

SECTION 09900

PAINTING AND COATINGS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. The work includes furnishing all plant, labor, materials and equipment required to complete the painting and coatings as indicated on the Drawings and in these specifications.
- B. Surface preparation, paint and coatings materials, and their application shall be as recommended by the coating manufacturer and approved by the Engineer. The Contractor shall take all health and safety precautions necessary to prevent accidents during the storage, handling, application, and drying of any of the coatings described.
- C. Related Work Specified Elsewhere:
 - 1. Section 09902 - Pipe and Equipment Painting
 - 2. Section 13310 - Instrumentation & Controls

1.02 QUALITY ASSURANCE

- A. The Contractor is responsible for a satisfactory paint application which will adhere without peeling, flaking, blistering or discoloration. Before application of any painting materials, the Contractor shall submit a letter of Certification from the manufacturer of the materials selected for the application proposed.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are limited to the following:
 - 1. Ameron - Corrosion Control Division
 - 2. Carboline Company
 - 3. Rust-Oleum Corporation
 - 4. Themec Company, Inc.

1.03 SUBMITTALS

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples.
- B. Data Sheets and Color Charts:
 - 1. The full name of each product and descriptive literature shall be submitted along with a list of water and wastewater plants in Florida where the product has been used.
 - 2. Within a minimum of 30 days prior to application of paints and coatings, the Contractor shall submit six sets of color charts and data sheets for selection by the Owner. Before work is commenced, the Contractor shall prepare samples as required until the color and textures are satisfactory to the Owner.
 - 3. Resubmit samples as requested until required sheen, color and texture is achieved.
 - 4. On 12-inch x 12-inch hardboard, provide two samples of each color and material, with texture to simulate finish conditions. On actual wood surfaces, provide two 4-inch x 8-inch samples for stained wood finish. On concrete Masonry, provide two 4-inch square samples of masonry for each type of finish and color, defining filler, prime and finish coats. On actual wall surfaces and other building components, duplicate painted finish of acceptable samples, as directed by the Engineer.

1.04 DELIVERY AND STORAGE

- A. Deliver materials to job site in new, original, and unopened containers bearing manufacturer's name, trade name, and label analysis. Store where directed in accordance with manufacturer's instructions. All paint materials used on the job shall be kept in a single place which shall be kept neat and clean. All oily rags, waste or debris shall be removed every night and all precautions taken to avoid the danger of fire.
- B. Extra Stock: At the conclusion of the project, the Contractor shall provide the Owner with a minimum of one quart from each 50 gallons or fraction thereof for each paint system used on the project. The paint or

coating container shall indicate the applicable paint system as indicated in these specifications.

1.05 JOB CONDITIONS

A. Painting or coating and finishing of interior and exterior items and surfaces, unless otherwise indicated:

1. Paint all new construction and portions of existing facilities disturbed by new construction.
2. Paint all exposed surfaces, except as otherwise indicated, whether or not colors are designated. If not designated colors will be selected by the Owner's Representative from standard colors available for the coatings required.
3. Includes field painting of bare and covered pipes and ducts (including color coding), and hangers, exposed steel and iron work, and primed metal surfaces of equipment installed under mechanical and electrical work.
4. Painting shall be done at such times as the Contractor and Owner's Representative may agree upon in order that dust-free and neat work be obtained. Painting shall be done strictly in accordance with the manufacturer's instructions and shall be performed in a manner satisfactory to the Owner's Representative.
5. "Shop" painting as referred to defines the paint coat which shall be applied in the shop or plant immediately after manufacturer, fabrication or assembly and prior to shipment to the site of installation. "Field" painting defines the paint coats to be applied at the project site where the structure or equipment is completed, erected, or installed in place as specified.

B. Materials and Application:

1. Obtain painting materials from one manufacturer. Painting materials not obtainable from the prime manufacturer shall be obtained from a second source recommended by the prime manufacturer.
2. There shall be a perceptible difference in shades of successive coats of paint so that the

application of successive coats of paint can be properly and uniformly spread and inspected. Pipes, sheet metal ducts and other metal items which are to be installed in inaccessible locations shall be painted prior to installation.

3. Each coat shall be allowed to dry for the period of time recommended by the manufacturer before the next coat is applied.

C. Equipment, Machinery, and Shop Fabricated Items:

1. Pumps, motors, machinery, equipment and other manufactured items shall have surfaces prepared, primed and finish-coated in accordance with the standard practice of the manufacturer. Finish coat colors shall be as approved by the Engineer.
2. Shop-fabricated items and components for field assembly shall have surfaces prepared and shop-primed. Finish coat colors shall be as approved by the Engineer. Items for submerged service shall be field sandblasted and primed per Paint System B-3.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS - ALL SYSTEMS

- A. The film thickness designated and/or the number of coats to be applied shall not be decreased and shall be increased where required to meet other manufacturer's recommendations.
- B. There shall not be a change from the generic type of coating specified.
- C. Manufacturer's recommendations as to which finish coat should be used with a particular primer shall be observed. In all cases, the prime coat and finish coat shall be from the same manufacturer. All paint shall be mildew resistant.
- D. Tnemec products are given as examples of painting and coating systems identified in the following paragraphs. The products of other manufacturers (listed in Paragraph 1.02.B.) may be used as long as they are of the same quality and approved by the Owner's Representative.

2.02 **GROUP A - CONCRETE AND MASONRY**

A. System A-1. For use on above grade interior walls and ceilings and architectural surfaces not subject to high moisture, corrosion, splashing or fumes.

1. Surface Preparation: Level protrusions and remove mortar splatter from all surfaces. Allow new concrete to cure 28 days.

2. First Coat:

a) Concrete and dense block - Acrylic latex coating, matte finish, 2-3 mils of Tnemec 6 Tneme - Cryl, or Equal.

b) Lightweight or porous concrete block surfaces - two component, inorganic hybrid water-based epoxy, 80-110 S.F./Gal - Tnemec Surface Coat 54WB, or Equal.

3. Second Coat:

a) Concrete and dense block - Acrylic latex coating, semi-gloss type, minimum 2 mils dry thickness of Tnemec 1029 Enduratone, or Equal.

b) Lightweight or porous concrete block surfaces - acrylic latex coating, matte finish, 2-3 mils DFT, Tnemec 6 Tneme - Cryl, or Equal.

4. Third Coat:

a) Concrete and dense block - None.

b) Lightweight or porous concrete block surfaces - acrylic latex coating, semi-gloss type, 2-3 mils DFT, Tnemec 1029 Enduratone SG, or Equal.

B. System A-2. For use on above and below grade - interior walls, inside surfaces of tanks, ceilings, and non-traffic slabs, and subject to high moisture, corrosion, splashing or fumes. Use for immersion and non-immersion exposures.

1. Surface Preparation:

- a) Concrete - Brush-off blast, to remove laitance, fines, curing compounds, form release oils, other contaminants, open up bugholes, and establish a surface profile equal to ICRI CSP 5. Re-surface concrete and fill voids and bugholes using Tnemec Series 218 MortarClad, applied @ 1/16".
- b) Concrete Block Surfaces - Clean and dry, level protrusions and remove mortar splatter from all surfaces.

2. First Coat:

- a) Concrete - Two-component, polyamidoamine cured epoxy, semi-gloss 4-6 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.
- b) Concrete Block Surfaces - Two component, inorganic hybrid water-based epoxy, 80-110 S.F./Gal - Tnemec Surface Coat 54WB, or Equal.

3. Second Coat:

- a) Concrete- Two-component, polyamidoamine cured epoxy, semi-gloss 4-6 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.
- b) Concrete Block- Two-component, polyamidoamine cured epoxy, semi-gloss 4-6 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.

4. Third Coat:

- a) Concrete- NA
- b) Concrete Block- Two-component, polyamidoamine cured epoxy, semi-gloss 4-6 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.

