of a type which fit standard panelboard spaces for the breaker continuous current rating required.
3. Instrument power panel branch circuit breakers set for control instrumentation, telephone, data, fire alarm or auxiliary equipment circuits requiring continuous operation shall be provided with a lock-on device.
4. Circuit breakers used for fluorescent lighting circuit switching shall be approved for the purpose and shall be marked "SWD". Circuit breakers used for high intensity discharge lighting circuit switching shall be approved for the purpose and shall be marked "HID". Where required by Article 440 of the NEC, circuit breakers installed for air conditioning units shall be HACR type.

#### E. Directories

1. Approved directories with glass or noncombustible plastic cover and with typewritten designations of each branch circuit, shall be furnished and installed in each panelboard. The Contractor shall maintain in each panel, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service. This directory shall be updated as work progresses, and final, typewritten directories, as specified above, shall be installed at the end of the project. Designations and circuit locations shall conform to the panelboard schedules on the Contract Drawings, except as otherwise authorized by the Engineer.
2. The Contractor shall provide directories identifying panelboards and indicating the size of the feeder (cable and conduit) serving the panel, circuit numbers, and a description of associated branch circuits including branch circuit trip and connected load for each circuit.

## 2.04 POWER DISTRIBUTION PANELBOARDS



A. General

1. The Power Distribution Panelboards, as defined by NEC or noted on drawings, shall be of the configuration and rated as shown on the Contract Drawings. The panelboards shall be dead-front type with automatic trip-free, non-adjustable, thermal overload branch circuit breakers. Circuit breakers shall be bolt-on molded case type conforming to NEMA Standard AB1. Trip elements of the circuit breakers shall be rated 20A unless otherwise shown on the Contract Drawings. The bus ratings shall be as shown on the Contract Drawings. Panelboards shall be listed and labeled by Underwriter's Laboratories, Inc.
2. Power distribution panelboards shall be fully rated and shall have a short circuit rating of 25kA symmetrical, minimum. In the event the results of the Contractor's short circuit fault analysis, as accepted by the Engineer, indicate that a higher short circuit rating of the panelboards is required, furnish complete panelboards with that higher rating.
3. Power Distribution Panelboards shall be furnished with transient voltage surge suppression (TVSS) and filtering equipment as required in Section 16671 - Transient Voltage Surge Suppression (TVSS) 1kV or Less, and as indicated on the Contract Drawings. The TVSS devices shall be UL labeled.
4. Subject to compliance with specifications Power Distribution Panelboards shall be:
  - a) Square-D Company
  - b) Eaton/Cutler-Hammer Electric Corp.
  - c) General Electric
  - d) Approved equal

B. Cabinets

1. Except for power panelboards installed in motor control centers, the cabinets shall be NEMA 12 (minimum) constructed of #12 U.S.S. code gauge galvanized steel. The door shall be fastened to the cabinet with concealed brass hinges and shall be equipped with flush-type catches and locks. All

locks shall be keyed alike. The cabinet shall have wiring gutters on sides and shall be at least 20-inch wide and 5-3/4-inches deep. The Contractor shall provide nameplates for each panelboard. The nameplate shall include the panelboard designation, voltage, phase, wires, and bus rating.

2. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the cabinet.

#### C. Bus Work

1. Main bus bars shall be of ample size so that a current density of not more than 1,000A per square inch of cross section will be attained. This current density shall be based on the application of the full load connected to the panel plus approximately 25% of the full load for spare capacity. The main bus shall be full capacity as based on the preceding for the entire length of the panel so as to provide full flexibility of circuit arrangement.
2. Solid neutral bus bars, where required, shall be provided. Ratings shall be in accordance with applicable standards.
3. A separate ground bus shall be provided with lugs for termination of equipment grounding conductors.
4. Branch bus work shall be rated to match the maximum branch circuit breaker which may be installed in the standard space.
5. All bus shall be plated copper.

#### D. Circuit Breakers

1. Circuit breakers shall be bolt-on, molded-case type conforming to NEMA Standard AB 1. Trip elements of circuit breakers shall be 20A unless otherwise shown on the Contract Drawings. Minimum branch circuit breaker shall be 100A frame for 60A and above except where shown otherwise on the Contract Drawings or where a larger frame size is standard for the continuous current rating required. Breakers shall have an interrupting rating of 25kA symmetrical at 480VAC, minimum. All breakers shall have quick-make, quick-break, toggle mechanism for manual as well as automatic operation. Tandem or half-size breakers are not acceptable.

E. Directories

1. Approved directories with glass or noncombustible plastic cover, and with typewritten designations of each branch circuit, shall be provided in each panel. The Contractor shall maintain in each panel, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service. This directory shall be updated as work progresses, and final, typewritten directories, as specified above, shall be installed at the end of the project. Designations and circuit locations shall conform to the panelboard schedules on the Contract Drawings, except as otherwise authorized by the Engineer.
2. The Contractor shall provide directories identifying panelboards and indicating the size of the feeder (cable and conduit) serving the panel, circuit numbers, and a description of associated branch circuits including branch circuit trip and connected load for each circuit.

**2.05 PAINTING**

- A. All metal surfaces of the panelboard enclosures shall be thoroughly cleaned and given one prime of zinc chromate primer. All interior surfaces shall then be given one shop finishing coat of a lacquer of the nitro-cellulose enamel variety. All exterior surfaces shall be given three coats of the same lacquer. The color of finishing coats shall be light gray ANSI #61.
- B. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

**PART 3 EXECUTION**

**3.01 MOUNTING**

- A. The lighting panelboards, power distribution panelboards, and combination power units shall be furnished and installed as shown on the Contract Drawings and as recommended by the equipment manufacturer.

- B. Panelboards shall be set true and plumb in all locations as shown on the Contract Drawings. The top of panelboard enclosure shall not exceed 6 feet above finished floor elevation.
- C. Panelboards installed outdoors shall NOT be mounted to hand-rail or safety rail.
- D. Enclosures shall not be fastened to concrete or masonry surfaces with wooden plugs, conical plastic anchors. Appropriate cadmium plated or galvanized steel bolts shall be used with expansion shields or other metallic type concrete insert for mounting on concrete or solid masonry walls. Cadmium plated or galvanized steel toggle bolts shall be used for mounting on concrete block or other hollow masonry walls. Bolt diameter shall be as required considering the size and weight of the completed panelboard and enclosure to provide adequate structural support.
- E. The Contractor shall not use factory furnished knockouts with surface back boxes. The Contractor shall punch or drill required openings during installation and shall equip flush back boxes with manufacturer's standard pattern of knockouts. The Contractor shall equip cabinet doors exceeding 40-inches height with vertical bolt three point locking mechanism.
- F. The Contractor shall install cabinets (and other enclosure products) in plumb with the building construction. Flush enclosures shall be installed so that the trim will rest against the surrounding surface material and around the entire perimeter of the enclosure.

**END OF SECTION**

## **SECTION 16475**

### **SAFETY DISCONNECT SWITCHES**

#### **PART 1 GENERAL**

##### **1.01 THE REQUIREMENT**

- A. The Contractor shall furnish and install separately mounted, individual disconnect switches as specified herein and indicated on the Contract Drawings.
- B. 16010 - Electrical Basic Requirements.
- C. 16111 - Conduit and Raceway

##### **1.02 TESTING**

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
  - 1. Witnessed Shop Tests: None required.
  - 2. Field Tests: Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and Section 16010 - Electrical Basic Requirements.

##### **1.03 SUBMITTALS**

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples and the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings
  - 2. Spare Parts List
- B. Each submittal shall be identified by the applicable specification section.

##### **1.04 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

- B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  - 1. Equipment specifications and product data sheets identifying all materials used and methods of fabrication.
  - 2. Complete layout and installation drawings with clearly marked dimensions for each type/size/rating of disconnect switch.
  - 3. Assembled weight of each unit.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

**1.05 TOOLS, SUPPLIES, AND SPARE PARTS**

- A. The equipment shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment, and with all spare parts as recommended by the equipment manufacturer.
- B. One complete set of spare fuses for each ampere rating installed shall be furnished and delivered to the Owner at the time of final inspection.
- C. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- D. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same parts number.

## **1.06 IDENTIFICATION**

- A. Each equipment item shall be identified with a nameplate. The nameplate shall be engraved indicating the operating voltage, panel and circuit number of the power source and the equipment name with which it is associated.

## **1.07 OPERATIONS AND MAINTENANCE MANUALS**

- A. Operation and Maintenance Manuals shall be submitted as outlined in Specification 01730 - Operation and Maintenance Data.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Contract Drawings.
- B. Disconnect switches shall be manufactured by:
  - 1. Square-D
  - 2. Eaton/Cutler-Hammer
  - 3. General Electric
  - 4. Allen-Bradley
  - 5. Siemens
  - 6. Approved equal

### **2.02 DISCONNECT SWITCHES**

- A. Disconnect switches shall be heavy-duty type and/or as specified in these Specifications. Switches shall be furnished and installed as shown on the Contract Drawings and as required by the NEC. Handles shall be lockable.
- B. Disconnect switches shall be NEMA Type HD, single throw, externally operated, non-fused, fused or provided with circuit breakers as required. Disconnect switches shall have the poles, voltage, and ampere ratings as shown on the Contract Drawings.
- C. Disconnect Switches shall be provided in NEMA 4X stainless steel enclosures.

- D. Disconnect switches shall be quick-make, quick-break and with an interlocked cover which cannot be opened when switch is in the "ON" position and capable of being locked in the "OPEN" position.
- E. Disconnect switches shall be quick-make, quick-break and with an interlocked cover which cannot be opened when switch is in the "ON" position and capable of being locked in the "OPEN" position.
- F. A complete set of fuses for all switches shall be furnished and installed as required. Time-current characteristic curves of fuses serving motors or connected in series with circuit breakers shall be coordinated for proper operation. Fuses shall have voltage rating not less than the circuit voltage.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. All disconnect switches to be mounted 60-inches above the floor, at the equipment height where appropriate, or as shown on the Contract Drawings.
- B. Disconnect switches shall NOT be mounted to any hand-rail or safety rail.
- C. The Contractor shall furnish and install fuses or circuit breakers as required or shown on the Contract Drawings.

**END OF SECTION**



## **SECTION 16481**

### **MOTOR CONTROL CENTERS**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

###### **A. Section Includes:**

1. Motor control centers, separately mounted motor starters (including those supplied with equipment), manual motor starters, control equipment.
2. Modifications to existing Westinghouse (Eaton) Series 2100 MCCs. As shown on the Contract Documents.

###### **B. Related Sections include but are not necessarily limited to:**

1. Division 1 – General Requirements
2. Section 16010 - Electrical Basic Requirements

##### **1.02 QUALITY ASSURANCE**

###### **A. Referenced Standards:**

1. American National Standards Institute (ANSI)
  - a) C62.41, Guide for Surge Voltages in Low Voltage AC Power Circuits
2. Canadian Standards Association (CSA)
3. Institute of Electrical and Electronics Engineers (IEEE)
4. National Electrical Manufacturers Association (NEMA)
  - a) ICS 2, Industrial Control Devices, Controllers, and Assemblies
  - b) 250, Enclosures for Electrical Equipment (1000 Volt Maximum)

5. National Fire Protection Association (NFPA)

a) 70, National Electrical Code (NEC)

6. Underwriters Laboratories, Inc (UL)

a) 845, Electric Motor Control Centers

B. Miscellaneous

1. Verify motor horsepower loads, other equipment loads and controls from approved shop drawings and notify Engineer of any discrepancies.

2. Verify the required instrumentation and control wiring for a complete system and notify Engineer of any discrepancies.

### **1.03 SUBMITTALS**

A. Shop Drawings:

1. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples and Section 16010 - Electrical Basic Requirements.

2. MCC elevation drawings and complete description of units in the MCC

3. Typical MCC unit wiring diagrams

4. Typical wiring diagrams for all control equipment

### **1.04 OPERATIONS AND MAINTENANCE MANUALS**

A. Operation and Maintenance Manuals shall be submitted as outlined in Specification 01730 - Operation and Maintenance Data.

## **PART 2 PRODUCTS**

### **2.01 ACCEPTABLE MANUFACTURERS**

A. Motor control centers:

1. Square D

2. Cutler Hammer

- 3. General Electric
- 4. Allen-Bradley
- B. Separately mounted motor starters:
  - 1. Square D
  - 2. Cutler Hammer
  - 3. General Electric
  - 4. Allen-Bradley
- C. Control relays:
  - 1. Square D
  - 2. Cutler Hammer
  - 3. General Electric
  - 4. Allen-Bradley
- D. Programmable controllers:
  - 1. Refer to Division 13
- E. Manual motor starters:
  - 1. Square D
  - 2. Cutler Hammer
  - 3. General Electric
  - 4. Allen-Bradley
- F. Submit requests for substitution in accordance with Specification Section 01600 – Material and Equipment.

## **2.02 COMPONENTS**

- A. Motor Control Centers:
  - 1. Design:
    - a) Service voltage: 480 V, 3 PH, 4 W, 60 HZ, unless otherwise indicated on the Drawings.

- b) Main horizontal bus: 800 A
  - 1) Unless otherwise indicated on the Drawings
- c) Vertical bus: 300 A
  - 1) Unless otherwise indicated on the Drawings
- d) Short circuit withstand rating: 65,000 AIC symmetrical
  - 1) Unless otherwise indicated on the Drawings
- e) Provide main horizontal bus in each structure; full capacity, full-length, with provisions for extension.
  - 1) Bus bars:
    - (a) Plated copper
    - (b) Rectangular cross section
    - (c) Support in each structure by means of bus supports
- f) Provide each structure with full-length vertical bus to distribute incoming power to each circuit breaker and starter in structure:
  - 1) Starters NEMA size 5 and larger and certain other components may be cable connected to the main bus with the approval of the Engineer.
  - 2) Vertical bus shall be extended to spaces provided for future equipment.
- g) Provide ground bus:
  - 1) Continuous
  - 2) 14" x 2" copper
  - 3) Solidly grounded to each structure

- 4) Locate near bottom of structure
- 5) Provide for lug connection of equipment ground wires
- h) Provide guides for supporting and aligning starters

2. Construction:

- a) NEMA Class I, Type B
- b) NEMA 1G, free standing
- c) Unit structures:
  - 1) Totally enclosed
  - 2) Joined together to form one (1) assembly:
    - (a) Each unit structure will be nominal 20" wide, 20" deep, and 90" high, unless otherwise indicated on the Drawings.
- d) Fabricate of not less than 14 GA steel with 16 GA steel doors in standardized units
- e) Provide each structure with two (2) horizontal wiring spaces.
  - 1) One (1) at top
  - 2) One (1) at bottom
  - 3) Spaces will line up with adjacent units to form convenient wiring raceway entire length of control center.
- f) Provide each structure with one (1) vertical wireway for unit wiring.
  - 1) With cable tie supports to hold wiring in place
  - 2) With a separate door

- g) Bottom shall have ample unrestricted space for conduit entry.
  - h) Doors:
    - 1) Formed round corners and rolled edges
    - 2) Gasketed
    - 3) Minimum of two (2) heavy-duty hinges or continuous piano hinge
    - 4) Held closed by means of captive fasteners.
  - i) Fabricate doors to be a part of the structure and not part of the starter.
  - j) Cubicles:
    - 1) Totally enclosed
    - 2) Effectively baffled to isolate any ionized gases which may occur within unit starter.
  - k) Assemblies effectively ventilated, to allow relocation of starters and other components:
    - 1) Within the assembly and with the same load.
    - 2) Without having to compensate for changes in location.
3. Combination full voltage magnetic starters mounted in MCC:
- a) Circuit breaker:
    - 1) Motor circuit protector (MCP) type.
  - b) Contactor NEMA rated.
  - c) Line plug-in, pull-out, lock-out type
    - 1) Except starters NEMA size 5 and larger

- (a) Fixed mounted with the approval of the Engineer.
- 2) Provide guides in structure for supporting and aligning unit starter during removal or replacement.
- 3) Plug-in units:
  - (a) Silver-plated
  - (b) Pressure type line disconnecting stabs
  - (c) High-strength copper alloy
- 4) Lock-out latch to padlock unit in "pull-out" position and at same time isolate stubs and entire unit from bus. Hold each unit in place by means of quick-captive fasteners.
- d) Operating handle shall clearly indicate whether circuit breaker is ON, OFF or TRIPPED.
  - 1) Provide means to lock each circuit breaker handle in OFF position with cover closed by means of up to three (3) padlocks. Interlock so that circuit breaker must be in OFF position before door can be opened:
    - (a) Provide defeater mechanism for use by authorized personnel.
- e) Provide starter unit with ambient compensated, external manually reset table, three (3) bimetallic type overload relays. Coordinate size with actual motor full load current.
  - 1) For motors with power factor correction capacitors, size heater elements to compensate for the capacitors effect on load current.
- f) Provide heavy-duty devices:

- 1) NEMA 4K 30mm selector switches
  - 2) NENA 4K 30mm pushbuttons
  - 3) NEMA 4X 30mm pilot lights:
    - (a) Push-to-test type
    - (b) LED Lamps
  - 4) Other devices as indicated on the Drawings
  - 5) Devices will be accessible with the door closed
- g) Provide each starter with two (2) extra field reversible N.O. auxiliary contacts for future use.
- h) Provide each starter with bus voltage to 120 V control power transformer:
- 1) 480/120 V
  - 2) Fused on primary and secondary sides
  - 3) Rated for minimum of one hundred forty percent (140%) of required load suitable for operating controls and power motor winding space heaters as per the drawings and specifications.
  - 4) For all motor starters
- i) Provide six-digit readout elapsed time meter
- j) Starter units will have the same fault current withstand rating as the main bus fault current withstands rating.
- k) Provide each starter with the following status signals, wired to terminal boards:
- 1) Motor run contact (N.O.)
  - 2) Motor stop contact (N.C.)



3) Auxiliary overload relay contact (N.O.)

B. Main and Feeder Circuit Breakers in MCC and Separately Mounted:

1. Molded case thermal magnetic or solid-state trip type, with minimum interrupting rating equal to the main bus fault current rating:
2. Circuit breaker frame sizes 150 A and less:
  - a) Non-interchangeable, non-adjustable thermal magnetic trip units.
3. Circuit breaker frame sizes 225 A and higher:
  - a) Interchangeable and adjustable thermal magnetic trip units.
4. Circuit breaker frame sizes 600 A and greater:
  - a) Solid state trip units, unless otherwise noted on the Drawings.
  - b) Current sensor or rating plug.
  - c) Adjustable current setting: Minimum range seventy to one hundred percent (70% - 100%) of current sensor or rating plug.
  - d) Adjustable instantaneous pickup: Minimum range three (3) to eight (8) times.
  - e) On circuit breakers 1000 A and larger provide ground fault protector.
    - 1) Adjustable pick-up
    - 2) Adjustable delay
5. Provide main circuit breaker with service entrance label.
6. All circuit breakers to be provided with padlocking provision in the OFF position for up to three padlocks.

7. Circuit breakers rated 400 A or above: One hundred percent (100%) rated.
- C. Provide ambient compensated devices
- D. Manual Starters with Thermal Element:
1. Quick-make, quick-break toggle mechanism
  2. Trip free
  3. Clearly indicate ON, OFF and TRIPPED position.
  4. NEMA rated enclosure per area classification unless otherwise indicated on the Drawings.
- E. Separately Mounted Starters:
1. Circuit breaker shall be motor circuit protector (MCP) type.
  2. Contactor shall be NEMA rated.
    - a) One-half (1/2) size and IEC sized starters not permitted.
  3. Operating handle shall clearly indicate whether circuit breaker is ON, OFF, or TRIPPED.
    - a) Provide means to lock each circuit breaker handle in OFF position with cover closed by means of up to three padlocks.
    - b) Interlock so that circuit breaker must be in OFF position before door can be opened. Provide defeater mechanism for use by authorized personnel.
  4. Provide starter unit with ambient compensated, external manually resettable, three (3) bimetallic type overload relays. Coordinate size with actual motor full load current.
    - a) For motors with power factor correction capacitors size heater elements to compensate for the capacitors effect on load current.

5. Provide heavy-duty oil tight selector switches, pushbuttons, push-to-test pilot lights with LED lamps, or other devices as indicated on the Drawings. These devices will be accessible with the door closed.
6. Provide each starter with two (2) extra field reversible NO auxiliary contacts for future use.
7. Provide each starter with 480/120 V control power transformer fused on secondary side and rated for a minimum of one hundred forty percent (140%) of required load suitable for operating controls and motor winding space heaters as per the drawings and specifications.
8. Provide six-digit readout elapsed time meter.
9. Starter units will have the same fault current withstand rating as the MCC main bus fault current withstand rating from which they are fed.
10. Provide each starter with the following status signals, wired to terminal boards.
  - a) Motor run contact (N.O.)
  - b) Motor stop contact (N.C.)
  - c) Auxiliary overload relay contact (N.O.)

F. Selector Switches, Indicating Lights, and Pushbuttons:

1. NEMA 4X for all areas
2. NEMA 4X/7 and 4X/9 for Class I, Division I Groups C and D; and Class II, Division I, Groups E, F, and G hazardous locations.
3. Selector switches shall have standard gloved operator.
4. Pushbuttons shall have standard flush operator.
5. Provide switch positions and contacts:
  - a) As specified on Contract Drawings or as necessary for proper control.

6. Switch contacts shall be NEMA A600 rated.
7. Indicating lights with LED lamps, unless specified otherwise.
8. Provide fifty percent (50%) replacement lamps for indicating lights.
9. Provide ten percent (10%) percent replacement caps for indicating lights.

G. Alarm Horns

1. Siren type
2. Sheet metal housing
  - a) Primer and finish coat of paint shall be suitable for use in corrosive areas.
3. Adjustable mounting bracket
4. For use on 120 V AC
5. Universal motor
6. Nominal 106 dE at 10' from source
7. Federal Signal Model ATT or approved equal

H. Control Relays:

1. Provide industrial control relays as specified on the Drawings and as required for proper operation and control of supplied equipment.
2. All control relays shall have 120 V coils capable of operating on line voltage fluctuations of plus or minus ten percent (+/- 10%) unless specified otherwise.
3. Relays shall be provided with NEMA A600 rated contacts, and shall be capable of supporting a minimum of eight contacts.
4. Provide relays with all N.O. contacts unless otherwise specified.

a) Contacts shall be field reversible.

5. Provide contacts for all required control plus two (2) spares.

I. Remote Operator Stations:

1. NEMA 12 for unclassified areas unless specified otherwise.

2. NEMA 4X for wet areas, outdoors or equipment specified WP, and control panel enclosures not covered under Div 11.

3. NEMA 4X for corrosive areas.

4. NEMA 7 and 9 for Class I, Division I, Groups C and D; and Class II, Division I, Groups E, F, and G hazardous locations.

5. Construction and installation shall be in accordance with NEC Article 373.

6. Provide barrier-type terminal strips for termination of all control and 120 V power field wiring plus twenty percent (20%) spare for all control panels.

7. Control panel construction:

a) 14 GA steel

b) Continuously welded seams

c) Manufacturer's standard gray

J. Time Delay Relays:

1. Provide time delay relays with delayed pickup or release as specified on Drawings.

2. All time delay relays shall operate at 115 V AC plus or minus ten percent (+/- 10%)

3. Heavy duty, solid-state construction

4. Contact rating: 10 amps.

5. Provide external adjust dial with 0-9.99/99.9/999 second selectable range unless specified otherwise.
6. Operating temperature ranges: -18 to +50 °C
7. Repeat accuracy: plus or minus three percent (+/- 3%) plus ±10ms over specified voltage range.
8. Provide all required contacts plus two (2) N.O. spares.
9. Provide auxiliary relays as required to perform functions specified on Drawings.

K. Terminal Strips:

1. 600 V
2. Full size
3. Rated for 20 A continuous current

L. Enclosures and Control Panels:

1. NEMA 12 for unclassified areas
2. NEMA 4X for outdoor or wet areas
  - a) Except MCCs, which shall be NEMA 3R non-walk-in type
3. NEMA 4X for corrosive areas
4. NEMA 7 for Class I hazardous locations

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Install as indicated and in accordance with manufacturer's recommendations and instructions.
- B. Mount MCC on 4" high concrete pad:
  1. Install two (2) 4" wide channel sills flush in pads to support and maintain alignment of the MCC.

- 2. Align front of MCC with top edge of pad chamfer.
- C. Mount other equipment as scheduled in Section 16010 – Electrical Basic Requirements.

**3.02 FIELD QUALITY CONTROL**

- A. Field-test and verify operation of the equipment.

**END OF SECTION**





## **SECTION 16483**

### **VARIABLE FREQUENCY DRIVES**

#### **PART 1 GENERAL**

##### **1.01 SCOPE OF WORK**

- A. This section provides specification requirements for adjustable frequency drives; variable speed drives or herein identified as AC Drives for use with NEMA B design AC motors.
- B. The AC Drive manufacturer shall furnish, field test, adjust and certify all installed AC Drives for satisfactory operation.
- C. Any exceptions/deviations to this specification shall be indicated in writing to the specifying engineer in the submittal documentation.
- D. AC Drives shall fit in locations as shown in the contract documents.
- E. AC Drives shall operate auxiliary equipment such as seal water valves, motor space heaters, and include safety and equipment protection interlocks as shown in the contract documents.
- F. The AC Drive manufacturer shall be responsible for providing all equipment specified under this section, and furnishing the equipment to the Contractor for installation.

##### **1.02 REFERENCES**

- A. NFPA-70 "National Electric Code (NEC)"
- B. ANSI C84.1 "Electric Power Systems and Equipment - Voltage Ratings (60Hz)"
- C. CSA® C22.2 No.14-95 "Industrial Control Equipment"
- D. UL508A "Standard for Safety for Industrial Control Panels"
- E. UL508C "Standard for Safety for Power Conversion Equipment"

- F. NFPA 79 "Electrical Equipment of Industrial Machines/Industrial Machinery
- G. NEMA ICS7 "Industrial Control and Systems: Adjustable Speed Drives
- H. NEMA ICS7.1 "Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems
- I. NEMA 250 "Enclosures for Electrical Equipment (1000V maximum
- J. IEC 61800-2 "Adjustable speed electrical power drive systems - Part 2: General requirements - rating specifications for low voltage adjustable frequency AC power drive systems"
- K. IEC 61800-3 "Adjustable speed electrical power drive systems - Part 3: EMC product standard including specific test methods"
- L. IEC 61800-5-1 "Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
- M. IEC 61800-6 "Adjustable speed electrical power drive systems - Part 6: Guide for determination of types of load duty and corresponding current ratings."
- N. EGSA 101P "Engine Driven Generator Sets - Performance Standard"
- O. IEEE 519 "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems"

### **1.03 SUBMITTALS**

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples.
- B. Approval drawings shall be furnished for Engineer's approval prior to factory assembly of the AC Drives. These drawings shall consist of elementary power and control wiring diagrams and enclosure outline drawings. The enclosure drawings shall include front and side views of the enclosures with overall

dimensions and weights shown, conduit entrance locations and nameplate legend details.

- C. Standard catalog sheets showing voltage, horsepower, maximum current ratings and recommended replacement parts with part numbers shall be furnished for each different horsepower rated AC Drive provided.

#### **1.04 WARRANTY**

- A. The equipment manufacturer shall provide a two (2) year warranty beginning from substantial completion of the project, and shall guarantee that the equipment furnished is suitable for the purpose intended and free from defects of design, material and workmanship. In the event the equipment fails to perform as specified, the equipment manufacturer shall promptly repair or replace the defective equipment without any cost to the Owner (including handling, shipment, labor, travel time and expense costs).

#### **1.05 QUALITY ASSURANCE**

- A. The manufacturer of the AC Drive shall be a certified ISO 9001 facility.
- B. The AC Drive and all associated optional equipment shall be UL LISTED according to UL508C Power Conversion Equipment. A UL label shall be attached inside each enclosure as verification.
- C. The AC Drive shall be designed constructed and tested in accordance with NEMA, NEC, VDE, IEC standards.
- D. Every power converter shall be tested with an actual ac induction motor, 100% load and temperature cycled within an environmental chamber at 104°F. Documentation shall be furnished to verify successful completion at the request of the engineer.
- E. All Drive door mounted pilot devices shall be tested to verify successful operation. Documentation shall be furnished upon written request of the engineer.
- F. The AC Drive shall undergo QA test procedures and be submitted to a hi-pot test with all enclosed devices mounted and wired, prior to shipment.

## **1.06 OPERATIONS AND MAINTENANCE MANUALS**

- A. Operations and maintenance Manuals shall be submitted as outlined in Specification 01730 - Operation and Maintenance Data.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. The AC Drive shall be provided by ABB, or approved equal.
- B. AC drive shall be ABB ACS 800 series, direct torque controls, Yaskawa, or Allen-Bradley including the following features: VFD, Bypass starter with service Switch, NEMA 12 enclosure with fans and filters, Input Circuit Breaker, 480 volt with factory authorized start-up.
- C. Drive output rating shall be a minimum of 96 Amps at 480 Volts and shall be suitable for operation with 60 to 75 HP, submersible Pump Motors.
- D. Drive shall include control interfaces as shown on the drawings and as specified. The VFD remote control shall be through an Allen Bradley Ethernet IP interface
- E. Drive enclosure shall be a standard manufactured assembly by the drive manufacture with dimensions of 84"H X 31.5"W x 24"D, NEMA 12 with front ventilation. Drives assembled into an enclosure by an OEM are not acceptable. There shall be no restriction on space requirements between the sides and rear of the floor mounted enclosures.
- F. Alternate control techniques other than pulse width modulated (PWM) are not acceptable.

### **2.02 GENERAL DESCRIPTION**

- A. The Drive shall be solid state, with a Pulse Width Modulated (PWM) output. The drive shall be a Direct Torque Control (DTC) AC to AC converter utilizing the latest isolated gate bipolar transistor (IGBT) technology. The Drive shall employ Direct Torque Control (DTC) inner loop torque control strategy that mathematically determines motor torque and flux every

25 microseconds ( $\mu$ s) (40,000 times per second). The drive must also provide an optional operational mode for scalar or V/Hz operation.

#### B. Ratings

1. The Drive shall be rated to operate from 3-phase power at 230VAC to 500VAC +10/-10%, 48Hz to 63Hz. The Drive shall employ a full wave rectifier to prevent input line notching and operate at a fundamental (displacement) input power factor of 0.97 at all speeds and loads. The Drive efficiency shall be 98% or better at full speed and load. An internally mounted AC line reactor or DC choke shall be provided to reduce input current harmonic content, provide protection from power line transients such as utility power factor correction capacitor switching transients and reduce RFI emissions.
2. The overvoltage trip level shall be a minimum of 30% over nominal, and the under voltage trip level shall be a minimum 35% under the nominal voltage.
3. Output voltage and current ratings shall match the adjustable frequency operating requirements of standard 460VAC, 3ph, 60Hz, NEMA design A or NEMA design B motors. The overload current capacity shall be 110% of rated current for one (1) minute out of five (5). Output frequency shall be adjustable between 0Hz and 300Hz. Operation above motor nameplate shall require programming changes to prevent inadvertent high-speed operation. The drive's switching pattern shall be continually adjusted to provide optimum motor flux and avoid the high-pitched audible noise produced by motors energized by conventional PWM drives. The drive shall be furnished in a UL Type 1 listed enclosure rated for operation at ambient temperatures between 0° and 40°C at an altitude not exceeding 3300 feet, with relative humidity less than 95% and no condensation allowed. The drive shall be protected from atmospheric contamination by chemical gasses and solid particles per IEC 721-3-3, classes 3C2 and 3S2. The drive shall be protected from vibration per IEC 68-2-6 (max.

sinusoidal displacement 1 mm, 5Hz to 13.2Hz and max. acceleration  $7\text{m/s}^2$ , 13.2Hz to 100Hz).

C. Control Functions and Adjustments

1. An intelligent start-up assistant shall be provided as standard. The Start-up assistant will guide the user through all necessary adjustments to optimize operation and will include "plug and produce" operation, which recognizes the addition of options/fieldbus adapters and provides the necessary adjustment assistance.
2. Start-up data entries shall include motor nameplate power, speed, voltage, frequency and current.
3. A motor parameter ID function shall automatically define the motor equivalent circuit used by the sensor less vector torque controller.
4. A PID speed/torque loop regulator shall be provided with an auto tune function as well as manual adjustments.
5. A selection of six (6) preprogrammed application macro parameter sets shall be provided to minimize the number of different parameters to be set during start-up. Macros included as standard are as follows: Factory Default, Hand/Auto, PID Control, Sequential Control, and Torque Control. A selection of two (2) user defined macros shall also be available.
6. Start/Stop control functions shall include two (2) or three-(3) wire start/stop, coast/ramp stop selections, optional dynamic braking and flux braking.
7. The AFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to reference without safety tripping or component damage (flying start). The AFD shall also be capable of flux braking at start to stop a reverse spinning motor prior to ramp.
8. The AFD shall have the ability to automatically restart after an overcurrent, overvoltage, under voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable.