C. System A-3. For use on exterior walls above grade to a point six inches below finish grade.

- 1. Surface Preparation. Fill voids with grout; remove loose protrusions and mortar splatter. Allow new concrete and stucco to cure 28 days.
- 2. First Coat:

- a) Concrete & Stucco: Acrylic latex coating, matte finish, 2-3 mils dry thickness of Tnemec 6 Tneme - Cryl, or Equal.
 - b) Concrete Block: Two component, inorganic hybrid water-based epoxy, 80-110 S.F./Gal - Tnemec Surface Coat 54WB, or Equal.
- 3. Second Coat:
 - a) Concrete and Stucco: Acrylic latex coating, semi-gloss type, 2-3 mils DFT of Tnemec 1029 Enduratone - or Equal.
 - b) Concrete Block: Acrylic latex coating, matte finish, 2-3 mils DFT - Tnemec 6 Tneme - Cryl, or Equal.
- 4. Third Coat:
 - a) Concrete: None
 - b) Concrete Block & Stucco: Acrylic latex coating, semi-gloss type, 2-3 mils DFT-Tnemec 1029 Enduratone or Equal.
- D. System A-4: For use on exterior walls below a point six inches below finish grade.
 - 1. Surface Preparation: Brush-off blast.
 - 2. First Coat: Asphalt base high build coal tar epoxy foundation coating, 8-10 mils DFT Tnemec 46H-413 hi-Build Tneme - Tar, or Equal.
 - 3. Second Coat: Asphalt base high build coal tar epoxy foundation coating applied at right angles to First Coat, 8-10 mils DFT Tnemec 46H-413 hi-Build Tneme - Tar, or Equal.
- E. System A-5: For use on interior concrete block walls.
 - 1. Surface Preparation: Clean and dry, level protrusions and remove mortar splatter from all surfaces.
 - 2. First Coat: Two component, inorganic hybrid water-based epoxy, 80-110 S.F./Gal - Tnemec Surface Coat 54WB, or Equal.

3. Second Coat: High performance acrylic epoxy, 4-6 mils DFT - Tnemec Series 113 H.B. Tnemec-Tufcoat, or Equal.

**2.03 GROUP B - STRUCTURAL STEEL; CONCRETE AND STEEL TANKS;
EQUIPMENT AND PIPING**

- A. System B-1: For use on exposed structural and miscellaneous steel, piping, equipment, and tanks, both interior and exterior - not exposed to corrosion, splash, fumes, or immersion conditions.

1. Surface Preparation: Commercial blastclean per SSPC SP-6.
2. First Coat: One coat of Modified Aromatic Polyurethane Primer: Tnemec Series 1 Omnithane, 2.5-3.5 mils DFT.
3. Second Coat: One coat of two-component, polyamidoamine cured epoxy, semi-gloss 4-6 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.
4. Third Coat:
 - a) Interior: One coat of two-component, polyamidoamine cured epoxy, semi-gloss 4-6 mils DFT - Tnemec N69 HB Epoxoline II, or Equal
 - b) Exterior: One coat of semi-gloss acrylic polyurethane, 2.0-4.0 mils DFT-Tnemec Series 73 Endurashield, or Equal.

- B. System B-2: For use on bituminous coated cast iron, ductile iron or steel pipe.

1. Surface Preparation: Hand or power tool clean, scarify or wire brush per SSPC SP-2 and SP-3.
2. First Coat: One coat of two-component, polyamidoamine cured epoxy, semi-gloss 4-6 mils DFT - Tnemec N69 HB Epoxoline II, or Equal. If the bituminous coating "bleeds through" after application of the first coat, allow the bleed through to dry prior to application of the second coat.
3. Second Coat: Same as first coat.

4. Third Coat (exterior exposure only): One coat of semi-gloss acrylic polyurethane finish, 2-3 mils DFT - Tnemec 73 Endura - Shield, or Equal.
- C. System B-3: For use on interior walls of steel tanks, piping and equipment, submerged or non-submerged, exposed to spray, splash or corrosive atmosphere, excluding chains and sprockets and similar items. This system shall be used for all materials submerged or in contact with wastewater.
1. Surface Preparation. FIELD sandblast to a near white metal blast cleaning according to SSPC-SP10.
 2. First Coat: One coat of Modified Aromatic Polyurethane Primer: Tnemec Series 1 Omnithane, 2.5-3.5 mils DFT.
 3. Second Coat: One coat of Hydrophobic Aromatic Polyurethane, Tnemec Series 446 Perma-Shield MCU, 6.0-8.0 mils DFT.
 4. Third Coat: Same as second coat
- D. System B-4: For use on structural steel, tanks, equipment and piping subject to severe abrasion, corrosive atmosphere, splash or spray, not in contact with wastewater or where a color finish is desired.
1. Surface Preparation: Submerged surfaces, near white metal blast according to SSPC-SP 10. Non-submerged surfaces, commercial blast according to SSPC-SP 6.
 2. First Coat: One coat of Modified Aromatic Polyurethane Primer: Tnemec Series 1 Omnithane, 2.5-3.5 mils DFT.
 3. Second Coat: One coat of Hydrophobic Aromatic Polyurethane, Tnemec Series 446 Perma-Shield MCU, 6.0-8.0 mils DFT.
 4. Third Coat:
 - a) Interior - Same as second coat.
 - b) Exterior Exposure - One coat of semi-gloss polyurethane, 2-4 mils DFT - Tnemec 73 Endura - Shield, or Equal.

- E. System B-5: For use on hollow metal (steel) doors and frames, steel embedments, and steel lintels:
1. Surface Preparation: Pre-primed with alkyd primer.
 2. First Coat (touch-up only): Universal alkyd primer, 2-4 mils DFT, Tnemec 37H Chem-Prime HS, or Equal.
 3. Second Coat: One coat of high-gloss HDP acrylic polymer, Tnemec Series 1028, 2.0-3.0 mils DFT.
 4. Third Coat: Same as second coat.

2.04 GROUP C - GALVANIZED AND NON-FERROUS METALS

- A. System C-1: For use in interior corrosive areas, submerged or non-submerged surfaces, non-potable water applications, galvanized steel and aluminum, including ductwork.
1. Surface Preparation: Solvent cleaning followed by brush-off blast to provide a 1 to 2 mil profile suitable for mechanical adhesion per SSPC-SP1.
 2. First Coat: One coat of two-component, polyamidoamine cured epoxy, semi-gloss 2.5-3.5 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.
 3. Second Coat: Same as first coat.
- B. System C-2: For use in interior dry galvanized steel and aluminum, including ductwork.
1. Surface Preparation: Solvent clean per SSPC-SP1.
 2. First Coat: One coat of Two-component, polyamidoamine cured epoxy, semi-gloss 2.5-3.5 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.
 3. Second Coat: Same as first coat.
- C. System C-3: For use in exterior areas, non-immersion, subject to occasional corrosive spray or fumes, galvanized steel and aluminum materials, including ductwork.
1. Surface Preparation: Solvent cleaning followed by brush-off blast to provide a 1 to 2 mil profile suitable for mechanical adhesion per SSPC-SP7.

2. First Coat: One coat of Two-component, polyamidoamine cured epoxy, semi-gloss 2.5-3.5 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.
3. Second Coat: One coat of polyurethane finish, 2.5-3.5 mils DFT -Tnemec 73 Endura - Shield, or Equal.

2.05 GROUP M - SPECIAL COATINGS

- A. System M-1. For use as barrier between dissimilar materials and metals.
 1. Prime: None
 2. Finish: One component coal tar solution, Tnemec Series 46-465, 8.0-10.0 mils DFT
- B. System M-2. For sealing concrete floors where concrete is shown as natural in the Finish Schedules and on all exposed concrete floors where no finish has been shown.
 1. Surface Preparation: Mechanically abrade floor to achieve a profile equal to ICRI CSP 2-CSP 3.
 2. First Coat: One coat of clear epoxy floor sealer, 8-10 mils DFT, Tnemec 201 Epoxoprime, or Equal.
- C. System M-3. For coating of PVC piping interior or exterior.
 1. Surface Preparation: SSPC SP1 first then scarify surface.
 2. Prime: Epoxy equal to Tnemec Series 66 at 2.0 to 3.0 mil DFT.
 3. Finish: Epoxy equal to Tnemec Series 73 at 2.0 to 3.0 mil DFT.

2.06 FINISH COAT OVER EXISTING FINISH

- A. The required painting shall consist of one coat of the system "Finish Coat" to provide continuity of texture and color over previously painted surfaces.

2.07 THINNING

- A. Where thinning is necessary, only the products for the particular purpose and by the manufacturer furnishing

the paint shall be allowed. All thinning shall be done strictly in accordance with the manufacturer's instructions and with the full knowledge and approval of the Engineer.

PART 3 EXECUTION

3.01 SHOP PAINTING

- A. All ferrous and non-ferrous surfaces shall be solvent cleaned before priming. Primer shall be applied in the shop to protect surfaces from rust during shipment and storage.
- B. Apply two coats of paint to surfaces which are inaccessible after assembly or erection.