9. Accel/Decel control functions shall include two (2) sets of ramp time adjustments with linear and three (3) s-curve ramp selections.
10. Speed/Torque control functions shall include:
  - a) Adjustable min. /max. speed and/or torque limits
  - b) Selection of up to 15 preset speed settings or external speed control
  - c) Three (3) sets of critical speed lockout adjustments.
  - d) A built-in PID controller to control a process variable such as pressure, flow or fluid level.
  - e) Reference signal processing shall include increase/decrease floating point control and control of both speed/torque and direction using a "joystick" reference signal. Two (2) analog inputs shall be programmable to form a reference by addition, subtraction, multiplication, minimum selection or maximum selection.
11. Output control functions shall include:
  - a) Flux optimization to limit the audible noise produced by the motor and to maximize efficiency by providing the optimum magnetic flux for any given speed/torque operating point.
  - b) Current and torque limit adjustments to limit the maximum Drive output current and the maximum torque produced by the motor. These limits shall govern the inner loop torque regulator to provide tight conformance with the limits with minimum overshoot.
  - c) A torque regulated operating mode with adjustable torque ramp up/down and speed/torque limits.
12. The Drive shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay output shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.

13. The Drive shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.
  14. Two (3) programmable critical frequency lockout ranges to prevent the AFD from operating the load continuously at an unstable speed.
- D. Static and Dynamic Performance
1. Open loop static speed regulation shall be 0.1% to 0.3% (10% of motor slip). When motor speed feedback is provided from a suitable encoder, closed loop speed regulation shall be 0.01% or better. Dynamic speed accuracy shall be 0.3-0.4 %-sec or better open loop and 0.1-0.2 %-sec or better-closed loop.
  2. Torque response time shall be 5ms or less. In the torque regulating mode, torque regulating accuracy shall be 4% or better.
- E. Operator Control Panel (Keypad)
1. Each Drive shall be equipped with a front mounted operator control panel (keypad) consisting of a four- (4-) line by 20-character back-lit alphanumeric display and a keypad with keys for Run/Stop, Local/Remote, Increase/Decrease, reset, menu navigation and parameter select/save.
  2. All parameter names, fault messages, warnings and other information shall be displayed in complete English words or standard English abbreviations to allow the user to understand what is being displayed without the use of a manual or cross-reference table.
  3. Other languages selectable in addition to American English (Am) shall be as follows: English (European), French, Spanish, Portuguese, German, Italian, Dutch, Danish, Swedish, Finnish, Czech and Polish.
  4. The Display shall have contrast adjustment provisions to optimize viewing at any angle.
  5. The control panel shall include a feature for uploading parameter settings to control panel memory and downloading from the control panel to the same drive or to another drive.
  6. All Drives throughout the entire power range shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating.



7. The keypad is to be used for local control, for setting all parameters, and for stepping through the displays and menus.
8. The keypad shall be removable and insertable under drive power, capable of remote mounting, and shall have its own non-volatile memory.
9. During normal operation, one (1) line of the control panel shall display the speed reference, and run/stop forward/reverse and local/remote status. The remaining three (3) lines of the display shall be programmable to display the values of any three (3) operating parameters. At least 26 selections shall be available including the following:
  - a) Speed/torque in percent (%), RPM or user-scaled units
  - b) Output frequency, voltage, current and torque
  - c) Input voltage, power and kilowatt hours
  - d) Heatsink temperature and DC bus voltage
  - e) Status of discrete inputs and outputs
  - f) Values of analog input and output signals
  - g) Values of PID controller reference, feedback and error signals
  - h) Control interface inputs and outputs shall include:

F. I/O Capabilities

1. Six (6) discrete inputs, all independently programmable with at least 25 input function selections. Inputs shall be designed for "dry contact" inputs used with either an internal or external 24 VDC source.
2. A minimum of three (3) form C relay contact outputs, all independently programmable with at least 30 output function selections. Relay contacts shall be rated to switch 2 Amps at 24VDC or 115/230VAC. Function selections shall include indications that the drive is ready, running, reversed and at set speed/torque. General and specific warning and fault indications shall be available. Adjustable supervision limit indications shall be available to indicate programmed values of operating speed, speed reference, current, torque and PID feedback.
3. Three (3) analog inputs, one (1) +/- 0VAC - 10VAC and two (2) 4mA - 20mA, all independently

programmable with at least ten (10) input function selections. A differential input isolation amplifier shall be provided for each input. Analog input signal processing functions shall including scaling adjustments, adjustable filtering and signal inversion. If the input reference (4-20mA or 2-10V) is lost, the AFD shall give the user the option of the following: (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the AFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus.

4. Two (2) analog outputs providing 4mA to 20mA signals. Outputs shall be independently programmable to provide signals proportional to at least 12 output function selections including output speed, frequency, voltage, current and power.

G. Drive Control Communications

1. Communication interface modules shall be provided utilizing Allen Bradley Ethernet communication protocol. Communications modules shall be connected to the drive by Cat. 6 cables via a rj-45 connector I/O shall be accessible through the serial communications adapter.
2. Communication capabilities shall include, but not be limited to, run-stop control; speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, and accel/decel time adjustments. The drive shall have the capability of allowing the Distributed Drive Controller (DDC) to monitor feedback such as process variable feedback, output speed/frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), relay outputs, and diagnostic warning and fault information. Additionally, remote Local Area Network (LAN) VFD fault reset shall be possible. A minimum of 15 field parameters shall be capable of being monitored. The DDC system shall be able to monitor if the motor is running in the AFD mode or bypass mode (if bypass is specified) over serial communications.

3. The AFD shall allow the DDC to control the drive's digital and analog outputs via the Ethernet interface. The ethernet communications interface shall allow for Digital Output DO (relay) control and Analog Output (AO) control. This control shall be independent of any AFD function. Examples of possible DO usage are as follows: Opening check valves, opening discharge valves, starting auxiliary equipment, etc. In addition, the status of the DO's is available over the communications link. Examples of possible AO usage are as follows: Controlling a bypass valve position, throttling valve position, etc. In addition, the status of the AO's is available over the communications link.
4. The AFD shall have built-in to its logic fifteen (15) blocks of adaptive programming capable of twenty (20) different functions. These blocks shall be connectable to drive actual signals and functions allowing the user to tailor the drive to the specific application requirements without additional hardware. These blocks shall be programmable through the standard operator panel and through the use of a DriveAP Microsoft Windows®-based software.

#### H. Protective Functions

1. For each programmed warning and fault protection function, the drive shall display a message in complete English words or Standard English abbreviations. The five (5) most recent fault messages and times shall be stored in the drive's fault history.
2. The drive shall include internal MOV's for phase to phase and phase to ground line voltage transient protection.
3. Output short circuit and ground fault protection rated for 65,000 amps shall be provided per UL508C without relying on line fuses. Motor phase loss protection shall be provided.
4. The drive shall provide electronic motor overload protection qualified per UL508C.
5. Protection shall be provided for AC line or DC bus overvoltage at 130% of maximum rated voltage or under voltage at 65% of min. rated voltage and input phase loss.

6. A power loss ride through feature will allow the drive to remain fully operational after losing power as long as kinetic energy can be recovered from the rotating mass of the motor and load.
7. Stall protection shall be programmable to provide a warning or stop the drive after the motor has operated above a programmed torque level for a programmed time limit.
8. Underload protection shall be programmable to provide a warning or stop the drive after the motor has operated below a selected underload curve for a programmed time limit.
9. Over-temperature protection shall provide a warning if the power module temperature is less than 5°C below the over-temperature trip level.
10. Input terminals shall be provided for connecting a motor thermistor (PTC type) to the drive's protective monitoring circuitry. An input shall also be programmable to monitor an external relay or switch contact (klixon).

## 2.03 OPERATOR CONTROLS

- A. Industrial rated control operators and pilot devices shall be door mounted and used independently of the keypad display control modes of Hand-Off-Auto, VFD-OFF-BYPASS, etc. as required. The Keypad Display shall be mounted on front of the drive cabinet.

Control modes shall function as follows:

1. Hand - The Hand mode shall allow manual operation of start, stop and speed control. The AC drive shall start when the control operator is in the Hand mode and run at low speed setting of the drive or higher as required by the position of the manual speed potentiometer. This mode shall function as 2-wire control and automatically restart after a power outage or auto restart after fault.
2. Off - The "Off" position of the control operator shall stop the AC drive and prevent it from restarting while in the "Off" position. This position shall also reset the AC Drive after a fault condition has occurred.

3. Auto - The Automatic mode shall receive an auto start contact to control start and stop of the AC Drive. This contact shall also start and stop bypass (if used) when both the Automatic mode and Bypass modes of operations are selected. In Automatic mode the user shall remotely reset the AC Drive by opening and closing the Auto-start contact. Speed control shall be from a customer supplied 4-20mA signal.
- B. The AC Drive shall include door-mounted "VFD Run", "VFD Fault", "External/MOL Fault" and "Bypass Run" pilot lights. All pilot lights shall Utilize LED lamps.

#### **2.04 SYSTEM CONTROL AND INTERFACE REQUIREMENTS**

- A. The following additional controls and interface requirements shall be provided:
  1. Seal Water Solenoid - The AC Drive shall provide 120Vac/50VA to operate the seal water solenoid whenever the motor is energized.
  2. Check Valve Sequencing - The AC Drive shall provide a circuit that shuts down the drive whenever a user supplied check valve limit switch does not open within a specified time. This circuit shall provide an illuminated reset push button to indicate improper sequence.
  3. Provide N.C. Contacts and 120V AC power source for motor winding space heater.
  4. Auxiliary Contacts - The AC Drive shall provide the following auxiliary contacts to indicate the following conditions:
    - 1 N.O. contact to indicate DRIVE RUN
    - 1 N.O. contact to indicate VFD FAULT
    - 1 N.O. contact to indicate BYPASS RUN
    - 1 N.O. contact to indicate AUTO MODE
    - 1 N.O. contact to indicate HAND MODE

#### **2.05 EMERGENCY FULL SPEED REQUIREMENTS (BYPASS)**

- A. The AC Drive shall include fully rated isolation and bypass contactors complete with Class 20 thermal

overload relay protection for emergency full speed capability. Bypass and isolation contactor shall be interlocked. Emergency full speed bypass starters for motors larger than 75 HP shall be solid state reduced voltage soft starter. Bypass and isolation contactors shall be integrated construction configuration.

1. Integrated bypass shall consist of integrating bypass and isolation contactors into the same enclosure compartment as the AC drive controller if space permits. One disconnect shall be common to the drive controller and bypass contactor.
- B. Manual transfer to bypass function shall be provided in the event of drive fault or failure. This feature shall be enabled or disabled by an internally mounted selector switch. An adjustable timer shall provide control of the delay time between fault and transfer to bypass.

## **2.06 HARMONIC MITIGATION EQUIPMENT REQUIREMENTS**

- A. The AC Drive shall be provided with a line reactor mounted inside the enclosure.

## **PART 3 EXECUTION**

### **3.01 INSPECTION**

- A. Verify that the location is ready to receive work and the dimensions are as indicated.
- B. Do not install AC Drive equipment until the building environment can be maintained within the service conditions required by the manufacturer.

### **3.02 PROTECTION**

- A. Before and during the installation, the AC Drive equipment shall be protected from site contaminants and debris in accordance with the manufacturer's recommendations.

### **3.03 INSTALLATION**

- A. The Drive manufacturer shall provide adequate drawings and instruction material to facilitate installation of the Drive by the Contractor. Installation shall

comply with manufacturer's instructions, drawings and recommendations.

- B. The AC Drive manufacturer shall provide a factory certified technical representative to supervise the Contractor's installation, testing and start-up of the AC Drives furnished under this specification as required. The technical representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations. A Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer. A copy of all drives configuration parameters and their associated settings programmed into each VFD shall be provided to the Owner at the completion of start-up and shall be included in the final O&M.

#### **3.04        TRAINING**

- A. The AC Drive manufacturer shall arrange for an on-site training course of a minimum of 2 training days, provided by a representative of the AC Drive manufacturer plant and/or maintenance personnel.

**END OF SECTION**





## **SECTION 16500**

### **LIGHTING**

#### **PART 1 GENERAL**

##### **1.01 THE REQUIREMENT**

- A. The Contractor shall furnish all labor, materials, tools and equipment necessary for furnishing, installing, connecting, testing and placing into satisfactory operation all lighting fixtures, lamps, contactors, controls, supports, etc. as required for a complete and operational lighting system as specified herein and indicated on the Contract Drawings.
- B. Lighting shall be in accordance with the latest requirements of the Illuminating Engineering Society, and all lighting fixtures shall have the Underwriters Laboratories, Inc. label of approval.
- C. All wiring shall be placed in conduit and shall comply with the Specifications for conduit, outlet boxes, pull and junction boxes, wires and cables, grounding, and other Sections as set forth in these Specifications and as noted herein.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Specification Section 16010 - Electrical Basic Requirements.

##### **1.03 SUBMITTALS**

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples. The Contractor shall provide submittals to include the following:
  - 1. Equipment specifications and product data sheets identifying all materials used and methods of fabrication.
  - 2. Catalog cuts for each lighting fixture type showing performance and construction details of standard lighting fixtures, and complete working drawings showing all proposed construction details of special or modified standard lighting fixtures.
  - 3. Photometric curves
  - 4. Photometric plans shall be provided if substitutions are made from the equipment shown or

specified. Data shall be submitted electronically in an approved Engineer format.

5. Lamp data
6. Ballast information
7. Catalog data including applicable coefficients of utilization tables, isolux chart of illumination on a horizontal plane, beam efficiency, horizontal and vertical beam spread, and beam lumens.
8. Wind-load calculations for light poles

#### **1.04 OPERATIONS AND MAINTENANCE MANUALS**

- A. Operations and Maintenance Manuals shall be submitted as outlined in Specification 01730 - Operation and Maintenance Data.

### **PART 2 PRODUCTS**

#### **2.01 GENERAL REQUIREMENTS**

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable firms regularly engaged in the manufacturing of lighting equipment, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Contract Drawings.
- B. Manufacturer's catalog number and description in the lighting fixture schedule on the Contract Drawings establishes a level of quality, style, finish, etc. The use of a catalog number describing the various types of light fixtures shall be used as a guide only, and does not exclude all the required accessories or hardware that may be required for a complete installation.
- C. All products shall be UL listed and meet the requirements of the National Electrical Code (NEC). Electrical components shall be listed and labeled by U.L.

#### **2.02 TOOLS, SUPPLIES, AND SPARE PARTS:**

- A. The Contractor shall provide to the Owner, for each equipment item, the following:

1. Special tools necessary to disassemble, service, repair and adjust the equipment.
2. All spare parts as recommended by the equipment manufacturer.
3. A minimum two (2) or one (1) ballast for every ten (10) ballasts (of the same type) installed; whichever is greater.
4. A minimum of one (1) lamp for every five (5) lamps (of the same type) installed; whichever is greater.

#### **2.03 LIGHTING CONTROLS**

- A. The lighting systems shall be controlled as specified herein and indicated on the Contract Drawings.
- B. Lighting contactors shall be furnished and installed for specific lighting control applications as specified herein and indicated on the Contract Drawings.

#### **2.04 EXTERNALLY MOUNTED PHOTOCELL SWITCHES**

- A. Hermetically sealed cadmium sulfide cell with single-throw contacts rated for 277V for 1800VA. The photocell switch shall be housed within a die-cast, vandal and impact resistant enclosure. Designed to turn on at level below 3 footcandles and off at 3 to 10 footcandles. A 15 second time delay to prevent switching from transient light sources. Directional lens, mounted in front of cell, to prevent fixed light sources from turning unit off. Temperature range -40F to +170F. Power consumption less than 1.4W average.

#### **2.05 LIGHT FIXTURES**

- A. Light fixture leads shall be as required by the NEC.
- B. All glassware shall be high quality, homogeneous in texture, uniform in quality, free from defects, of uniform thickness throughout and properly annealed. Edges shall be well rounded and free from chips or rough edges.
- C. Refer to the lighting fixture schedule on the Contract Drawings.

#### **2.06 BALLASTS**

- A. Where available, ballasts shall be as manufactured by the lighting fixture manufacturer. Ballasts for fluorescent light fixtures shall be rapid-start, high

efficiency and high power factor, with certification by ETL, CBM and Underwriters Laboratories, Inc. Ballasts shall have copper windings. All ballasts for indoor fluorescent light fixtures shall be equipped with an internal, thermally actuated automatic reclosing protection device. Ballasts shall be guaranteed against service failure for a period of two (2) years. Ballasts shall be rated "Class P" to agree with requirements of 410-73 (e) and other applicable articles of the NEC, to conform to the time schedule for this requirement, and shall be Class A sound rated.

- B. Ballasts for HID light fixtures shall have copper windings and shall be high power factor, constant wattage autotransformer (CWA) (i.e. lead type for high pressure sodium or peak lead type for metal halide), or constant wattage (CW) with certification by ETL, CBM and Underwriters Laboratories, Inc. All ballasts for HID light fixtures shall be Class "H" insulated, encapsulated for quiet operation, and shall have an integral thermal protector.
- C. All outdoor light fixtures and lighting fixtures located in unheated areas shall be furnished and installed with ballasts rated for outdoor installation.
- D. Light fixtures shown or specified to be controlled by dimmers shall be furnished with suitable dimming ballasts.
- E. Ballasts shall be as manufactured by Holophane, Universal, Advance, or equal.

## **2.07 LAMPS**

- A. The Contractor shall furnish and install lamps in all light fixtures. Lamps shall be of the following types:
  - 1. Compact Fluorescent: 120VAC
  - 2. Fluorescent: Rapid-Start, Low Level Mercury
  - 3. HID: High Pressure Sodium, or Metal Halide
- B. Lamps shall be as manufactured by:
  - 1. General Electric Company
  - 2. Sylvania Lighting Equipment
  - 3. Phillips Lighting Company
  - 4. Approved equal

## **2.08 LIGHT POLES**

- A. Pole mounted light fixtures shall be mounted on light poles as designated in the lighting fixture schedule or as indicated on the Contract Drawings. Light poles shall be designed for wind loading in accordance with the latest edition of the Florida Building Code for 3 second gust wind speeds per specific site location.
- B. The Contractor shall furnish and install a concrete foundation for all light poles as required or as indicated on the Contract Drawings. All anchor bolts and nuts shall be stainless steel and provided by the light pole manufacturer.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Lighting fixtures shall be located symmetrically with architectural lines and landscape features as shown on the Contract Drawings. The Contractor shall furnish and install the light fixtures to allow "convenient" access for maintenance such as cleaning, relamping, and other activities. The light fixtures shall be installed to be accessed by a 25FT ladder. Where light fixtures are shown in locations on the Contract Drawings where maintenance would be difficult, the Contractor shall notify the Engineer.
- B. The Contractor shall provide and install all inserts, conduit, structural supports, lamps, ballasts, poles, wiring, and any other items as required for a complete system. Contractor shall properly adjust and test, to the satisfaction of the Engineer, the entire lighting system.
- C. The Contractor shall furnish and install all pendant trapezes and pendant stem hangers with durable swivel or equivalent trapeze hanger permitting normal light fixture motion and self-alignment. Light fixture pendants shall be type UNJ ball type flexible hanger at the light fixture and supports from a JBLX junction box with JBLX hub cover, or approved equal. Pendant lengths shall be adequate and adjusted to provide uniformity of installation heights above the reference datum. Stems shall be one-piece, with matching canopies and fittings.
- D. Light fixtures located on the exterior of the building shall be provided with neoprene gasket and non-ferrous metal screws finished to match the light fixtures.
- E. The finish or exposed metal parts of light fixtures and finish trims of all recessed light fixtures shall be as directed by the Engineer.

- F. The Contractor shall furnish and install recessed light fixtures with a separate junction box concealed and located as to be accessible when the light fixture is removed.
- G. The Contractor shall furnish and install all boxes for light fixtures such that the box is not the sole support of the light fixture. The boxes shall be offset to allow maintenance such that access to wiring within the box can be attained without having to consider supporting the light fixture.
- H. All lighting units, when installed, shall be set true and be free of light leaks, warps, dents, and other irregularities. All hangers, cables, supports, channels, and brackets of all kinds for safely erecting this equipment in place, shall be furnished and erected in place by the Contractor.
- I. The Contractor shall install light fixtures at mounting heights indicated on the Contract Drawings or the Engineer. In areas with exposed ducts and/or piping, installation of light fixtures shall be adapted to field conditions as determined by the Engineer.
- J. The Contractor shall support each light fixture securely. Each light fixture shall be secured to the building structure. The Contractor shall not secure light fixtures to the work of other trades, unless specified or noted otherwise, and shall not support light fixtures to plaster. The Contractor shall furnish and install all steel members and supports as required to fasten and suspended light fixtures from the structure.
- K. In all mechanical equipment areas, the Contractor shall install light fixtures on the ceiling after all piping and equipment therein has been installed. Exact locations for such light fixtures may be determined by the Engineer on the site during the course of the work.
- L. Upon completion of work, and after indoor areas are cleaned, all lighting fixtures shall be made clean and free of dust and all other foreign matter both on visible surfaces, and on surfaces that affect the lighting performance of the light fixture including diffusers, lenses, louvers, reflectors, and lamps.
- M. All light fixtures that require physical adjustment shall be so adjusted in accordance with the directions of the Engineer. The Contractor shall also adjust angular direction of light fixtures and/or lamps, as directed.

- N. Relamping access shall require no special tools. All optical control surfaces such as lenses and reflectors shall be safely and securely attached to lighting fixtures and shall be easily and quickly removed and replaced for cleaning without the use of tools. No light fixture part that may be removed, for maintenance, shall be held in place by metal tabs that must be bent to remove said part.
- O. Pole mounted light fixtures shall be mounted on poles as designated in the lighting fixture schedule or as indicated on the Contract Drawings. All metal poles shall be bonded to the site grounding system. Poles shall have adequate handholes and weatherproof receptacles where indicated.
- P. The Contractor shall furnish and install switches as indicated on the Contract Drawings. Switches shall be installed in accordance Specification Section 16140 - Wiring Devices.
- Q. The Contractor shall furnish and install time switches or photocells as specified herein or indicated on the Contract Drawings
- R. All exterior light fixtures mounted on concrete or masonry shall be caulked with approved color matching compounds.
- S. The Contractor shall protect all light fixtures and light poles at all times. Before final acceptance, by the Engineer, all light fixtures, light poles and associated devices shall be:
  - 1. Operating condition
  - 2. Free of any scraps, dents or chips in the finish
  - 3. Cleaned of all dust, dirt or other material
  - 4. Fully lamped

**END OF SECTION**





## **SECTION 16671**

### **TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) 1kV OR LESS**

#### **PART 1 GENERAL**

##### **1.01 THE REQUIREMENT**

- A. The Contractor shall furnish and install the Transient Voltage Surge Suppression (TVSS) equipment having the electrical characteristics, ratings and modifications as specified herein and as shown on the Contract Drawings.
- B. The TVSS equipment shall provide effective high-energy protection against transient surges, temporary over voltages, voltage swells and high-frequency noise attenuation for power, control and telephone/data circuits 1kV or less and as shown on the Contract Drawings.
- C. The TVSS units and all components shall be designed, manufactured and tested in accordance with the latest applicable UL standards.
- D. The TVSS equipment installation shall conform to local code requirements and the National Electric Code (NEC).
- E. All materials and workmanship shall be of the highest quality.

##### **1.02 DEFINITIONS**

- A. EMI: ElectroMagnetic Interference
- B. NTRL: Nationally Recognized Testing Laboratory
- C. SCCR: Short Circuit Current Rating
- D. SPD: Surge Protection Device
  - 1. Type-I: Permanently connected between the secondary of the utility transformer and the line or load side of the service entrance overcurrent device and intended to be installed without an external overcurrent device.
  - 2. Type-II: Permanently connected to the load side of the service entrance overcurrent device including branch circuit panels.

- 3. Type-III: Connected from the electrical service panel to the point of utilization with a minimum conductor length of 30 FT.
- 4. Type-IV: Component and/or component assemblies.
- E. SVR: Suppressed Voltage Rating
- F. TOV: Temporary Over Voltage
- G. TVSS: Transient Voltage Surge Suppressor

### **1.03 QUALITY ASSURANCE**

#### **A. Referenced Standards:**

- 1. Institute of Electrical and Electronics Engineers (IEEE):
  - a) C62.41, IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits.
  - b) C62.43, IEEE Certified by NRTL as "Secondary Surge Arrestor"
  - c) C62.45, IEEE Guide for Surge Testing for Equipment Connected to Low-Voltage AC Power.
- 2. International Electrotechnical Commission (IEC):
  - a) 61024, Protection of Structures against Lightning.
- 3. National Electrical Manufacturers Association (NEMA):
  - a) LS-1 (1992), Low Voltage Surge Protection Devices
- 4. National Fire Protection Association (NFPA):
  - a) NFPA 70, National Electrical Code (NEC) Article 285.
- 5. Underwriters Laboratories, Inc (UL):
  - a) 1283, Electromagnetic Interference Filters
  - b) 1449, Transient Voltage Surge Suppressors

#### **1.04 SUBMITTALS**

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples.
- B. Product Data: For each type of product indicated, include unit dimensions, weights, installation instructions, wiring details, rated capacities, operating characteristics, furnish specialties and accessories. Include the following documents:
  - 1. Suppressed Voltage Rating
  - 2. Symmetrical Fault Current Withstand Ratings
  - 3. Provide independent third-party testing lab report indicating device is capable of surviving the specified number of 8x20 micro-second waveforms.
  - 4. Spectrum Analysis based on MIL-STD-220A test procedures between 50 kHz and 200 kHz verifying the device noise attenuation equals or exceeds 50 dB at 100 kHz.
  - 5. Survivability of multiple TOV events for Type-I and Type-II devices.
- C. Product Certificates: For TVSS/SPD devices, signed by third-party NRTL testing agencies certifying compliance with the following standards:
  - 1. UL 1283
  - 2. UL 1449 Second Edition 2005 Revision
  - 3. IEEE C62.34 Secondary Surge Arrestor
  - 4. NEMA LS-1 (1992) Low Voltage Surge Protective Devices
- D. Qualification Data: Third-Party testing lab or U.S. Department of Labor/OSHA approved NRTL.
- E. Field Quality-Control test reports, including the following:
  - 1. Test procedures used. Include single impulse testing data that matches label rating, including fuses or upstream breaker.
  - 2. Test results that comply with requirements.

3. Failed test results and corrective actions taken to achieve requirements.
- F. Operation and Maintenance Manuals shall be submitted as outlined in Specification 01730 - Operation and Maintenance Data. For each type or series of TVSS/SPD devices to include emergency, operation and maintenance manuals.
  - G. Warranties: The manufacturer shall provide a full ten (10) year warranty from the date of installation against any TVSS/SPD device part failure when installed in compliance with manufacturer's written instructions and any applicable national or local codes.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Subject to compliance with requirements, provide products by one of the following manufacturers:
  1. Advanced Protection Technologies Inc.
  2. Current Technology
  3. Eaton/ Cutler Hammer
  4. Innovative Technology
  5. General Electric
  6. Square-D
  7. Approved Equivalent

### **2.02 SERVICE ENTRANCE SPD (TYPE-I)**

- A. Surge Protection Device Description: Modular design with field-replaceable module with EMI filtering and the following features:
  1. The SPD unit tested at 200kA interrupting capacity (AIC).
  2. The SPD unit shall provide overvoltage protection as follows:
    - a) >1800 cycles at 180% of rated voltage to 0.7 OHM load
    - b) Test Report included

3. Fabrication using bolted compression lugs for internal wiring.
  4. Utilizing copper bus bars, wire connections and bolted connections to phase buses, neutral bus and ground bus.
  5. Integral disconnect switch capable of passing full rated surge current.
  6. Multiple suppression circuits with current sharing.
  7. LED indicator lights for power and protection status.
  8. Monitoring system capable of the following:
    - a) Number of transient surges, overvoltages and undervoltages
    - b) Neutral-to-ground voltage and current
    - c) EMI filter status
    - d) Percentage of protection available
  9. Audible alarm with silencing switch to indicate when protection has failed.
  10. Dual set of dry contacts rated at 5A and 250VAC for remote monitoring of protection status.
  11. Field testable with test data from factory provided comparison.
  12. Field replaceable surge protection modules.
- B. Peak Single-Impulse Surge Current Rating of 200kA per mode.
- C. Connection Means: Permanent
- D. Protection modes and UL 1449 SVR for voltages of 480/277V, 3-Phase, 4-Wire, grounded wye circuits shall be as follows:
1. Line to Neutral: 800V
  2. Line to Ground: 1000V
  3. Neutral to Ground: 900V

- E. EMI noise rejection or attenuation values shall be in compliance with test and evaluation procedures outlined in NEMA LS-1 1992.

## **2.03 MOTOR CONTROL CENTER (MCC) SPD (TYPE-II)**

- A. Surge Protection Device Description: Modular design with field-replaceable module mounted externally to the MCC with EMI filtering and the following features:
  - 1. Supplied with fuses rated at 200kA interrupting capacity (AIC).
  - 2. Fabrication using bolted compression lugs for internal wiring.
  - 3. Utilizing wire connections to phase buses, neutral bus and ground bus.
  - 4. Multiple suppression circuits with current sharing.
  - 5. LED indicator lights for power and protection status.
  - 6. Monitoring system capable of the following
    - a) Number of transient surges, overvoltages and undervoltages
    - b) Neutral-to-ground voltage and current
    - c) Percentage of protection available
  - 7. Audible alarm with silencing switch to indicate when protection has failed.
  - 8. Dual set of dry contacts rated at 5A and 250VAC for remote monitoring of protection status.
  - 9. Field testable with test data from factory provided comparison.
  - 10. Field replaceable surge protection modules.
- B. Peak Single-Impulse Surge Current Rating of 100kA per mode.
- C. Connection Means: Permanent
- D. Protection modes and UL 1449 SVR for voltages of 480/277V, 3-Phase, 4-Wire, grounded wye circuits shall be as follows:

1. Line to Neutral: 900V
  2. Line to Ground: 900V
  3. Neutral to Ground: 900V
- E. EMI noise rejection or attenuation values shall be in compliance with test and evaluation procedures outlined in NEMA LS-1 1992.

#### **2.04 LIGHTING PANELBOARD SPD (TYPE-II)**

- A. Surge Protection Device Description: Modular design with field-replaceable module mounted externally to the panelboard with EMI filtering and the following features:
1. Supplied with fuses rated at 200kA interrupting capacity (AIC).
  2. Fabrication using bolted compression lugs for internal wiring.
  3. Utilizing wire connections to phase buses, neutral bus and ground bus.
  4. Multiple suppression circuits with current sharing.
  5. LED indicator lights for power and protection status.
  6. Monitoring system capable of the following
    - a) Number of transient surges, overvoltages and undervoltages
    - b) Neutral-to-ground voltage and current
    - c) Percentage of protection available
  7. Audible alarm with silencing switch to indicate when protection has failed.
  8. Field testable with test data from factory provided comparison.
  9. Field replaceable surge protection modules.
- B. Peak Single-Impulse Surge Current Rating of 80kA per mode.
- C. Connection Means: Permanent

- D. Protection modes and UL 1449 SVR for voltages of 208/120V, 3-Phase, 4-Wire, grounded wye circuits shall be as follows:
  - 1. Line to Neutral: 400V
  - 2. Line to Ground: 500V
  - 3. Neutral to Ground: 500V
- E. EMI noise rejection or attenuation values shall be in compliance with test and evaluation procedures outlined in NEMA LS-1 1992.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION OF SURGE PROTECTION DEVICE (SPD)**

- A. For Dual Rated Surge Protection (listed as both Surge Arrestor and SPD) for service entrance, product can be placed on either Line or Load side of the Service Entrance Equipment.
  - 1. Provide and install circuit breakers or fuses as shown on the Contract Drawings.
- B. For all remaining SPD devices:
  - 1. Provide and install circuit breakers or fuses as shown on the Contract Drawings.
- C. Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do NOT exceed manufacturer's recommended lead length. Do NOT connect neutral and ground leads together.
- D. SPD devices shall NOT be integrated with Switchgear or Panelboards as recommended by IEEE-1100, Section 8.4.2.5.
- E. All SPD devices shall have the raceway between the SPD and the switchgear enclosure sealed with approved fire sealant. The sealant shall prevent vapors from entering the switchgear enclosure.

#### **3.02 PLACING EQUIPMENT INTO SERVICE**

- A. Do not energize or connect service entrance equipment, panelboards, control panels or telephone/data equipment to their sources until surge protection devices are installed and connected.



### **3.03 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Contractor shall engage a factory-authorized service representative to perform inspections, field tests and adjustments to the equipment including all connections. Service Representative shall report results in writing to the Engineer.
1. Verify that the electrical wiring installation complies with manufacturer's written installation instructions and requirements.
  2. After installation of SPD devices but before circuitry has been energized, test for compliance with requirements.
  3. Complete installation checks according to manufacturer's written instructions.
  4. Remove and replace malfunctioning SPD devices and retest as specified as above.

**END OF SECTION**



## **SECTION 16960**

### **ELECTRICAL EQUIPMENT TESTING**

#### **PART 1 GENERAL**

##### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions, Supplementary Conditions (if included), and Division 1 Specifications Sections, apply to this Section.

##### **1.02 SECTION INCLUDES**

- A. Electrical equipment test reports.