3.02 FIELD PREPARATION

- A. All surfaces to be painted shall be prepared in a workmanlike manner with the objective of obtaining a smooth, clean and dry surface. No painting shall be done before the prepared surfaces are approved by the Engineer.
- B. Surface preparation for miscellaneous surfaces to be painted, not specifically covered in these specifications, shall be as recommended by the manufacturer of the paint selected for use and as approved by the Engineer.
- C. Perform preparation and cleaning procedures in strict accordance with coating manufacturer's instructions for each substrate condition.
- D. Remove hardware and accessories, machined surfaces, plates, lighting fixtures and similar items in place and not to be finish-painted, or provide surface-applied protection. Reinstall removed items after painting is completed. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes to masonry walls unless moisture content of surfaces are below 12 percent.

3.03 APPLICATION

- A. Mix, prepare, and store painting and finishing materials in accordance with manufacturer's directions.
- B. Apply painting and finishing materials in accordance with the manufacturer's directions. Use applicators

and techniques best suited for the material and surfaces to which applied.

- C. Workmanship for applying paint shall be of professional quality. The painter shall apply each coat at the rate recommended by the manufacturer smoothly without runs, sags, or holidays. If the material has thickened or must be diluted for use with a spray gun, the coating shall be built up to the same thickness as achieved with undiluted materials. In other words, one gallon of paint as originally furnished by the manufacturer shall not cover a great square foot area when applied by spray gun than when applied by brush. Deficiencies in film thickness shall be corrected by the application of additional coat or coats of paint. On masonry, application rates will vary according to the surface texture; however, in no case shall the manufacturer's stated coverage rate be exceeded. On porous surfaces, it shall be the painter's responsibility to achieve a protective and decorative finish either by decreasing the coverage rate or by applying additional coats of paint. Before succeeding coats are applied to a surface, the preceding coat shall have been approved by the Engineer.
- D. Drying time shall be construed to mean "under normal conditions". Where conditions are other than normal because of the weather or because painting must be done in confined spaces, longer drying times will be necessary. Additional coats of paint shall not be applied, nor shall units be placed in service, until paints are thoroughly dry.

TABLE 09900-1

PAINTING SCHEDULE

- A. Above ground Flowmeter and Flow Control Valve Piping Assemblies.
1. Ductile iron pipe, valves, fittings, flow meters, motors, equipment and supports - System B-4
 2. Galvanized and non-ferrous metals - System C-3.
 3. PVC Pipe and conduit - System M-3.
 4. Top of concrete equipment pads - System M-2

END OF SECTION

SECTION 09902

PIPE AND EQUIPMENT PAINTING

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This Section includes pipe painting and identification as required for this project.

1.02 SUBMITTALS

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

1.03 WARRANTY

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

PART 2 PRODUCTS

2.01 PAINTING AND IDENTIFICATION

- A. Exposed piping (except stainless steel) shall be painted. Metal pipe shall be painted B-3 or B-4 depending on location. Seal coats shall be used over bitumen coated surfaces as applicable utilizing System B-2. Plastic pipe shall be painted in accordance with pipe manufacturer's recommendations utilizing System M-3.
- B. General Notes and Guidelines:
 - 1. All color numbers and names herein refer Tnemec to master color card. Colors of specified equal manufacturers may be substituted with approval of the Engineer.
 - 2. Pipe lines, equipment, or other items which are not listed here shall be assigned a color by the Engineer and shall be treated as an integral part of the Contract.
 - 3. When color coding is specified or directed by the Engineer, it shall consist of color code painting and identification of all exposed conduits, through lines and pipelines for the transport of gases, liquids, or semi-liquids including all

accessories such as valves, insulated pipe coverings, fittings, junction boxes, bus bars, connectors and any operating accessories which are integral to a whole functional mechanical pipe and electrical conduit systems.

4. Description on titles (Abbreviated Code on Pipe/Equipment) to be lettered on pipes or equipment will be black or white to contrast with color of pipes and equipment and shall be stenciled applied, as approved by the Engineer.
5. All moving parts, drive assemblies, and covers for moving parts which are potential hazards shall be Safety Orange 04SF.
6. All safety equipment shall be painted in accordance with OSHA standards.
7. All inline equipment and appurtenances not assigned another color shall be painted the same base color as the piping. The pipe system shall be painted with the pipe color up to but not including the flanges attached to pumps and mechanical equipment assigned another color.
8. All pipe hangers and pipe support floor standards shall be painted.
9. All conduit shall be painted to match its background surface.
10. Building surface colors shall be painted as scheduled in the Finish Schedule or as selected by the Engineer.
11. Doors and frames shall be painted as scheduled in the Finish Schedule or as selected by the Engineer.
12. Wood casework, frames, doors, etc. shall be finished with urethane as specified except as specifically noted otherwise.

2.02 PAINT COLOR CODE SCHEDULE

- A. In situations where two colors do not have sufficient contrast to easily differentiate between them, a six-inch band of contrasting color should be painted on one of the pipes at approximately 30-inch intervals. The

name of the liquid or gas should also be painted (stenciled) on the pipe in a contrasting color. In some cases, it may be advantageous to paint arrows indicating the direction of flow.

Color of Pipe and Equipment Color

Description of Title to Be Lettered on Pipes and Equipment	Title Letters	Color Name	Color Number
<u>EQUIPMENT</u>			
Sump Pumps	White	Light Gray	A0385
Sluice Gate Operators	White	Safety Orange	04SF
Sodium Hypochlorite Pumps	Black	Safety Yellow	02SF
Effluent Reuse Pumps	White	Pantone Purple	522-C
Filter & Effluent Sample Pumps	White	Aquamarine	G0427
Conduit	White	Cypress Green	G0383
Conduit Trays	White	Cypress Green	G0383
<u>PIPES</u>			
Raw Wastewater Pipe	White	Light Gray	A0385
Sump Pump Pipes	White	Light Gray	A0385
Sodium Hypochlorite Pipe & Header	Black	Safety Yellow	02SF
Effluent Reuse Pipe	White	Pantone Purple	522-C
Sodium Hypochlorite Sample Pipe	Black	Safety Yellow	02SF
Cold Water	Black	Azure	J8162
Hot Water	Black	Azure	J8162

**2.03 PAINTING OF EXISTING STRUCTURES, PIPING, VALVING AND
EQUIPMENT**

- A. Touch up existing structures and equipment where finish
has been damaged by new construction.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 11001

EQUIPMENT - BASIC REQUIREMENTS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provisions: Requirements specified in Division 1 form a part of this Section.
- B. Work Included in this Section. The Contractor shall provide all the required labor, project equipment and materials, tools, construction equipment, safety equipment, transportation, and test equipment for furnishing, installation, adjustment, and full test loading of all the mechanical work shown on the Contract Drawings and included in these Specifications.
- C. Unless otherwise specified, the work of this division is also subject to the requirements of all other divisions of these specifications including, but not limited to: Divisions 9, 13, 15 and 16. Unless otherwise specified, all other sections of this division are subject to the requirements of this section.

1.02 QUALITY ASSURANCE

- A. Incorporated Documents: Published specifications, standards, tests, or recommended methods of trade, industry, or governmental organizations apply to work of these Specifications where cited below. In every situation, the latest specifications, standards, tests, etc., shall apply unless otherwise noted.
- B. Variances: In instances where two codes are at variance, the more restrictive requirements shall apply.
- C. Contractor's Expense: The Contractor shall obtain and pay for the required bonds, insurance, licenses, permits, and inspections (unless otherwise specified), and pay all taxes, fees and utility charges that shall be required for the construction work.
- D. Extra Work: Work that is not included in the Contract Documents shall not be performed, except when approved in writing by the Owner.

- E. Standard of Quality: Items of equipment are specified herein by the name of a manufacturer for the purpose of establishing a standard of quality and acceptable experience. Alternate equipment will be given consideration, per Section 01600 - Material and Equipment.
- F. Data: Unless otherwise specified, all equipment furnished shall have a data plate fabricated of 316 stainless steel with a minimum thickness of 1/16 inch and embossed or preprinted lettering, and fastened to the frame with corrosion-resisting pins. Nameplates shall have stamped on them the manufacturer, serial number, model number, type, operating and performance data, and other pertinent data. Letters and numerals shall not be smaller than 3/16 inch high.
- G. Taggings: Where the size of the equipment prevents the fastening of data plates, name tags shall be provided and attached to the equipment and device item to identify it. The name tags shall have a rectangular configuration with square corners and shall be approximately 1-1/2 inches by 3 inches in size. They shall be made from brass or stainless steel sheet metal and have a minimum thickness of 0.032-inch. Letters and numerals shall be engraved or etched in the name tags by a professional engraver and shall not be smaller than 3/16 inch high in size. The name and number for each item of equipment, as designated on the Contract Drawings, shall appear on the name tag for the item. Valve tag information shall conform to Section 15100 - Valves and Appurtenances. A 3/16-inch diameter hole shall be provided in the upper left-hand corner of each name tag and shall be used to attach the name tags to the equipment and device items with 1/8-inch stainless steel cable.