##### **1.03 SUBMITTALS**

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples.
- B. All testing shall be performed by a third party independent testing company certified by the International Electrical Testing Association (NETA).
- C. Motor Circuit Test Reports: Complete Motor Circuit Test Report for each three-phase motor 5 HP and above.
- D. Low Voltage Feeder Insulation Test Reports: Complete the Low Voltage Feeder Insulation Test Report for each single-phase and three-phase feeder rated 100 amperes and above.
- E. Ground Resistance Test Reports: Complete the Ground Resistance Test Report for each structure that receives a service or a feeder.
- F. Medium and High Voltage Feeder Insulation Test Reports: Complete the Medium and High Voltage Feeder Insulation Test Report for each medium and high voltage feeder and motor circuit.
- G. Manufacturer's insulation testing instructions for medium and high voltage cable.

##### **1.04 OPERATION AND MAINTENANCE MANUALS**

- A. Operations and Maintenance Manuals shall be submitted as outlined in Specification 01730 - Operation and Maintenance Data.

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION**

**3.01 FIELD QUALITY CONTROL**

- A. Use an ohmmeter for motor winding resistance testing. Perform in accordance with ohmmeter manufacturer's instructions.
- B. Use a ground resistance test instrument for ground resistance testing. Perform testing in accordance with test instrument manufacturer's instructions. Perform test in normally dry weather, not less than 48 hours after rainfall.
- C. Use a 1000 VDC megohms meter for low voltage insulation testing. Perform testing in accordance with megohms meter manufacturer's instructions.
- D. Use suitable test instruments for medium and high voltage insulation testing. Perform testing in accordance with test instrument manufacturer's instructions.
  - 1. Individually test each conductor with all other conductors and all shields grounded.
  - 2. Provide proper corona suppression at each termination using a guard ring or other suitable method.
  - 3. Apply DC hypotential in at least eight equal increments until maximum test voltage is reached. Record the DC leakage current at each step after a constant stabilization time consistent with system charging current decay.
  - 4. Hold the test voltage at the maximum level for 10 minutes. Record the DC leakage current every 30 seconds for the first 2 minutes, and then every minute thereafter.

5. Reduce the test voltage to zero and apply ground to tested conductor for a period adequate to drain all potential stored in the insulation.
6. Make a graphic plot of the leakage current versus the test voltage at each step and continue plot with leakage current versus time based upon the recorded values.
7. Maximum Test Voltage: IEEE and manufacturer's stated levels.
8. Use an ohmmeter to test shield continuity and record values measured.
9. Replace conductors and cable which indicate poor insulation levels as determined by the ENGINEER. Do not splice as a means of repair.
10. Install additional ground rods as required to achieve specified ground resistance. See Section 16450 - Grounding and Bonding.

### 3.02 REPORT FORMS

#### A. Motor Circuit Test Report

Equipment \_\_\_\_\_ Location \_\_\_\_\_  
 Manufacturer \_\_\_\_\_ Frame \_\_\_\_\_  
 Horsepower \_\_\_\_\_ Phase \_\_\_\_\_ RPM \_\_\_\_\_ Service Voltage \_\_\_\_\_  
 Motor Overload \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Nameplate Volts\* \_\_\_\_\_ Running Volts\* \_\_\_\_\_  
 Nameplate Amperes\* \_\_\_\_\_ Running Amperes\* \_\_\_\_\_  
 Nameplate Locked Rotor Amps \_\_\_\_\_ Nameplate Power Factor \_\_\_\_\_ % Nameplate Efficiency \_\_\_\_\_ %  
 Insulation Class \_\_\_\_\_ Starting Code \_\_\_\_\_  
 Feeder runs from \_\_\_\_\_  
 Feeder Wire Size \_\_\_\_\_ Insulating Voltage Rating \_\_\_\_\_ Insulation Type \_\_\_\_\_

\* Give armature/field for DC motors.

1. Motor Winding Resistance Test (multi-meter)

Winding	Resistance (ohms)
A to B	
B to C	
C to A	

2. Motor Feeder/Winding Insulation Test (Megohm Meter)

- Perform the following test AFTER connecting the feeder to the motor.
- Test from load side of motor controller.
- Readings must be greater than 50 Megohms.

Phase	Megohms at 1000 VCD
A to Ground	
B to Ground	
C to Ground	

Testing performed by \_\_\_\_\_ Date: \_\_\_\_\_

Testing Witnessed by \_\_\_\_\_

B. Feeder Insulation Test Report

1. Perform test BEFORE terminating feeder to equipment.

Feeder runs from \_\_\_\_\_

Feeder runs to \_\_\_\_\_

Wire Size \_\_\_\_\_ Insulation Voltage Rating \_\_\_\_\_ Insulation Type \_\_\_\_\_

Readings must be greater than 50 Megohms.

Phase	Megohms at 1000 VDC
A to Ground	
B to Ground	
C to Ground	

Testing performed by \_\_\_\_\_ Date: \_\_\_\_\_

Testing Witnessed by \_\_\_\_\_

**COMMENTS**

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### C. Grounding Test Report

Type of Ground \_\_\_\_\_  
(Single Rod or Multiple Rod - Provide Quantity)

Location \_\_\_\_\_

Date \_\_\_\_\_  
Installed \_\_\_\_\_

Weather Conditions(Temp, Humidity) \_\_\_\_\_

Date of Last Rain \_\_\_\_\_

Ground Resistance (ohms) \_\_\_\_\_

Testing Performed by \_\_\_\_\_ Date: \_\_\_\_\_

Testing Witnessed by \_\_\_\_\_

## COMMENTS

[illegible]



#### D. Hi-Pot Test Report

[illegible]

END OF SECTION



## **GEOTECHNICAL ENGINEERING SERVICES REPORT**

For the

**SWWRF LAKE FILTRATION SYSTEM AND  
NORTH POND IMPROVEMENTS  
BRADENTON, FLORIDA**

Prepared for

**McKim & Creed  
North Village Professional Center  
3802 Erlich Road, Suite 306  
Tampa, Florida 33624**


Prepared by

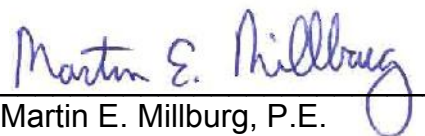
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**McKim & Creed Project Code 01024-0147**

**PSI Project No. 775-871**

**March 31, 2011**

  
David S. Harris, P.E.  
Project Engineer  
Florida License No. 68377

  
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SHEET 1 – BORING LOCATION PLAN  
SHEET 2-4 – SOIL BORING PROFILES

# 1.0 PROJECT INFORMATION

## 1.1 PROJECT AUTHORIZATION

Written authorization to proceed with this project was provided through McKim & Creed Project No. 01024-0147 on November 10, 2010. This study was conducted in accordance with our written proposal for these services dated June 25, 2010 (Reissued September 9, 2010), PSI Proposal No. 775-24362.

## 1.2 PROJECT DESCRIPTION

We understand that improvements are to be made to the Southwest Water Reclamation Facility (SWWRF) in Bradenton, Florida. The north pond at this facility covers an area approximately 1,000 by 1,500 feet in plan. The southeast portion of the pond area, covering approximately 500 by 300 feet, is land. The pond will be converted to a 18 million gallon (MG) lined reject pond and a lined Part III reclaimed water (RCW) storage pond with a berm separating the two. The proposed pond will have a depth of 10 to 12 feet with three feet of freeboard and 4H:1V slopes along the berm. PSI was requested to provide subsurface soil and information for the design of the proposed pond improvements.

The site has minimal vegetation, with shrubbery lining the berm. Some erosion was observed along the berm on the pond side, apparently due to runoff from the ridge. A survey provided by McKim & Creed gives an average elevation of 30' at the top of the berm, 14' along the shore, and 10' at the pond bottom. Pond water depths in December 2010 ranged from about 5.5' to 7'. The existing berm has slopes ranging from 1.5:1 to 2.5:1.



**Photo shows slopes along berm and reclaimed water pump station.**

A filtration structure about 1,500 square feet is planned. This structure is planned to be about 10 feet tall and is anticipated to have a mat foundation. A maximum bearing pressure on the mat foundation of about 1,000 psf is anticipated.

Should any of the above information or assumptions made by PSI be inconsistent with the planned construction, we request that you contact us immediately to allow us to make any necessary modifications to the recommendations contained herein.

### **1.3 PURPOSE AND SCOPE OF WORK**

The purpose of this study is to provide subsurface information for the proposed stormwater pond improvements. In this regard, engineering assessments of the following items have been formulated:

1. A discussion of subsurface conditions encountered including pertinent soil properties, water levels, and estimated seasonal high water levels.
2. Evaluation on the stability of the berm in its current state and configuration as well as recommendations relating to pond capacity based on the findings
3. Recommendations for improving the long term stability of the berm
4. Recommendations relating to maintenance and inspection of the berm
5. Pond design criteria including depth to the seasonal high groundwater and the suitability of existing soils for liner bedding purposes.

The following services have been provided in order to achieve the preceding objectives:

#### **1.3.1 LAKE FILTRATION STUDY**

1. Executed a program of subsurface exploration consisting of subsurface sampling and field-testing. PSI performed two (2) Standard Penetration Test (SPT) boring to depths ranging from 20 to 30 feet below the ground surface. Samples were collected virtually continuously for the top 10 feet and on intervals of 5 feet thereafter. Representative soil samples were returned to the Tampa office for visual classification and testing.
2. Visually classified representative soil samples in the laboratory using the Unified Soil Classification System (USCS). Conducted a limited laboratory testing program. Identified soil conditions at each boring location and formed an opinion of the site soil stratigraphy.
3. Observed groundwater level measurements and estimated normal wet seasonal high groundwater levels.
4. The results of the exploration have been used in the engineering analysis and the formulation of recommendations. The results of the subsurface exploration, including the recommendations and the data on

which they are based, are presented in this report supervised by a professional engineer.

### **1.3.2 POND LINING STUDY**

1. Executed a program of subsurface exploration consisting of subsurface sampling and field-testing. As requested, we performed eleven (11) Standard Penetration Test (SPT) borings extending 20 feet into the underlying sediment within the pond, and twenty one (21) SPT borings to a depth of 30 feet along the pond perimeter. Samples were collected virtually continuously for the top 10 feet and on intervals of 5 feet thereafter. Representative soil samples were returned to the Tampa office for visual classification and testing.
2. Visually classified representative soil samples in the laboratory using the Unified Soil Classification System (USCS). Conducted a limited laboratory testing program. Identified soil conditions at each boring location and formed an opinion of the site soil stratigraphy.
3. Observed groundwater level measurements and estimated normal wet seasonal high groundwater levels.
4. Completed a field reconnaissance of the berm including photo documentation of areas with suspected signs of erosion or seepage, if present.
5. The results of the exploration have been used in the engineering analysis and the formulation of recommendations. The results of the subsurface exploration, including the recommendations and the data on which they are based, are presented in this report supervised by a Professional Engineer.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands or hazardous or toxic materials in the soil, bedrock, ground water, or air, on or below or around this site. Any statements in this report or on the boring logs regarding odors, unusual or suspicious items or conditions are strictly for the information of our client.

## **2.0 SUBSURFACE CONDITIONS**

### **2.1 SOIL BORINGS**

As noted above, the subsurface conditions were explored using SPT borings. The SPT boring locations were based on the requested boring location plan provided by Matthew Love, PE, Project Manager for McKim & Creed. The borings were located by measuring from landmarks shown in an aerial photograph of the site. The boring locations are located on Sheet 1 of the Appendix.

Samples were obtained in the field and returned to our Tampa laboratory for visual classification and laboratory testing. Drilling and sampling techniques were accomplished in general accordance with ASTM Standards.

The majority of borings encountered fine sands (Unified Classification SP) and slightly silty fine sands (SP/SP-SM) to slightly clayey sands (SP-SC) from the ground surface to boring termination depths. Occasional coarse sands (SW) and clayey sands (SC) were encountered. Shell fragments were abundant. SPT resistances (N-values) ranged from 5 to 30 blows per foot (BPF) in the borings, indicating loose to medium dense soil conditions. N-values occasionally exceeded 30 blows per foot at depths beyond 20 feet along the berm, indicating dense soils.

The description presented above is of a generalized nature to highlight the major subsurface features and material characteristics. The soil profiles included on Sheets 2 through 4 should be reviewed for specific information at the individual boring locations. These profiles include soil description, N-values, stratifications, encountered water table depth and laboratory classification of soils. The stratifications shown on the boring profiles represent the conditions only at the actual boring location. Variations may occur and should be expected throughout the site. The stratifications represent the approximate boundary between subsurface materials, and the actual transition may be gradual.

### **2.2 GROUNDWATER INFORMATION**

Fluctuations in the water table are due in part to the fact that the soil borings were performed along the berm of the pond. Pond water level fluctuations impact water levels at this site. In addition, its raised berms also contributed to deeper water levels in the borings. Boring B-34, performed downstream at lower elevation, exhibits a shallower water level. These factors contribute to uncertainty in establishing water levels. Water level measurements deeper than 10 feet are generally not recorded due to the impact of drilling mud on the water levels. Since water was not observed in the upper 10 feet on the berms, we anticipate the Seasonal High Groundwater Level (SHGL) is no higher than 6 to 7 feet below the top of the berms and could be significantly deeper. It should be noted that groundwater levels tend to fluctuate during periods of prolonged drought and extended rainfall and may be affected by manmade influences. In addition, a seasonal effect will also occur in which higher groundwater levels are normally recorded in rainy seasons.



In general, the estimated seasonal high groundwater level is not intended to define a limit or ensure that future seasonal fluctuations in groundwater levels will not exceed the estimated levels. Groundwater levels could exceed the estimated seasonal high groundwater levels as a result of a series of rainfall events, changed conditions at the site that alter surface water drainage characteristics, and/or variations in duration, intensity, or total volume of rainfall. We recommend that groundwater monitoring well levels be evaluated and considered to more accurately estimate the SHGL at this site.

## **3.0 EVALUATION AND RECOMMENDATIONS**

### **3.1 GENERAL**

The following design recommendations have been developed on the basis of the previously described project characteristics and subsurface conditions encountered. If there are any changes in these project criteria, including project location on the site, a review must be made by PSI to determine if any modifications in the recommendations will be required. The findings of such a review should be presented in a supplemental report.

### **3.2 LAKE FILTRATION**

#### **3.2.1 SITE SUITABILITY**

Based on the results of the subsurface exploration and discussion regarding housing for the lake filtration system, a shallow foundation system on unimproved ground may be feasible.

More detailed discussions pertaining to site preparation and foundation design matters follow. The design recommendations have been developed on the basis of the previously described project characteristics and subsurface conditions encountered. If there are any changes in these project criteria, including project location on the site, a review must be made by PSI to determine if any modifications in the recommendations will be required. The findings of such a review would be presented in a supplemental report.

Once final design plans and specifications are available, a general review by PSI is strongly recommended as a means to check that the evaluations made in preparation of this report are correct and that earthwork and foundation recommendations are properly interpreted and implemented.

### **3.2.2 FOUNDATION DESIGN CONSIDERATIONS**

#### **3.2.2.1 MAT FOUNDATIONS**

As noted earlier, mat foundations may be able to be used for these structures if they can withstand the estimated settlement provided below. A design foundation net allowable soil bearing pressure value of 1,000 psf for the structures is anticipated. Settlement estimates have been proposed based upon this bearing pressure.

#### **3.2.2.2 SETTLEMENT FOUNDATIONS**

The settlement of shallow foundations supported on sandy soils should occur rapidly after loading. Thus, the majority of expected settlements should occur during construction as dead loads are imposed. Settlement of the concrete mat foundation is expected to be on the order of 2 inches in the center. Differential settlement between the center and the edge of the foundation mat is anticipated to be about half the estimated total settlement.

The Modulus of Subgrade reaction (k) is often used by the structural engineer for mat and/or slab design. We recommend that a k value of approximately 20 pounds per cubic inch be used.

### **3.2.3 DESIGN CONSIDERATIONS**

#### **3.2.3.1 SITE CLEARING**

Site clearing should include the removal of any abandoned underground utilities. If removal of abandoned underground utilities is not feasible, they should be completely filled with grout. The pavement at this site may remain in place, if desired.

#### **3.2.3.2 SUBGRADE COMPACTION**

If the site is lowered such that the subgrade is exposed, field density control should be exercised within the upper 12 inches of the densified subgrade soils. We recommend that the soils within this zone be compacted to at least 95 percent of the modified Proctor maximum dry density (ASTM D-1557).

#### **3.2.3.3 ENGINEERED FILL**

Material required for engineered fill for the project should consist of clean sand that is free of significant organic matter and other deleterious substances. It should have a fines content that does not exceed 12 percent (i.e. less than 12 percent by dry weight passing the U.S. Standard Number

200 sieve).

Engineered fill should be placed at a moisture content near optimum and in uniform lifts not exceeding 12 inches in loose thickness. It should be thoroughly compacted to at least 95 percent of its ASTM D-1557 maximum dry density.

### **3.3 POND DESIGN RECOMMENDATIONS**

We understand a plastic pond liner is planned to be used. The sandy soils encountered throughout the pond area are well suited for supporting a pond liner. The designer should consider placing a layer of sand 6 to 12 inches thick on the liner for protection from UV rays and physical damage. If the pond liner is constructed below the water table, we recommend that 1 foot of sand be placed on top of the liner for every 1.7 feet below the seasonal high water table in order to prevent 'floating' of the liner.

The PSI borings did not encounter significant sludge deposits in the pond. However, such deposits are not uncommon in WWTP ponds. If these materials decompose, they generate gasses, which can accumulate under the liner and fail it at one or more locations by lifting the liner. The pond area should be drained to allow a thorough inspection and removal of all non suitable soils in the area of the proposed mat.

We anticipate a new berm will be constructed. While slopes of 3H:1V could be considered using proper material and compaction, we recommend slopes of 4H:1V for berm construction, as that slope will be resistant to failure due to erosion from rapid drawdown conditions.

We have reviewed an alternative to soil berm construction. A 15-foot wide and 15-foot tall vertical berm section could be constructed using 6-inch concrete walls driven to a depth of 5 feet, then tied together and filled with soil. Such a berm may need to have separation filter geotextile such as Mirafi 140 N or another approved equal to reduce migration of fines through the wall face. This alternative could prove less costly than a berm constructed with 4:1 slopes; existing soils in the area should be suitable for use as fill to support this load.

### **3.4 FILL AVAILABILITY**

The soils strata encountered at this site are all suitable for use as select fill, except for Stratum 4 Clayey Sand (SC). Stratum 4 could be used, but the higher fines content may make it more sensitive to moisture content changes. PSI may provide suitability recommendations for specific fill usages as required.

### **3.5 EXCAVATIONS**

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, Part 1926, Subpart P". This document was issued to better insure the safety of workmen entering trenches or excavations. It is mandated by this federal regulation that excavations, whether they be utility trenches, basement excavations or footing excavations, be constructed in accordance with the current OSHA guidelines. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractors "responsible person", as defined in 29 CFR, Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in all local, state, and federal safety regulations.

We are providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the contractor's or other party's compliance with local, state, and federal safety or other regulations.

### **4.0 REPORT LIMITATIONS**

The recommendations submitted are based on the available subsurface information obtained by PSI and design details furnished by McKim & Creed for the proposed SWWRF Lake Filtration System and north pond improvements. If there are any revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine if changes in the pond recommendations are required.

Much of the State of Florida is underlain by a soluble limestone foundation. This limestone can dissolve, resulting in the formation of a sinkhole. An evaluation of the risk of sinkhole development was not included in the Scope of work for this study.

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

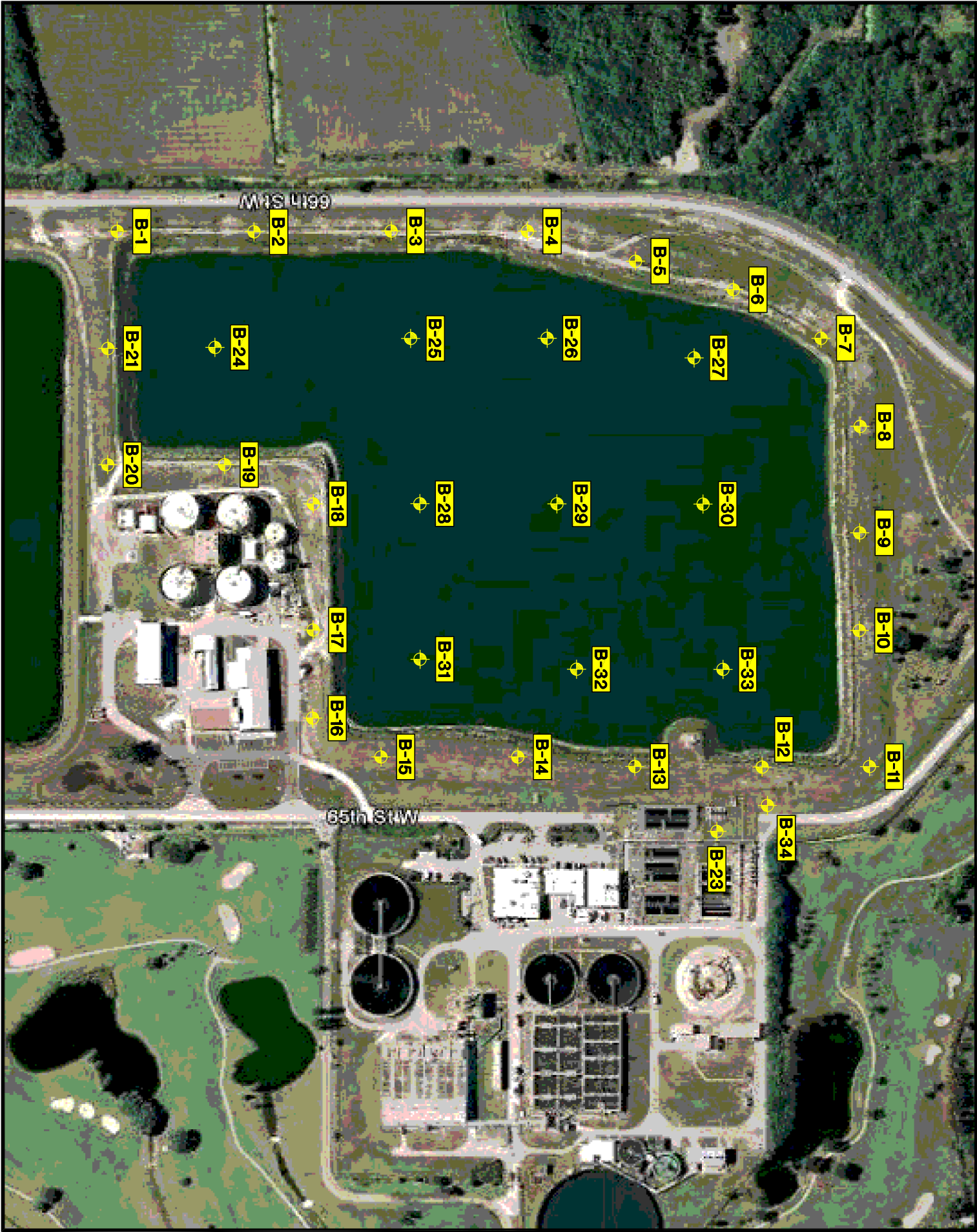
After the plans and specifications are more complete, the geotechnical engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly




incorporated into the design documents. This report has been prepared for the exclusive use of McKim & Creed and its consultants for the specific application to the proposed pond improvements at the SWWRF in Bradenton, Florida.



## APPENDIX



# LEGEND

 Approximate SPT boring location

## BORING LOCATION PLAN




DRAWN	DJG
CHECKED	DH
APPROVED	MEM
SCALE	NOTED

GEOTECHNICAL SERVICES

SWWRF IMPROVEMENTS

LAKE FILTRATION SYSTEM AND NORTH POND IMPROVEMENTS

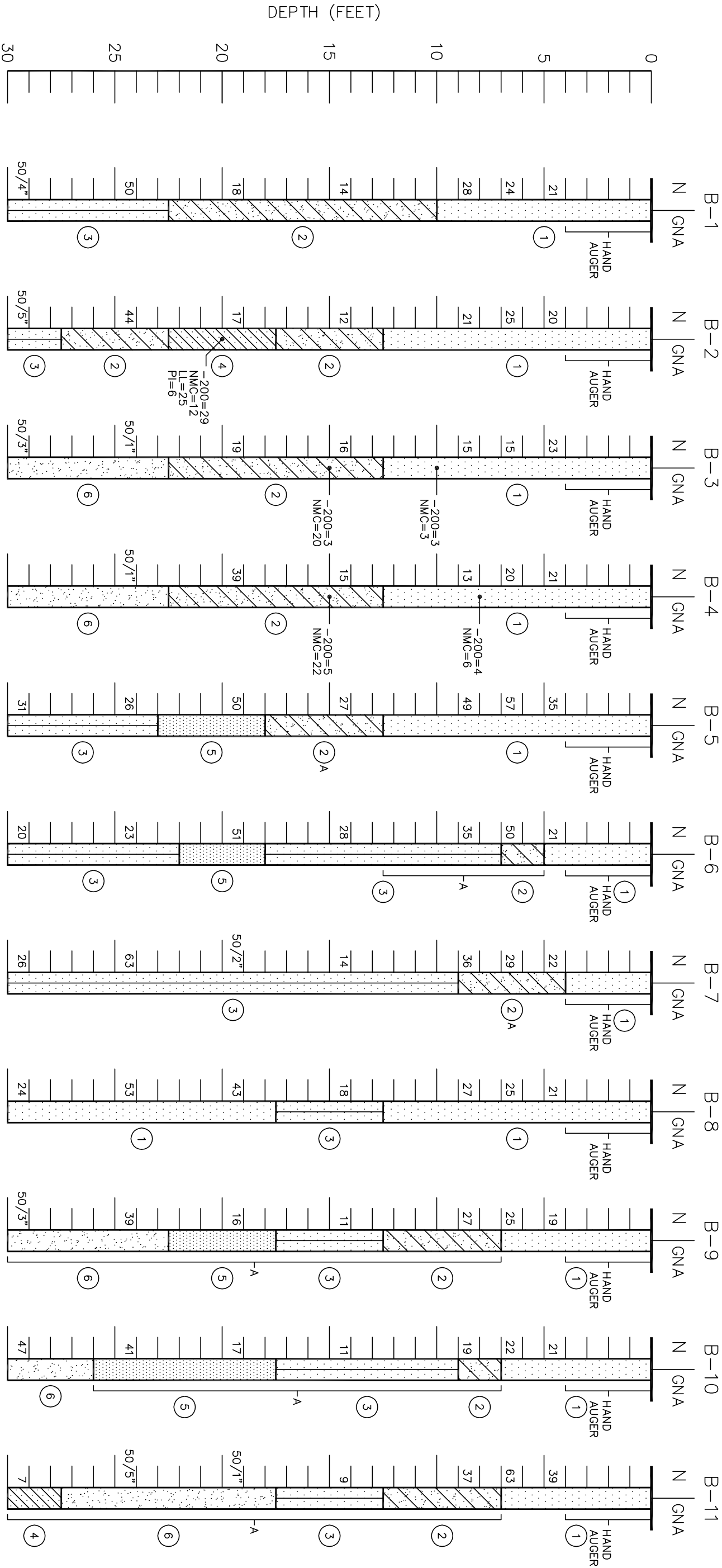
BRADENTON, FLORIDA

 **Information**

*To Build On*

Engineering • Consulting • Testing

DATE	JAN 11	PROJ. NO.	0775871	SHEET	1
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- 1

Brown to gray fine SAND with shell fragments (SP)
- 2

Brown slightly clayey fine SAND (SP-SC)
- 3

Brown to dark gray fine SAND to slightly silty fine SAND (SP/SP-SM)
- 4

Light gray clayey SAND (SC)
- 5

Gray to light tan fine to coarse SAND (SW)

- 6

Brown to white fine SAND (SP)
- Unified Soil Classification System (ASTM D 2487) group symbol as determined by visual review
- SP

Groundwater level, March 2011
- Groundwater level not apparent in the upper 10 feet of soils
- N

SPT N-value in blows/foot

DRAWN	DJG
CHECKED	DH
APPROVED	MEM
SCALE	NOTED

GEOTECHNICAL SERVICES

SWWRF IMPROVEMENTS

LAKE FILTRATION SYSTEM AND NORTH POND IMPROVEMENTS

BRADENTON, FLORIDA

psii

To Build On

Engineering • Consulting • Testing

DATE

JAN 11

PROJ. NO.

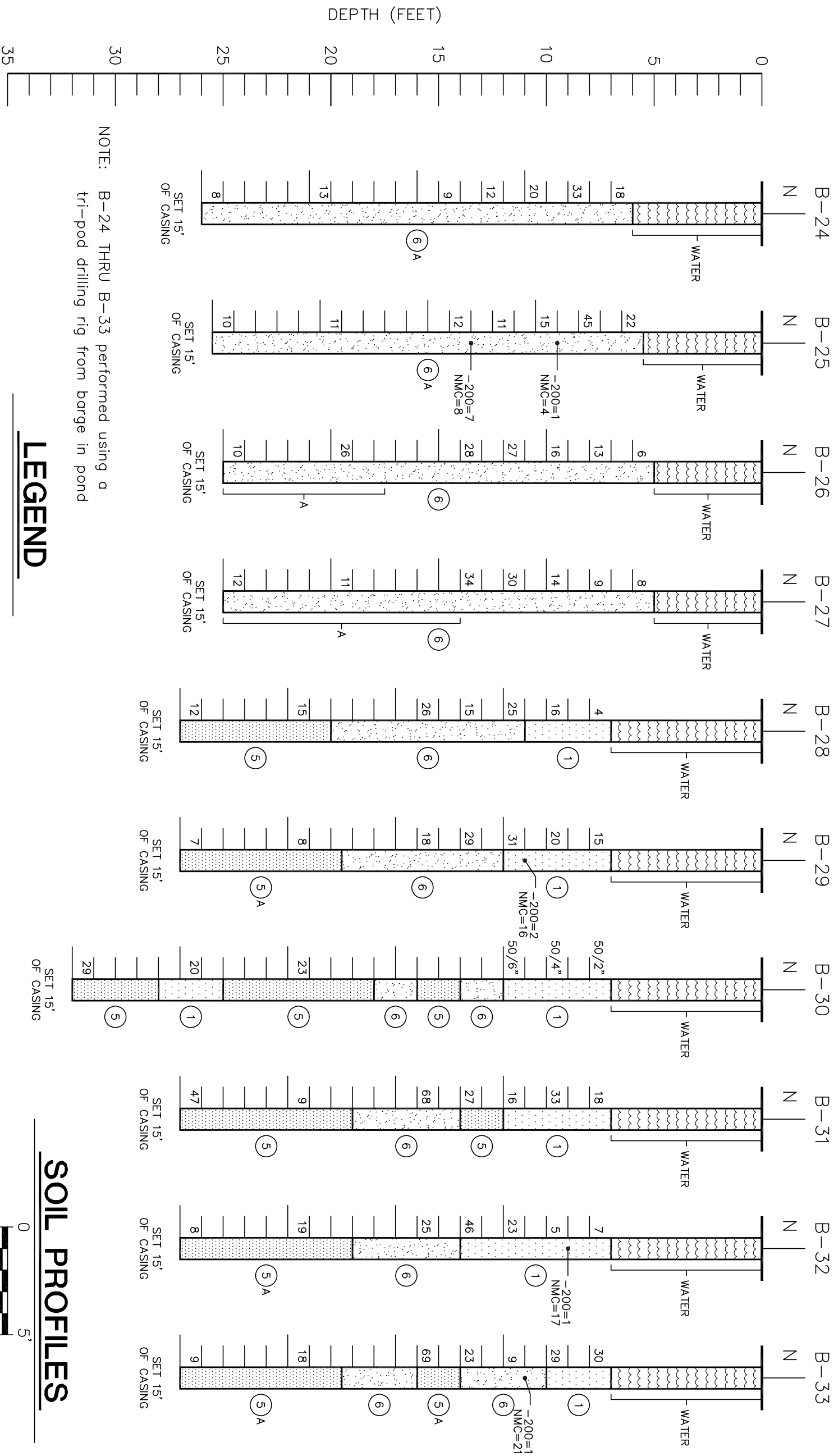
0775871

SHEET

2












NOTE: B-24 THRU B-35 performed using a tri-pod drilling rig from barge in pond

## LEGEND

- |   |  | 50/6" Fifty blows for six inches     |
|---|--|--------------------------------------|
| ①  | Brown to gray fine SAND with shell fragments (SP)  | A With shell fragments               |
| ②  | Brown slightly clayey fine SAND (SP-SC)  | -200 Fines passing No. 200 sieve (%) |
| ③  | Brown to dark gray fine SAND to slightly silty fine SAND (SP/SP-SM)                          | NMC Natural Moisture Content (%)     |
| ④  | Light gray clayey SAND (SC)  | LL Liquid Limit (%)                  |
| ⑤   | Gray to light tan fine to coarse SAND (SW)   | PI Plasticity Index (%)              |
|   | N SPT N-value in blows/foot  |                                      |
|   | GNA Groundwater level not apparent in the upper 10 feet of soils                             |                                      |
|   | Unified Soil Classification System (ASTM D 2487) group symbol as determined by visual review |                                      |
|   | Groundwater level, March 2011  |                                      |

## SOIL PROFILES



## POND BORINGS

GEOTECHNICAL SERVICES  
**SWWRP IMPROVEMENTS**  
LAKE FILTRATION SYSTEM AND NORTH POND IMPROVEMENTS  
BRADENTON, FLORIDA

**PSI** Information  
To Build On  
Engineering • Consulting • Testing

DRAWN	DJG
CHECKED	DH
APPROVED	MEM

DATE	JAN 11	PROJ. NO.	0775871	SHEET	4
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**GEOTECHNICAL ENGINEERING  
SERVICES FINAL REPORT**

For the

**PERICO PRESERVE EVALUATION  
BRADENTON, FLORIDA**

Prepared for

**Stantec  
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**PSI Project No. 0775-1312**

**February 17, 2012**



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## **1.0 PROJECT INFORMATION**

### **1.1 PROJECT AUTHORIZATION**

PSI has completed a geotechnical study for the proposed Perico Preserve in Bradenton, Florida. Authorization to proceed with this project was provided by Elizabeth Anders in the form of written agreement to PSI's proposal. This study was conducted in accordance with our proposal for these services dated January 22 2012, PSI Proposal No. 0775-60971.