1.03 DRAWINGS

- A. Project Drawings: The Drawings are diagrammatic and show the general layout of the complete construction work.
 - 1. Locations of equipment, inserts, anchors, motors, panels, conduits, stub-ups, fittings, fixtures, air, water, power and process inlets, unless specifically dimensioned on the Contract Drawings, shall be determined to suit field conditions encountered, and the Contractor shall be responsible for ensuring clearance between pipes,

equipment, and similar appurtenances, without extra cost to the Owner.

2. The Contractor shall review the Contract Drawings and Specifications of other trades and shall include the mechanical work shown thereon that will be required for the installations.
3. Should there be a need to deviate from the Contract Drawings and Specifications, the Contractor shall submit written details and reasons for all changes to the Engineer for approval before making such changes. All extra costs to make the changes will be borne by the Contractor.
4. In the event of varying interpretations of the Contract Documents, the Engineer's interpretation shall govern.

B. Shop Drawings

1. Prior to fabrication, the Contractor shall obtain, from the manufacturer, shop drawings for all equipment. Shop drawings shall include fabrication, assembly, unit support drawings, installation drawings, and wiring diagrams together with detailed specifications and data covering materials used, power drive assembly, parts, devices, and other accessories forming a part of the equipment to be furnished.
2. The Contractor shall submit Certified performance or Certified test curves, as specified for all pumps furnished under this Contract. The Contractor shall notify the Engineer three weeks prior to all testing should the Engineer elect to witness the tests.
3. Submit shop drawings and material lists for approval as specified in applicable Sections and in conformance with the requirements of Section 01340 - Shop Drawings, Project Data and Samples.

1.04 ADAPTATION OF EQUIPMENT

- A. Should any alternate equipment selected require any revision to the structure, piping, electrical, or other work shown on the Contract Drawings, the Contractor shall include the cost of such revisions in his bid for the equipment and no extra payment shall be made for

such revision. All such revisions shall be subject to the approval of the Engineer.

1.05 UTILITY SERVICE AND PROCESS INTERRUPTION

- A. All utility service and/or process interruptions initiated by the Contractor in the prosecution of his work shall be scheduled in advance and approved in writing by the appropriate Utility Company and the Owner.

1.06 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit to the Engineer operation and maintenance manuals on all mechanical equipment in accordance Specification 01730 - Operation and Maintenance Data. Two (2) copies of draft manuals shall be submitted for approval not later than the date of shipment of the equipment. Five (5) final conformed copies shall be submitted and available to Owner's personnel at least two weeks prior to start-up and instruction for each piece of equipment. Refer to Division 1.

1.07 INSTALLATION MANUALS

- A. In addition to operation and maintenance manuals, the Contractor shall submit to the Engineer three (3) copies of all installation manuals for each piece of equipment. This manual shall be submitted at the same time as the operation and maintenance manual. Installation of equipment shall not be performed until installation manuals are received.

1.08 EQUIPMENT GUARANTEE

- A. The Contractor shall furnish and replace, without cost to Owner, all equipment parts that are defective or show undue wear within 3 years from the date of substantial completion of the work by the Owner unless extended periods of warranty for specific pieces of equipment are specified elsewhere. In addition to performance guarantees, all processes or systems shall comply with the requirements of applicable portions of the Sections of these Specifications describing those systems.

PART 2 PRODUCTS

2.01 MATERIALS AND WORKMANSHIP

- A. All equipment furnished under this Division shall be new and guaranteed free from defects in materials, design, and workmanship. These Specifications, to the extent possible, identify service conditions and requirements for all equipment; however, it shall be the manufacturer's responsibility to ascertain, to his satisfaction, the conditions and service under which the equipment will operate and to warrant that operation under those conditions will be successful. All parts of the equipment shall be amply proportioned for all stresses that may occur during fabrications, erection, and intermittent or continuous operation.
- B. All equipment shall be designed, fabricated, and assembled in accordance with the best modern engineering and shop practice. Individual parts shall be manufactured to standard sizes and gauges so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests. Materials shall be suitable for service conditions.
- C. Except where otherwise specified, structural and miscellaneous fabricated steel used in items of equipment shall conform to the Standards of the American Institute of Steel Construction. All structural members shall be considered as subject to shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment, shall have a minimum nominal thickness of 1/4 inch. The location of the fabricator and his shop schedule shall be furnished to the Engineer prior to the beginning of fabrication so that the Engineer can schedule shop inspection if so desired.

2.02 EQUIPMENT BASES AND BEDPLATES

- A. Unless otherwise indicated, a 316 Stainless Steel (SS) base shall be provided for each item of equipment which is to be installed on a concrete foundation. Equipment assemblies, unless otherwise specified, or shown on the Contract Drawings, shall be mounted on a single, heavy, 316 SS bedplate. Bases and bedplates shall be provided with machined support pads, tapered dowels for

alignment of mating, or adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits. All seams and contact edges between SS plates and shapes shall be continuously welded and ground smooth. The plates shall have a minimum thickness of 1/4 inch. All pump bedplates must include a drip lip and provision for directing accumulated gland leakage to a single disposal drain point.

2.03 JACKING SCREWS AND ANCHOR BOLTS

- A. Jacking screws shall be provided in the equipment bases and bedplates to aid in leveling prior to grouting.
- B. Equipment suppliers shall furnish anchor bolts, nuts, washers, and sleeves of adequate design as required for proper anchorage of the bases and bedplates to the concrete bases. Sleeves shall be a minimum of 1-1/2 times the diameter of the anchor bolts. Unless otherwise shown or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-inch of grout beneath the baseplate and to provide adequate anchorage into structural concrete. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed. Anchor bolts shall be 316 stainless steel which conforms to ASTM A-167 and ASTM A-267.

2.04 LUBRICATION

- A. Lubrication of equipment shall ensure constant presence of lubricant on all wearing surfaces. Lubricant fill and drain openings shall be readily accessible. Easy means for checking the lubricant level shall be provided. Prior to testing and/or operation, the equipment shall receive the prescribed amount and type of lubricant as required by the equipment manufacturer. The Contractor shall provide to the Owner a 1-year supply of lubricants for each piece of equipment installed. All lubricants shall be properly packaged, labeled, and delivered to the Owner concurrent with equipment installation. An inventory listing of lubricant types by equipment and quantities shall be provided.

PART 3 EXECUTION

3.01 COORDINATION

- A. The Contract Drawings show, in a diagrammatic form, the arrangements desired for the principal apparatus, piping, and similar appurtenances, and shall be followed as closely as possible. Proper judgment must be exercised in carrying out the work to secure the best possible headroom and space conditions throughout, to secure neat arrangement of piping, valves, fixtures, hangers, and similar appurtenances, and to overcome local difficulties and interference of structural conditions wherever encountered.
- B. The Contractor shall take all measurement for his work at the installation sites, verify all subcontractor Drawings prior to required submittal and be responsible for the proper installation, within the available space, of the apparatus specified and shown on the Drawings. The Contractor must secure the approval of the Engineer for all variations and/or substitutions before making any changes.

3.02 PROTECTION

- A. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling and storage. All equipment shall be protected from exposure to the elements and shall be kept thoroughly dry and clean at all times. Pumps, blowers, motors, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weather tight storage facilities such as warehouses. All materials and equipment showing evidence of rust, dirt contamination, or other surface or subsurface deterioration shall be cleaned and restored to the Engineer's satisfaction prior to installation.
- B. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted in accordance with the requirements of Section 09900 - Painting and Coatings to the satisfaction of the Engineer.
- C. Electrical equipment, controls, and insulation shall be protected against moisture or water damage.

- D. The Contractor shall maintain equipment storage facilities in accordance with the provisions of Division 1.
- E. All equipment shall be stored in the designated storage facilities from delivery until installation.
- F. All mechanical equipment, whether in the Contractor's designated storage facility prior to final installation, or whether installed, but not yet placed into service or accepted by the Owner, shall be periodically exercised at intervals, and in accordance with procedures prescribed by each manufacturer, if such a recommendation is included in the manufacturer's installation, operation and maintenance instructions.