### **1.2 PROJECT DESCRIPTION**

Perico Preserve covers about 30 acres, and is located on the east - central portion of Perico Island, north of State Road 64, in Manatee County, Florida. This area was previously cleared and farmed. Manatee County purchased the land with the aim to restore it for wildlife habitat. The planned restoration will include excavation of channels and ponds. Restoration plans have not been finalized, but based on our January 17, 2012 meeting, we understand that most of the excavations will be a maximum of 6 feet deep. We anticipate about half of the area may be excavated.

Material excavated is planned to be utilized for the berm construction and raising the bottom elevation of the south pond at the Manatee County Waste Water Treatment Plant about 5 miles southeast of Perico Island. PSI issued a Geotechnical Engineering Services Report for this plant on March 31, 2011 (PSI Project No. 775-871). About two-thirds of the material is required to raise the pond bottom and the rest is to be used for berm construction. In order to assist with the preparation of project plans and specifications, and construction contracts required to be let to accomplish this work, it is important to determine the nature of the soils to be excavated at this site.

If any of this project description information is incorrect or has changed, please inform PSI so that we may amend, if appropriate, the recommendations represented in this report.

### **1.3 PURPOSE AND SCOPE OF WORK**

The purpose of this study was to obtain information on the general subsurface conditions at the proposed project site. For this preliminary assessment of borrow material, PSI performed a soil review for each 20,000 square feet, or at a frequency of about 2 borings per acre. The subsurface materials encountered were then evaluated with respect to the available project characteristics. In this regard, engineering assessments of the following items have been formulated:

1. A discussion of subsurface conditions encountered including pertinent soil properties, water levels, and estimated seasonal high water levels.



2. Limited laboratory testing to assist in classification of the recovered samples and determination of selected soil properties. (Lab results are pending.)

The following services have been provided in order to achieve the preceding objectives:

1. Reviewed readily available published topographic and soils information. This published information was obtained from the "Anna Maria, Florida," and "Bradenton Beach, Florida," Quadrangle Maps published by the United States Geological Survey (USGS) and the "Soil Survey of Bradenton County, Florida," published by the United States Department of Agriculture (USDA) Soil Conservation Service (SCS).
2. Executed a program of subsurface exploration consisting of soil sampling and field testing. The number, depth and location of the borings was determined by PSI. We performed a total of thirty (30) sample locations. To allow for larger soil samples to be examined, 20 of these locations were test pits, and 10 soil borings were performed with a soil drilling rig. Samples were obtained at regular intervals to allow classification of the soils.
3. Classified representative soil samples visually and through selected laboratory testing using the Unified Soil Classification System (USCS). Identified soil conditions at each sample location and formed an opinion of the site soil stratigraphy.
4. Collected groundwater level measurements and estimated seasonal high groundwater levels at the test pit locations.
5. The results of the exploration have been used in the engineering analysis and the formulation of recommendations. The results of the subsurface exploration, including the recommendations and the data on which they are based, are presented in this written report supervised by a professional engineer.

Any statements in this report or on the boring logs regarding odors, colors, unusual or suspicious items or conditions are strictly for the information of our client.

## **2.0 SITE AND SUBSURFACE CONDITIONS**

### **2.1 SITE LOCATION AND DESCRIPTION**

The site overlaps to mapped areas. The area is located in Sections 26 & 27, Township 34 South, and Range 16 East of the "Anna Maria, Florida," map and in Section 27, Township



34 South, and Range 16 East on the “Bradenton Beach, Florida,” map. More specifically, the site is located on the east - central portion of Perico Island, north of State Road 64, in Manatee County, Florida, approximately 1 mile east of the bridge to Holmes Beach. Based on the “Anna Maria, Florida,” and “Bradenton Beach, Florida,” United States Geological Survey (USGS) topographic maps (see **APPENDIX SHEET 1**), the ground surface elevation at the property is approximately +1 to +4 feet National Geodetic Vertical Datum (NGVD) 1929.

## **2.2 SUBSURFACE CONDITIONS**

The subsurface conditions were explored using a total of twenty (20) test pits ranging in depth from 6 to 7 feet and ten (10) power augers to a depth of ten (10) feet. Sample depths and locations were selected by PSI, Inc., and located in the field by PSI using GPS technology and existing site features. The approximate test locations are presented on **APPENDIX SHEET 2**. Test locations were cleared and pits dug using a backhoe; auger borings were performed with a drilling rig. Soil samples were routinely obtained during the digging process.

Visual and laboratory classification was performed in general accordance with the Unified Soil Classification System (USCS).

The description presented below is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The soil profiles included on **APPENDIX SHEETS 3** and **4** should be reviewed for specific information at individual test locations. These profiles include soil description, stratifications and laboratory classification of soils. The stratifications shown on the soil profiles represent the conditions only at the actual pit or boring locations. The stratifications represent the approximate boundary between subsurface materials; the actual transition may be gradual.

## **2.3 DISCUSSION OF SOIL CONDITIONS**

Generally, the soils encountered at the test locations consisted of fine sand to slightly silty fine sand (SP/SP-SM) (Unified Classification SP), slightly silty fine sand, (SP-SM), silty fine sand (SM), and muck (Pt). See **APPENDIX SHEETS 3** and **4** for specific soil strata information.

## **2.4 MANATEE COUNTY SOIL SURVEY**

The “Soil Survey of Manatee County, Florida” published by the USDA SCS was reviewed for general near surface soil information. This information indicates there are three (3) primary mapping units, *EauGallie fine sand (20)* and *Pomello Fine Sand, 0 to 2 percent slopes (42)*, at the project location.



EauGallie soils are composed of sandy and loamy marine deposits found in flatwoods on marine terraces. This soil type is poorly drained with a low available water capacity and moderately low to high permeability. The seasonal high water table is normally at a depth of 6 to 18 inches.

Pomello soils are composed of sandy marine deposits found on marine terraces. This soil type is moderately well drained with a low available water capacity and high permeability. The seasonal high water table is normally at a depth of 24 to 42 inches.

It should be noted that information contained in the USDA Soil Survey is of a very general nature and therefore may not be reflective of actual soil and groundwater conditions, particularly if recent development in the project vicinity has modified soil conditions or surface/subsurface drainage.

## **2.5 GROUNDWATER INFORMATION**

Groundwater levels were recorded during borings and test pit excavation and corroborated through a visual examination of the obtained soil samples. Generally, groundwater was found at depths ranging from 6 inches to 4 feet below the ground surface. It should be noted that groundwater levels tend to fluctuate during periods of prolonged drought and extended rainfall and may be affected by man-made influences. A seasonal effect will occur in which higher groundwater levels are normally recorded in rainy seasons.

Tidal influences also may affect the water table in this location. Fluctuations higher than the levels recorded in this exploration should be anticipated. Taking the various influences into consideration, as well as the USDA SCS data, the seasonal high depth to groundwater at this site is estimated to be at-grade to 3 feet below the existing ground surface. We recommend groundwater levels be evaluated at the time of construction to determine ecological constraints on design.

## **3.0 EVALUATION AND RECOMMENDATIONS**

In the Geotechnical Engineering Services Report issued March 31, 2011 (PSI Project No. 775-871), we recommended that any engineered fill required for the project consist of clean sand that is free of significant organic matter and other deleterious substances. It should have a fines content that does not exceed 12 percent (i.e. less than 12 percent by dry weight passing the U.S. Standard Number 200 sieve).

Engineered fill should be placed at a moisture content near optimum and in uniform lifts not exceeding 12 inches in loose thickness. It should be thoroughly compacted to at least 95 percent of its ASTM D-1557 maximum dry density.

Based on subsurface conditions encountered at the test pit locations, the existing sandy soils (SP/SP-SM, SP-SM) found in the upper 4 to 5 feet of these borings and test pits are





generally acceptable for use in berm construction. Generally, the silty soils and muck found in some of the test locations should be evaluated before use as construction materials, especially in the areas near test pits TP-11 and TP-16, where muck was found at four feet below ground surface. A review of historical aerials dating to 1994 indicates limited earthwork activity has occurred in the area, as the land had previously been cleared for farming.

The recommendations presented herein have been developed on the basis of the previously described project characteristics and subsurface conditions encountered. If there are any changes in these project criteria, including project location on the site, a review must be made by PSI to determine if any modifications in the recommendations will be required. The findings of such a review should be presented in a supplemental report.

## **4.0 OTHER CONSIDERATIONS**

### **4.1 CONSTRUCTION CONSIDERATIONS**

As stated previously in this report, seasonal high groundwater depths of about at-grade to 3 feet below the existing ground surface are anticipated for this site during rainy periods and/or under certain tidal conditions. We anticipate seasonal high water levels may be as high as two (2) feet above sea level during rainy periods.

It is recommended that PSI be retained to provide observation and testing of construction activities involved in any earthwork and related activities of this project. PSI cannot accept any responsibility for any conditions which deviate from those described in this report, if not engaged to also provide construction observation and testing for this project.

### **4.2 EXCAVATION AND EMBANKMENT SLOPE CONSIDERATIONS**

In Federal Register, Volume 54, No.209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, Part 1926, Subpart P". This document was issued to better insure the safety of workmen entering trenches or excavations. It is mandated by this federal regulation that excavations, whether they be utility trenches, basement excavations or footing excavations, be constructed in accordance with the new OSHA guidelines. It is our understanding that these regulations are being strictly enforced and, if not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR, Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in all local, state, and federal safety regulations.



We are providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and federal safety or other regulations.

## **5.0 REPORT LIMITATIONS**

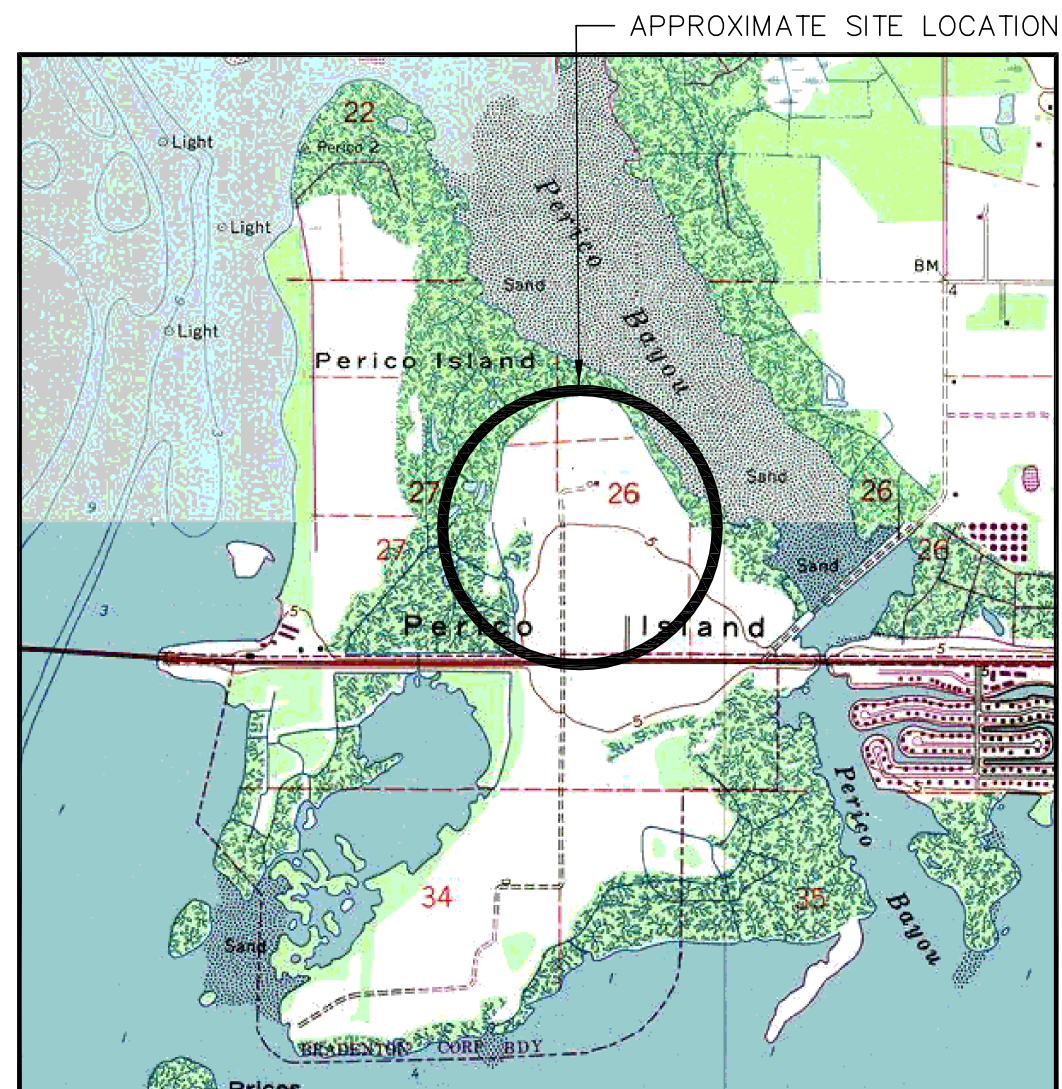
The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands or hazardous or toxic materials in the soil, bedrock, ground water, or air, on or below or around this site. Any statements in this report or on the boring logs regarding odors, unusual or suspicious items or conditions are strictly for the information of our client.

Florida is underlain by a soluble limestone formation, which can dissolve and result in surface subsidence and the formation of sinkholes. A more comprehensive assessment of the warehouse site for the potential for sinkhole development typically includes Ground Penetrating Radar (GPR) studies and the extension of deeper soil borings into the underlying limestone formation. Such an assessment is beyond the scope of this proposed study, but can be performed at significant additional cost, if desired.

After the plans and specifications are more complete, the Geotechnical Engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations. This report has been prepared for the exclusive use of Stantec, Inc., for the specific application to the Proposed Perico Preserve restoration in Bradenton, Florida.