3.03 INSTALLATION CHECK

- A. The Contractor shall have an experienced, competent, and authorized representative of the manufacturer or supplier of each major item of equipment visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The Contractor shall have the equipment supplier's representative revisit the job site as often as necessary until all problems are corrected and the equipment installation and operation is satisfactory to the Engineer.
- B. Each equipment supplier's representative shall furnish to the Owner, through the Contractor, a written report certifying that the equipment: (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from all stress imposed by connecting piping or anchor bolts; and, (4) has been operated successfully under full load conditions.
- C. Equipment manufacturers shall furnish the services of competent, factory-trained personnel during the warranty period specified to inspect, service, and repair the equipment where required. Service requests shall be answered and acted upon promptly. This requirement shall not include normal maintenance and service of equipment, which will be the responsibility of the Owner.
- D. All costs for this work shall be included in the price bid by the Contractor.

3.04 EQUIPMENT INSTALLATION

A. All equipment shall be installed in full accordance with the equipment manufacturer's recommendations and good practice. Where specified in other parts of this Division, factory-trained service personnel shall be on-site to supervise the installation. Sufficient notice shall be given to the Engineer prior to equipment installation in order that the Engineer or his representative may be present during installation. In general, the following installation practices shall be followed:

1. Examine equipment for damage in shipping and handling. The examination shall include checking for corrosion, poor workmanship, dirt or deleterious substances, and poor fits.
2. Level the base plate or bedplate
3. Install equipment
4. Check alignment of couplings
5. If grout has been used, check alignment and levelness after the grout has set.
6. Check direction of rotation and correct, if necessary, to insure proper operation.
7. Ensure that all submerged or intermittently submerged powered equipment does not have power and control cable splices of any kind inside wells or pits.

3.05 PLACING IN OPERATION

A. Prior to being placed in operation, equipment shall be inspected by the manufacturer's factory-trained personnel. All defects discovered during this inspection shall be corrected prior to initial equipment start-up. Internal coatings applied at the factory shall be removed if required. Lubricant shall be applied in the proper places and levels shall conform to the manufacturer's recommendations. In the presence of the Engineer, full-load operational testing shall be performed and the results of such tests shall be recorded. Unsatisfactory performance shall be corrected and tests shall be repeated until the equipment performance meets the Specifications. The Contractor shall furnish all power, materials,

services, test equipment and labor required to successfully complete all full load equipment testing specified. The Contractor shall certify in writing to the Engineer, in triplicate, that all tests were conducted in accordance with these Specifications and that all components within each system successfully function as required. The Contractor shall notify the Engineer ten (10) calendar days in advance of the time when the equipment will be placed into operation. During the course of initial operation, the Contractor shall instruct Owner's personnel in the proper operation and maintenance of the equipment, as specified herein.

3.06 INSTRUCTION

- A. After the equipment specified in Divisions 11, 13, 15 and 16 have been installed, tested, adjusted, and placed in satisfactory operating condition, services of representatives of each equipment manufacturer shall be provided to instruct the operating personnel in the use and maintenance of the equipment. The instruction period shall be scheduled at a time mutually agreed upon with the Owner, prior to final acceptance. The manufacturer's representatives shall fully instruct the Owner's personnel regarding use and maintenance of the equipment. During this instruction period, it shall be the responsibility of the manufacturer to answer all questions from the Owner's operating personnel. Manufacturer shall also demonstrate lubrication, disassembly, adjusting, routine parts replacement, and other "hands-on" activities related to maintenance of the equipment. Provide a minimum of not less than eight (8) hours for this instruction for each piece of equipment or set of identical pieces of equipment provided unless otherwise specified. More days shall be provided if called for in the individual equipment specification. Each manufacturer shall include the service in the price of his equipment. Training session schedules shall be coordinated with the Owner and Engineer and under no circumstances shall more than two training sessions be scheduled for the same day. The Contractor shall designate an individual through whom manufacturer's training will be coordinated. This individual will coordinate all training sessions through Owner's designated training coordinator.

3.07 SPECIAL TOOLS AND ACCESSORIES

- A. All special tools, special tool lists, equipment, or accessories required for the installation and

maintenance of equipment specified in Division 11, as well as three (3) copies each of instruction manuals necessary for the proper use of such tools, equipment, or accessories shall be provided by the equipment manufacturer. Special tools shall be defined as those items manufactured by the equipment supplier specifically for performing maintenance and installation of their respective equipment, including knocker wrenches for gearboxes.

3.08 SHOP PAINTING

- A. Except as specifically supplemented or superseded by requirements herein, shop painting shall conform to requirements in Section 09900 - Painting and Coatings. Electric motors, gears, starters, and other similar self-contained or enclosed components shall be shop primed and finished with a high-grade oil-resistant acrylic enamel. Surfaces which will be inaccessible after assembly shall be painted or otherwise protected before assembly by a method which provides protection for the life of the equipment.
- B. Surfaces to be painted at the project site shall be shop painted with one or more coats of a primer which will adequately protect the equipment until finishes are applied at the project site. Primers shall be as specified in Section 09900 - Painting and Coatings. All equipment shall be primed with primer compatible with the coating system selected by the Contractor, and if not, the Contractor shall reprime the equipment such that it is compatible and in conformance with Section 09900 - Painting and Coatings.
- C. Machined and polished metallic surfaces which are not to be painted shall be coated with a rust preventive compound as specified in Section 09900 - Painting and Coatings.

3.09 DAMAGED PRODUCTS

- A. The Contractor shall notify the Engineer in the event that any equipment or material is damaged subsequent to receipt at the job site, and prior to acceptance of the installation by the Owner.
- B. Repairs to damaged products in lieu of replacement shall not be made without prior approval by the Engineer.

END OF SECTION

SECTION 13300

INSTRUMENTATION AND CONTROLS, GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 THE REQUIREMENT:

- A. The Contractor shall provide, through the services of a single Control System Integrator (CSI), all components and system installation services, as well as all required and specified ancillary services, whether reflected in the Contract Documents or not, in connection with the Instrumentation and Control System (ICS) as specified herein for a complete and operable system. The system shall include all materials, labor, tools, fees and documentation required to furnish, install, test and place into operation, a complete and operable ICS whether or not shown and/or specified within this section, related ICS specification sections, and subsections within equipment specifications. The system shall include all measuring elements, signal converters, transmitters, specialty cables, control panels, digital hardware and software, remote telemetry units (RTU), signal and data transmission systems, interconnecting wiring and such accessories as shown, specified and/or required to provide the functions indicated, whether specifically mentioned or not.
- B. Additionally, the Contractor / Control Systems Integrator shall provide the services of Data Flow Systems, Melbourne FL (DFS) to install and provide the Data Flow RTU Systems described herein.
- C. The requirements provided within this section shall be applied to all of the Instrumentation and Controls specifications, Sections 13300 through 13340, as well as additional specifications sections as referenced. The ICS shall be provided as a single and complete system as specified herein and as specified within the following ICS specifications:
 - 1. Section 13310 - Instrumentation and Controls, Field Equipment
 - 2. Section 13320 - Instrumentation and Controls, Control Enclosures
 - 3. Section 13330 - Instrumentation and Controls, SCADA Hardware
 - 4. Section 13340 - Data Flow Systems RTU Hardware
- D. For the purposes of these specifications the Control System Integrator shall be referred to as the CSI. Where references are made to the SCADA System Programmer

- E. The Contractor shall be ultimately responsible for installation of the ICS. However, the CSI and DFS will include installation within the scope of the subcontract to provide for furnishing and installation of the complete system as specified. The CSI and DFS shall also coordinate this work with the Contractor to ensure that the proper type, size and number of wires with their conduits are provided and installed. This coordination will also ensure that proper electrical power circuits are provided for all components and systems.
- F. The Contractor's responsibilities, as distinct from the CSI's and DFS's responsibilities, shall be to provide all additional materials and work necessary to supplement the materials and work provided by the CSI and DFS, thereby satisfying all requirements that are within ICS.
- G. The Contractor shall coordinate structural work, penetrations, painting, etc., as required for installation of a complete ICS. In-line or integrally mounted items (such as flow elements, level sensors, etc.) shall be installed under the supervision of the CSI and DFS.
- H. The Contractor shall be responsible for coordinating interfaces between ICS equipment provided under the ICS specification sections and the equipment provided under other sections of the specifications. The Contractor shall verify and coordinate space requirements, process equipment power supply and voltage, process equipment control power supply and voltage, compatibility of control signals, details of equipment installation and interconnection. Coordination shall include distribution of approved shop drawings to all vendors, subcontractors, etc., involved in the control interface. Likewise, the Contractor shall ensure that instrumentation and control devices provided under other sections of the specifications are compatible and of the same quality and characteristics as similar devices specified under the ICS specification sections.
- I. The CSI will not be responsible for providing PLC and HMI control programming and logic. These services will be provided under a separate contract. The Hyper Tac and RTU equipment programming shall be provided by DFS.

1.02 SCOPE:

- A. The scope listed within this subsection pertains to major items of supply. Refer to the complete Contract Documents for all requirements. For additional clarification of scope refer to related specification sections.
- B. This project shall provide for the automation of the Reclaimed Water for the Manatee County Southwest and Southeast Water Reclamation Facility. This project will include and provide additions, upgrades and modifications to the in-plant SCADA System, Remote RTU Systems and existing ICS. The ICS shall monitor and control the remote storage ponds and reclaimed water valves as shown on the Drawings and Technical Specifications.
- C. The Data Flow RTU systems described herein shall communicate to the existing Hyper SCADA server located in the Administration Building at the Southwest and Southeast Water Reclamation Facility. The data from the remote RTU shall be exchange with the control room PIC PLC by utilizing the existing / proposed protocol converter installed in the Hyper SCADA server. The Southwest facility has an existing converter. The Southeast facility protocol converter shall be installed as part of this project. Data Flow Systems shall coordinate with the SSP for the registers required in the PIC PLC.
- D. Wireless Ethernet radios and programmable logic controllers shall be provided in the locations provided on the contract drawings to allow for ICS control of the reclaimed water ponds and valves for the Southwest facility.
- E. As part of this project modifications will be required in the following existing PLC control panels SP-X(SCADA Panels) others shown in the contract documents to accommodate the Input/Output and Communication requirements:
 - 1. Southwest SP-1(Main Electrical Building)
 - 2. Southwest SP-2(Chemical Building)
 - 3. Southeast SP-1(Main Electrical Building)
 - 4. Southeast SP-2(MCC/Blower Building No. 2)
 - 5. Southeast SP-3(MCC/Blower Building No. 3)
- F. The following additional major items of supply shall be provided:
 - 1. Furnish and install instrumentation as specified.

2. Furnish TVSS for instrumentation and control panels as specified.
3. Furnish and install new equipment to provide all specified SCADA Input/Output signals and functions.
4. Furnish and install all fiber optic cables and equipment as noted herein and on the drawings. Field install all communications equipment in vendor cabinets.
5. Interfacing with control panels provided by other equipment suppliers under this contract.
6. Spare parts as described herein.
7. Implementation and testing of the complete system, including testing with the SSP.
8. Training of Owner personnel.
9. Operations and Maintenance Manuals.

1.03 RELATED WORK SPECIFIED ELSEWHERE:

A. Division 11 - Equipment

1. Refer to individual product specifications within specification sections for additional requirements specific to those devices. Instrumentation and control equipment supplied as part of packaged systems shall be integrated into the ICS as specified.
2. Where Division 11 equipment suppliers are providing instrumentation and control equipment for which there is no specification within their respective equipment specification, they shall provide equipment in accordance with the ICS specifications. This equipment shall be compatible and of the same quality and characteristics as similar devices specified under the ICS specifications. If possible the same make and/or model supplied under the ICS specifications shall be provided.
3. PLC and HMI programming performed by Division 11 equipment suppliers shall be coordinated with the CSI to provide supervisory control and monitoring of control panels provided under Division 11 via network communications.

B. Division 16 - Electrical

1. Where electrical subcomponents are to be provided as part of ICS equipment, but for which there is no specification, provide in accordance with Division 16 - Electrical. These subcomponents shall be

2. The following work shall be provided under Division 16 - Electrical:

- a) Conduit, raceways and installation of wire and cable for all instrumentation and control system signal wiring, grounding systems, special cables and network cables except as noted.
- b) Instrumentation and control system signal field wire.
- c) Final wire preparation and termination of field wires to ICS equipment as directed by the CSI.
- d) Grounding systems for all ICS equipment.
- e) Mounting of ICS electrical enclosures (i.e. control panels, TVSS boxes, electronic instrumentation, etc.) with exclusion of final measuring elements of instrumentation (i.e. flow tubes, sensors in process piping, etc.) which shall be as coordinated by the Contractor.

3. The CSI shall provide all termination information for the ICS equipment, to support equipment terminations provided under Division 16. This information shall be provided within ten (10) days of ICS equipment arrival onsite or as required by the project schedule. The information shall be in the form of drawings and termination lists, showing complete termination information (to/from panels, terminal numbers, terminal block locations, signal types, voltages, etc.).

1.04 CODES AND STANDARDS:

- A. The ICS shall comply with the National Electric Code, National Electric Safety Code, OSHA and with all applicable federal, state, county, municipal and electrical utility codes and regulations, as well as the Contract Documents. In the event of any conflict between these codes, regulations and Contract Documents, the most restrictive shall apply.
- B. The Instrumentation and Control System shall comply with the following codes and standards as well as any others within the specifications and drawings. In

1. Applicable state, county and municipal code requirements.
2. Applicable standards of the National Fire Protection Association (NFPA)
 - a) National Electrical Code (NEC).
3. Applicable standards of the Underwriter's Laboratories, Inc. (U.L.)
 - a) UL 508 Industrial Control Equipment
 - b) UL 508A Industrial Control Panels
 - c) UL 698 Industrial Control Equipment for Use in Hazardous Locations
4. Applicable standards of the Institute of Electrical and Electronics Engineers (IEEE)
5. Applicable standards of the National Electrical Manufacturers Association (NEMA)
 - a) NEMA 250 Enclosures for Electrical Equipment (1000 V Maximum)
 - b) NEMA ICS 1 Industrial Control and Systems: General Requirements
 - c) NEMA ICS 6 Enclosures for Industrial Control and Systems
6. Applicable standards of the International Society of Automation (ISA)
 - a) S5.1 Instrumentation Symbols and Identification
 - b) S5.4 Instrument Loop Diagrams
 - c) S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves
 - d) TR20.00.01 Specification Forms for Process Measurement and Control Instruments

1.05

SUBMITTALS:

- A. All shop drawings shall be in accordance with Section 01340 - Shop Drawings, Project Data and Samples. In addition to the requirements set forth

- B. Every submittal shall have a separate section entitled "Requested Deviations from ICS Specifications" which shall clearly define and explain all requested deviations and exceptions of the Instrumentation and Control System to this Specification. Only those deviations requests listed in this section will be reviewed by the Engineer.
- C. After all changes or corrections resulting from the Engineer's review of the system supplier's drawings have been made, panels may be built and instrumentation devices may be supplied in accordance with the approved drawings. One set of 'As Shipped' prints shall be included in the panels when shipped from the system supplier's wiring and assembly shop.
- D. The following major list of submittals shall be provided as a minimum. Major submittals are generally listed in the order they are to be provided. Refer to related ICS specification sections and equipment subsections for additional submittals and submittal requirements.
1. Preliminary Design Review/Project Plan Submittal
 2. Process Field Instrumentation Submittal
 3. SCADA System Control Panel Submittal
 4. SCADA System Hardware and Software Submittal
 5. Preliminary Operation and Maintenance Manuals
 6. Training Submittal
 7. Testing Submittal
 8. Tools, Supplies and Spare Parts Lists Submittal
 9. Site Installation/Startup Plan Submittal
 10. Final Operation and Maintenance Manuals
- E. Preliminary Design Review/Project Plan Submittal
1. The Project Plan shall provide an overview of the proposed system including system architecture diagrams, the approach to work, the proposed work schedule indicating milestones and potential meetings, project personnel and organization, details of factory testing and field testing, details of training programs, and a paragraph by paragraph review

- a) Schedule for all subsequent project submittals.
- b) Tentative dates for all project design review meetings.
- c) Schedule of manufacture and staging of all instrumentation and control system equipment.
- d) Schedule for all testing.
- e) Schedule for shipment of all instrumentation and control system equipment and peripheral devices.
- f) Schedule for equipment start up.
- g) Schedule for all training.

- 2. The Project Plan submittal will be followed by a ICS project kickoff meeting which will be a discussion of the Project Plan Submittal concerns and issues. This meeting will be scheduled a minimum of two weeks following delivery of the submittal. No other submittals will be allowed prior to acceptance of the Project Plan.