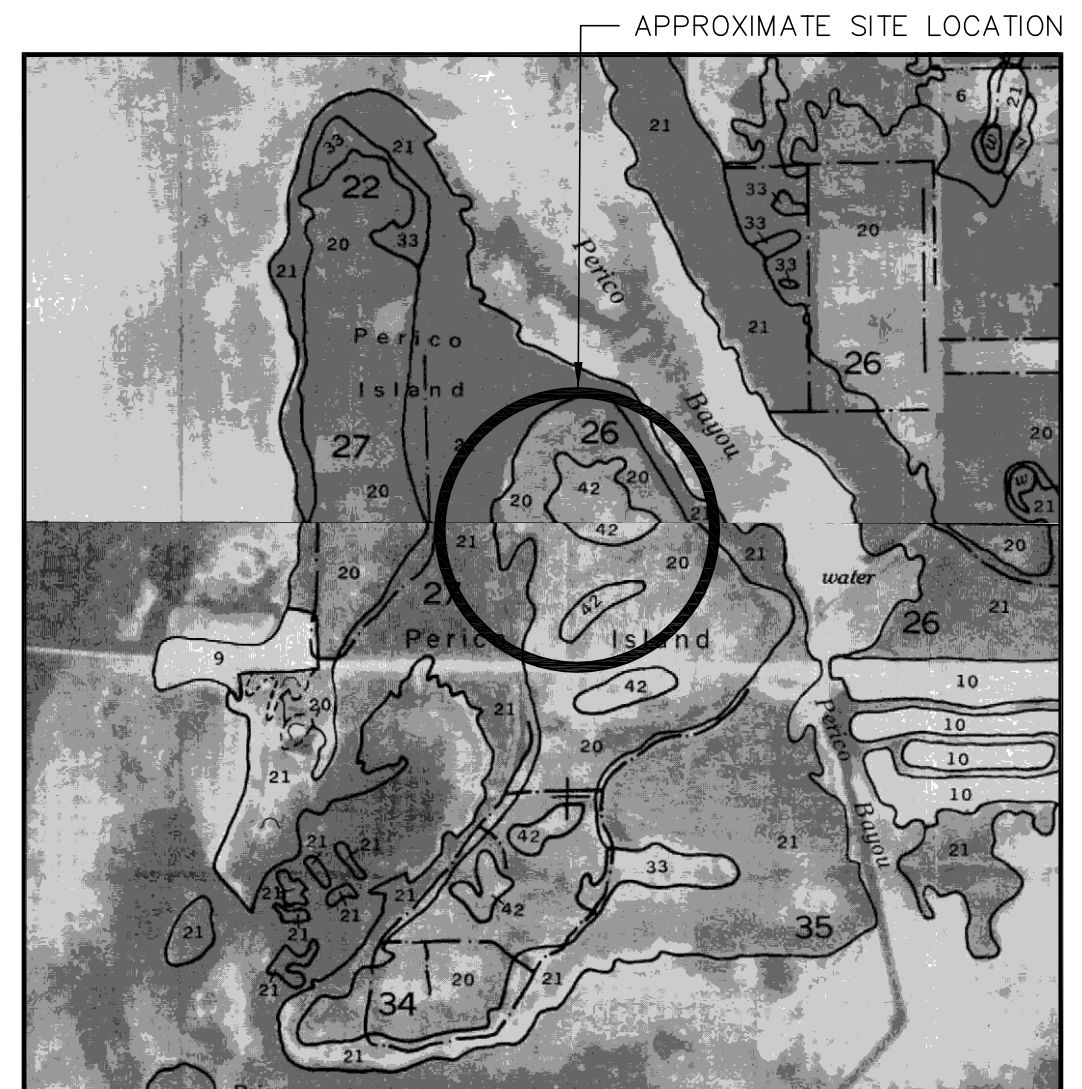
## APPENDIX



REFERENCE: USGS "ANNA MARIA, FLORIDA" QUADRANGLE MAP  
 TOWNSHIP: 34 SOUTH MAP VERSION: 1979  
 RANGE: 16 EAST PHOTOREVISED: -  
 SECTIONS: 26 & 27 SCALE: 1" = 2000'

REFERENCE: USGS "BRADENTON BEACH, FLORIDA" QUADRANGLE MAP  
 TOWNSHIP: 34 SOUTH MAP VERSION: 1984  
 RANGE: 16 EAST PHOTOREVISED: -  
 SECTION: 27 SCALE: 1" = 2000'

## USGS VICINITY MAP



REFERENCE: USDA SCS, "SOIL SURVEY OF MANATEE COUNTY, FLORIDA"  
 TOWNSHIP: 34 SOUTH ISSUED: 1983  
 RANGE: 16 EAST PHOTO: 1979  
 SECTIONS: 26 & 27 SCALE: 1" = 2000'

## USDA VICINITY MAP



DRAWN	DJG
CHECKED	DH
APPROVED	MEM
SCALE	NOTED

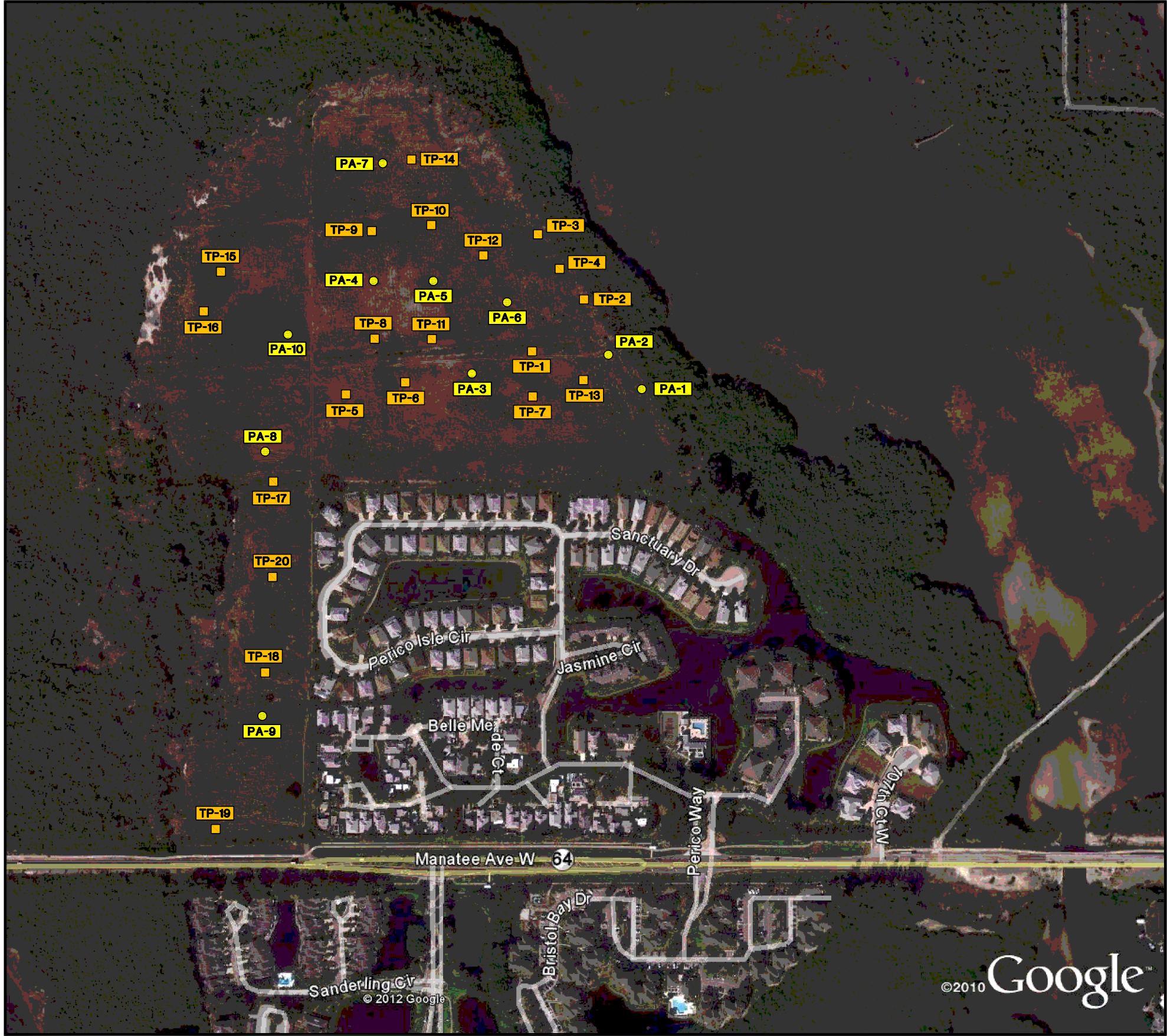
USGS & USDA VICINITY MAPS  
**PERICO PRESERVE EVALUATION**  
 BRADENTON, FLORIDA

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DATE	FEB 12	PROJ. NO.	07751312	SHEET 1
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## LEGEND

- Approximate Power Auger boring location
- Approximate Test Pit location

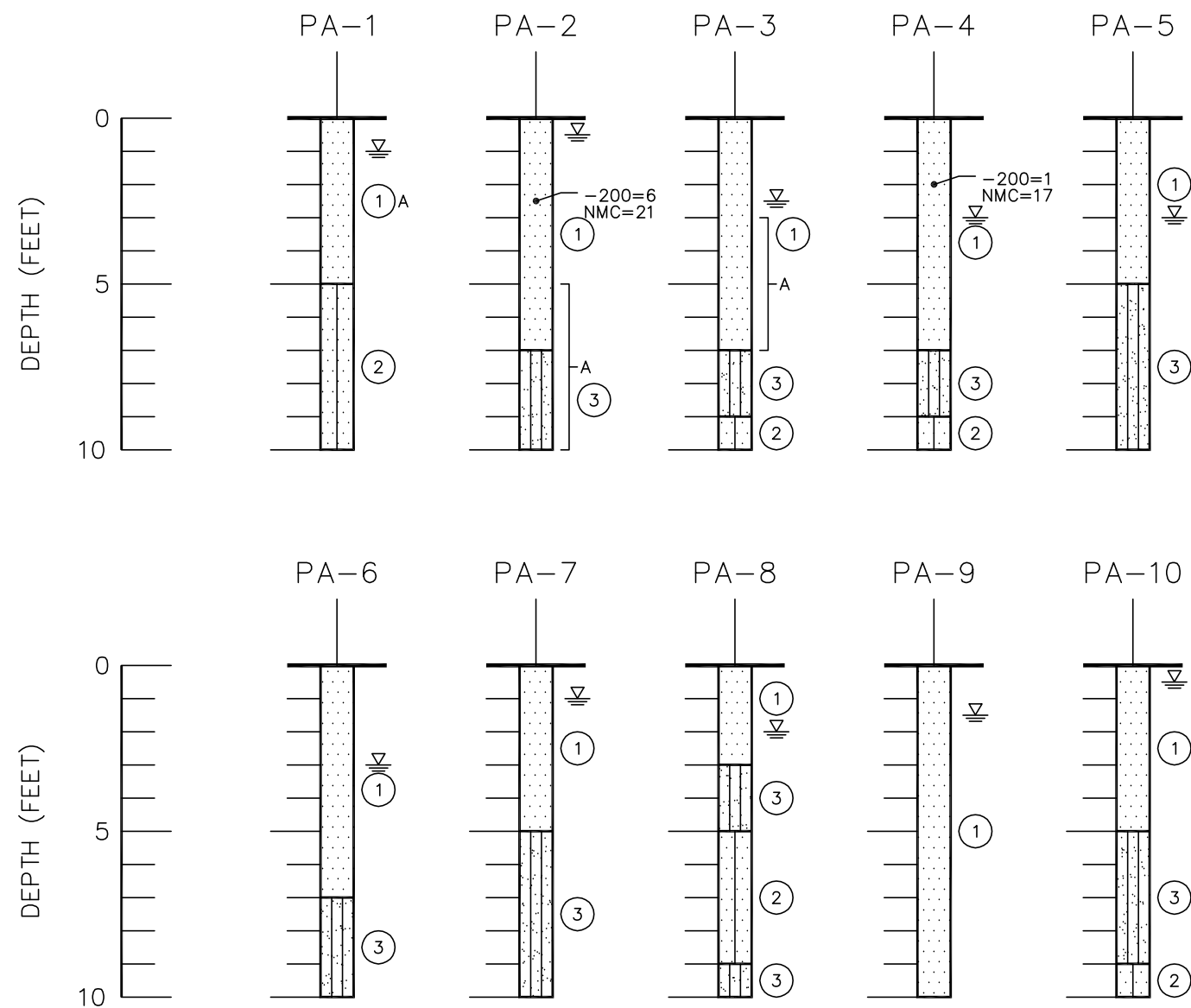
## BORING LOCATION PLAN



DRAWN	DJG
CHECKED	DH
APPROVED	MEM
SCALE	NOTED

GEOTECHNICAL SERVICES		
PERICO PRESERVE EVALUATION		
BRADENTON, FLORIDA		
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## SOIL PROFILES

0 5'

VERTICAL SCALE

## LEGEND

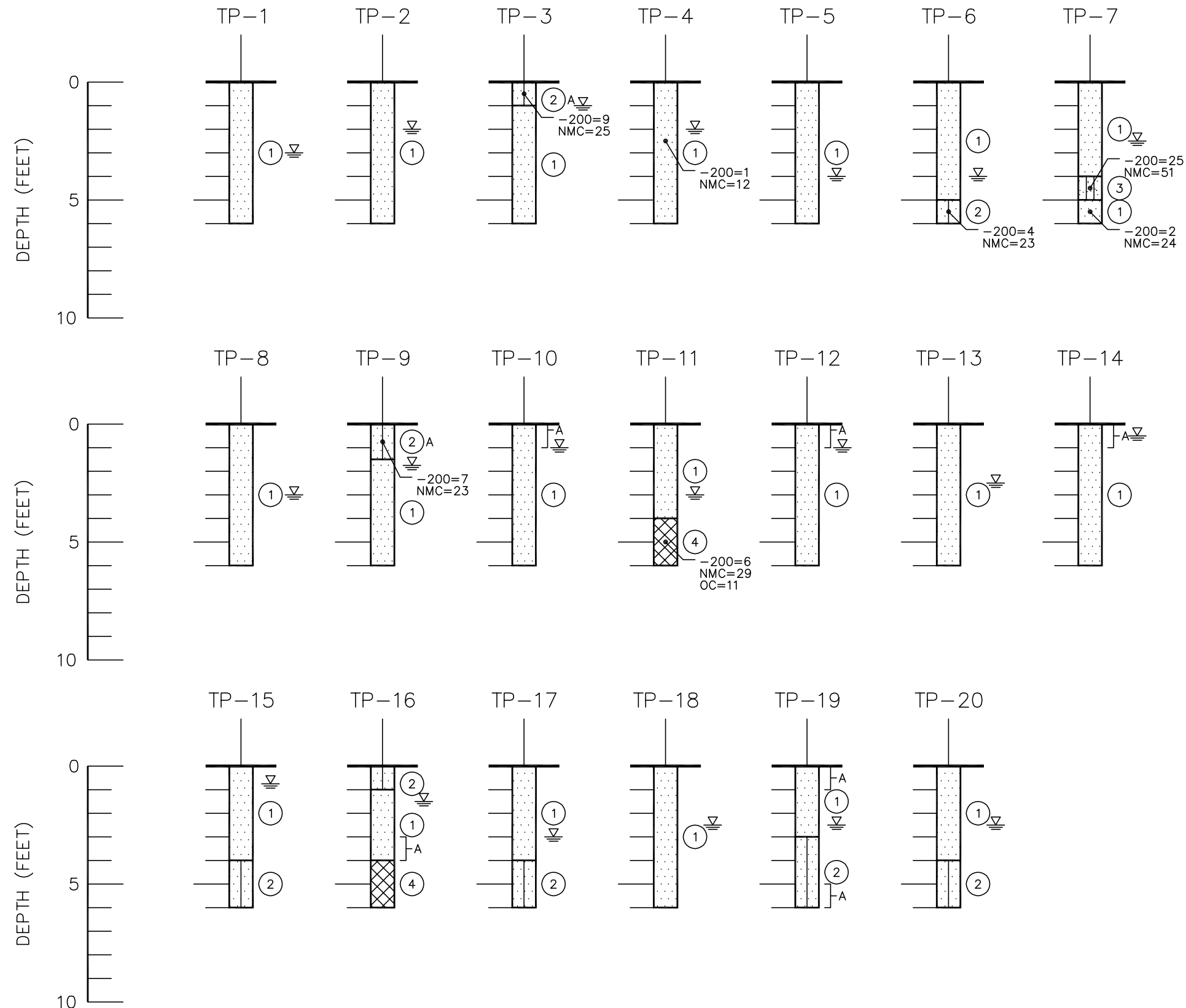
- ① White, light brown or gray fine SAND to slightly silty fine SAND (SP/SP-SM)
- ② Dark brown slightly silty fine SAND (SP-SM)
- ③ Dark brown or dark gray silty SAND (SM)
- ④ MUCK (PT)
- SP Unified Soil Classification System (ASTM D 2487) group symbol as determined by visual review
- ▽ Groundwater level, February 2012
- 200 Fines passing No. 200 sieve (%)
- NMC Natural Moisture Content (%)
- oc Organic Content (%)
- A With roots

DRAWN	DJG
CHECKED	DH
APPROVED	MEM
SCALE	NOTED

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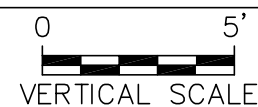
DATE	FEB 12	PROJ. NO.	07751312	SHEET	3
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## LEGEND

- ① [Symbol] White, light brown or gray fine SAND to slightly silty fine SAND (SP/SP-SM)
- ② [Symbol] Dark brown slightly silty fine SAND (SP-SM)
- ③ [Symbol] Dark brown or dark gray silty SAND (SM)
- ④ [Symbol] MUCK (PT)
- SP Unified Soil Classification System (ASTM D 2487) group symbol as determined by visual review
- ∇ Groundwater level, February 2012
- 200 Fines passing No. 200 sieve (%)
- NMC Natural Moisture Content (%)
- OC Organic Content (%)
- A With roots

## SOIL PROFILES



DRAWN	DJG
CHECKED	DH
APPROVED	MEM
SCALE	NOTED

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		SHEET 4