F. Process Field Instrumentation Submittal

- 1. This submittal shall provide complete documentation of all field instruments and other instrument and control equipment not specified to be submitted elsewhere.

- a) Provide data sheets for each component listing all model numbers, optional and ancillary devices that are being provided.

The data sheets shall be provided with an index and proper identification and cross referencing. They shall include but not be limited to the following information:

- 1) Plant Equipment Number and ISA tag number per the Loop Diagrams.
- 2) Product (item) name used herein and on the Contract Drawings.
- 3) Manufacturer's complete model number.
- 4) Location of the device.

- 5) Input - output characteristics.
 - 6) Range, size and graduations.
 - 7) Physical size with dimensions, enclosure NEMA classification and mounting details.
 - 8) Materials of construction of all components.
 - 9) Instrument or control device sizing calculations where applicable.
 - 10) Certified calibration data on all flow metering devices.
- b) Provide equipment specification sheets which shall fully describe the device including the intended function, how it operates and its physical environmental and performance characteristics. Each data sheet shall have appropriate cross references to loop or equipment identification tags. As a minimum the specification sheets shall include the following:
- 1) Dimension, rigid-clearances.
 - 2) Mounting or installation details.
 - 3) Connection.
 - 4) Electrical power or air requirements.
 - 5) Materials of construction.
 - 6) Environmental characteristics.
 - 7) Performance characteristics.
- c) The submittal shall also contain all planning information, site preparation instructions, grounding and bonding procedures, cabling diagrams, plug identifications, safety precautions or guards and equipment layouts in order to enable the Contractor to proceed with the detailed site preparation for all equipment.

G. SCADA System / RTU Control Panel Submittal

1. This submittal shall provide complete documentation of the proposed hardware (control panels, PLCs, peripherals, etc.) including:

- a) A complete system block diagram(s) showing in schematic form, the interconnections between major hardware components such as: control centers, panels, power supplies, consoles, computer and peripheral devices, telemetry equipment, local digital processors and like equipment. The block diagram shall reflect the total integration of all digital devices in the system and shall reflect any man/machine interface locations. All components shall be clearly identified with appropriate cross references to the location of each.

The diagram shall reference all interconnecting cabling requirements for digital components of the system including any data communication links.

- b) Data sheets for each hardware component, listing all model numbers, optional, auxiliary and ancillary devices that are being provided.

The data sheets shall be provided with an index and proper identification and cross referencing. They shall include but not be limited to the following information:

- 1) Equipment Number and ISA tag number per the Loop Diagrams (as applicable).
 - 2) Product (item) name used herein and on the Contract Drawings.
 - 3) Manufacturer's complete model number.
 - 4) Location of the device.
 - 5) Input - output characteristics.
 - 6) Range, size and graduations.
 - 7) Physical size with dimensions, enclosure NEMA classification and mounting details.
 - 8) Materials of construction of all components.
 - 9) Power supply device sizing calculations where applicable.
- c) Equipment specification sheets shall fully describe the device, the intended function, how it operates and its physical

- 1) Dimensions and working clearances.
 - 2) Mounting or installation details.
 - 3) Connection diagrams.
 - 4) Electrical power requirements (volts, amps).
 - 5) Materials of construction.
 - 6) Environmental characteristics.
 - 7) Performance characteristics.
- d) Provide detailed loop diagrams on a single 11-in x 17-in or 8.5-In x 11-in sheet for each monitoring or control loop. The loop diagram shall show all analog, digital and discrete components of the loop, including all relays, switches, dropping resistors, etc. which are being provided for proper operation. Loop numbers used shall correspond to the loop numbers indicated in the Contract Documents. The format shall be the International Society of Automation, Standard for Instrument Loop Diagrams, ISA-S5.4 plus the following requirements:
- 1) On each diagram, present a tabular summary of (1) the output capability of the transmitting instrument, (2) the input impedance of each receiving instrument, (3) an estimate of the loop wiring impedance based on wire sizes and approximate length used, (4) the total loop impedance, (5) reserve output capacity.
 - 2) Show all interconnecting wiring between equipment, panels, terminal junction boxes and field mounted components. The diagrams shall show all components and panel terminal board identification numbers and all wire numbers. This diagram shall include all intermediate terminations between field elements and panels (e.g. terminal junction boxes). The diagrams shall be coordinated with

- 3) Show location of all devices.
 - 4) Show instrument description including type, manufacturer, model number, range, set points and operation (e.g. fail open, open on energization, normally closed, etc.) as applicable.
 - 5) Show all instrument loop power or instrument air requirements back to termination on terminal block or bulkhead, fuse block (including fuse size), etc., as applicable.
- e) Provide detailed Drawings covering control panel consoles and/or enclosures which shall include:
- 1) Cabinet assembly and layout drawings to scale. These shall include both front, rear (where applicable) and interior layouts.
 - 2) Material, fabrication and painting specifications.
 - 3) Color selection samples for selection by the Engineer.
 - 4) Where graphic display panels are required, submit detailed layout to scale, including symbols and line widths, as well as color selection samples and details of fabrication. Half-scale layout will be acceptable.
 - 5) Panel wiring diagrams showing all power connections to equipment within and on the panel, combined panel power draw requirements (volts, amps), breaker sizes, fuse sizes and grounding. This wiring diagram shall be in ladder format and shall reference the appropriate loop drawing for continuations or details where required. Show all wire numbers and terminal block designations.
- f) The SCADA submittal shall also contain all planning information, site preparation instructions, grounding and bonding

H. SCADA System Hardware and Software Submittal

1. Software submittals shall include the following as a minimum:

- a) Bill of materials with hardware components, software names, vendors and complete listings of included software modules.
- b) Standard manufacturer's literature describing the products.
- c) Description of function of software in ICS System.
- d) Software features, limitations and constraints of software.
- e) Minimum system (processor and memory) requirements.

2. Submit information on the following software, where applicable:

- a) Operator Interface (SCADA or HMI) software, including all add-in software provided to perform specific functions (alarm dialers, schedulers, backup creation software, etc.).
- b) Control software (block oriented and/or ladder logic).
- c) Office-type products, such as spreadsheets, word processors, etc.
- d) Database management software.
- e) Communications software, including all applicable local and wide area network software.
- f) Programmable logic controller programming software.
- g) Software configuration, including:
 - 1) Graphic display organization.
 - 2) Database configuration for real-time, historical, etc. databases.

- 3) Trends.
- 4) System security.
- 5) Formats for all reports, including all required calculations.
- 6) Intercommunications between software products required to implement system functions.
- 7) Equipment backup configuration and requirements.

I. Training Submittals

1. Training Plan Submittal: The training plan shall include:
 - a) Definitions of each course with necessary pre-requisites.
 - b) Specific course attendance.
 - c) Schedule of training courses including dates, duration and locations of each class.
 - d) Résumés of the instructors who will actually conduct the training.

J. Testing Submittals

1. Three levels of system testing shall be required: Unwitnessed Factory Testing, Operational Readiness Testing and Performance Acceptance Testing.
2. Test plans shall be submitted only after all hardware submittals have been approved by the Owner and/or Engineer.
3. The test plan shall demonstrate that the CSI has designed and configured a system that meets the design specifications. The documents for the test plan shall be structured so that the Owner understands what the inputs are, what the predicted outputs should be, and what the actual outputs are. The test plan should have sign-off and date block for the CSI, the Contractor and the Owner.
4. The complete test plan should include but not be limited to the following:
 - a) Test assumptions and methods

- b) Test Equipment List
- c) Test Personnel Staffing and Qualifications
- d) Test Schedule with time allotted for each task
- e) System hardware and software summary.
- f) Communications test to the various PLCs for Discrete and Analog I/O data transfer.
- g) One hundred percent (100%) I/O point test including all spare points based upon the previously submitted System I/O list.
- h) Functional and Control strategy tests.

5. Test Procedures: Submit the procedures proposed to be followed during the test. Procedures shall include test descriptions, forms and checklists to be used to control and document the required tests. Testing may not be started until all Testing Submittals have been approved.

6. Test Documentation: Submit a copy of the signed off test procedures upon completion of each required test.

K. Tools, Supplies and Spare Parts Lists Submittal

1. This submittal shall include a list of all required and recommended spares. The following information shall be provided in table format:

- a) Specification Section
- b) Tagname
- c) Description
- d) Quantity
- e) Manufacturer
- f) Model, part, order number
- g) Local distributor and manufacturer contact information. Contact information shall include address, phone number and website.

L. Operation and Maintenance Manuals

1. Prior to installation of any equipment onsite, preliminary O&M manuals shall have been submitted and approved. No installation of equipment shall be permitted without the Contractor maintaining an updated version of

2. After all field changes or corrections made during installation and field check out have been completed, all system supplier documentation, including drawings, shall be revised to reflect the "as installed, corrected and accepted" condition of the system and final record copies of O&M manuals for the system shall be provided to the Owner and Engineer for approval.
3. Final system documentation shall be provided in 3-hole type binders of archival quality (e.g. slant D or elliptical binding, vinyl with metal hinge or extra heavy weight vinyl, etc.) with a binding no larger than 3". Materials shall be printed on 8.5" x 11" or 11" x 17" tear resistant paper or ring reinforced paper where tear resistant is not available. Drawings shall be either folded to fit within an 8.5" x 11" binder or in an 11" x 17" 3-hole binder. Each binder shall include fifteen percent (15%) spare space for the addition of future material. Tear resistant paper shall be Xerox Never Tear or equal.
4. Where electronic documentation is available, either by purchase through the manufacture or via Internet download, it shall be organized and provided on CD. All CAD drawings and word processing documents prepared by the CSI or one of their subcontractors shall be organized and provided on CD. Electronic documentation formats shall be Adobe PDF, AutoCAD, Microsoft Office documents, HTML, or as approved by the Engineer or Owner.
5. All electronic media (i.e. software, electronic documentation, configuration files/reports, device backups, etc.) shall be provided with two (2) backup copies, each organized into a separate binder. Media storage binders shall include but not be limited to the following:
 - a) Table of contents
 - b) Archival media holders (e.g. CD, DVD, floppy, tape disk, etc.)
 - c) Support contacts (i.e. company, phone, internet link, etc.)
 - d) Software system requirements and installation instructions

6. Laminated water/tear resistant copies of all applicable instrumentation and control system drawings shall be supplied in drawing pocket of each control enclosure after "as installed, corrected, and accepted" revisions have been made to the enclosure.
7. Operation and Maintenance manuals shall include but not be limited to the following:
 - a) Manufacturer standard O&M manuals for all equipment and software furnished.
 - b) Custom O&M information describing the specific configuration of equipment and software, and the operation and maintenance requirements for this particular project.
 - c) The manuals shall contain all illustrations, detailed drawings, wiring diagrams and instructions necessary for installing, operating and maintaining the equipment.
 - d) All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable.
 - e) A functional description of the entire system, with references to drawings and instructions.
 - f) A complete "as built" set of all approved shop drawings, which shall reflect all work required to achieve final system acceptance.
 - g) A complete list of the equipment supplied, including serial numbers, ranges and pertinent data.
 - h) Full specifications on each item.
 - i) Detailed service, maintenance and operation instructions for each item supplied.
 - j) Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

- k) Complete parts lists with stock numbers and name, address and telephone number of the local supplier.
- l) References to manufacturers' standard literature where applicable.
- m) Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.
- n) The operating instructions shall clearly describe the step by step procedures that must be followed to implement all phases of all operating modes. The instructions shall be in terms understandable and usable by operating personnel and maintenance crews and shall be useful in the training of such personnel.
- o) The maintenance instructions shall describe the detailed preventive and corrective procedures required, including environmental requirements during equipment storage and system operation, to keep the System in good operating condition. All hardware maintenance documentation shall make reference to appropriate diagnostics, where applicable, and all necessary wiring diagrams, component drawings and PCB schematic drawings shall be included.

1.06 MEETINGS:

- A. The Contractor shall be required to give the Owner, the Engineer and their representatives, at least three (3) weeks notice prior to any scheduled meetings. The notice may be shortened with Owner's and Engineer's consent.
- B. Preliminary Design Review Meeting: A preliminary design review meeting shall be conducted by the Contractor for the Owner and Engineer, to ensure design compliance, installation strategies and proper coordination between responsible subcontractors related to the ICS. The Contractor shall be responsible for arranging the on-site meeting no later than sixty (60) days after notice to proceed. The Contractor shall arrange for detailed meeting minutes to be recorded, approved and distributed to meeting attendees. Two (2) weeks prior to the meeting the Contractor shall submit the following for approval:

1. A proposed list of meeting attendees including organization and phone number.
2. A proposed meeting agenda.
3. A list of personnel to be involved in the project including their responsibilities, qualifications and phone numbers.
4. An overall system description.
5. An overall system block diagram.
6. A description of all numbering, lettering, color and format conventions that will be used including examples of loop drawings, interconnection diagrams, schematic diagrams, documentation table of contents, etc.
7. A project schedule and implementation plan that coordinates the ICS installation with the installation of the entire site project.

C. Preliminary Site Testing Meeting: A preliminary site testing meeting shall be conducted by the Contractor for the Owner and Engineer, to ensure site readiness, testing strategies and proper coordination between parties related or involved in testing the ICS. The Contractor shall be responsible for arranging the on-site meeting after the Site Testing Plan has been approved and no earlier than three (3) weeks prior to testing. The Engineer must be satisfied that the site is ready and that the testing will be performed to their satisfaction prior to any documented ICS testing being performed. The Contractor shall arrange for detailed meeting minutes to be recorded, approved and distributed to meeting attendees. Additional meetings may be required at the discretion of the Owner and Engineer to resolve specific action items not addressed in the preliminary site testing meeting. Two (2) weeks prior to the meeting the Contractor shall submit the following for approval:

1. A proposed list of meeting attendees including organization and phone number.
2. A proposed meeting agenda.
3. A list of personnel to be involved in the testing including their responsibilities, qualifications and phone numbers.
4. A list of tasks requiring Owner, Engineer or outside party involvement in testing.
5. A testing schedule that coordinates the ICS testing with the operability of the specific equipment being tested.

- D. Additional meetings may be required at the discretion of the Owner and Engineer, to resolve specific action items not addressed in the preliminary design review or preliminary site testing meeting.

1.07 CONTROL SYSTEM INTEGRATOR:

- A. The Control System Integrator shall be regularly engaged in the detailed design, fabrication, installation and startup of instrumentation and control systems for water and wastewater treatment facilities in the state of Florida. Any CSI that has been subject to litigation or the assessment of liquidated damages for nonperformance on any project within the last five (5) calendar years shall not be acceptable.
- B. Where specific manufacturers and/or models of major hardware or software products (PLC, software, network equipment, wireless equipment, etc.) are specified to be used on this project, the CSI shall have completed at least one (1) project using that specified hardware or software. As used herein, the term "completed" shall mean that a project has been brought to final completion and final payment has been made.
- C. Control System Integrators shall meet the following minimum qualifications:
 - 1. A minimum of seven (7) years experience with at least five (5) years in water / wastewater projects
 - 2. References for three (3) completed projects of like size and application to the project specified herein
 - 3. Project bonding capacity of two million dollars (\$2,000,000)
 - 4. UL 508 certified control panel manufacturing shop
 - 5. On staff licensed professional engineer registered in the state of Florida, if required to perform engineering services as specified to implement this project.
- D. The listing of acceptable Control System Integrators in this specification in no way relieves the Control System Integrator from meeting the qualifications specified herein. Acceptable Control System Integrators shall be as follows:
 - 1. Revere Control Systems: 2240 Rocky Ridge Road,
Birmingham, AL, 35216; (205) 824-0004;
www.reverecontrol.com

2. Curry Controls Company: 1019 Pipkin Road,
Lakeland, FL 33811, (863) 646-5781;
www.currycontrols.com
3. Rocha Controls: 5025 Rio Vista Ave; Tampa,
Florida 33634; (813) 628-5584;
www.rochacontrols.com

- E. The Owner shall have the right of access to the CSI's facilities and the facilities of their equipment suppliers to inspect materials and parts, to witness inspections, tests and work in progress, and to examine applicable design documents, records and certifications during any stage of design, fabrication and tests. The CSI and their equipment suppliers shall furnish office space, supplies and services required for these surveillance activities.

1.08 QUALITY ASSURANCE:

- A. The listing of specific products in this specification in no way relieves the Contractor of furnishing equipment which shall meet the performance and quality criteria specified herein.
- B. All equipment and materials shall be new and the products of reputable recognized suppliers having adequate experience in the manufacture of these particular items.
- C. For uniformity, only one (1) manufacturer will be accepted for each type of product.
- D. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses that may occur during fabrication, transportation and erection as well as during continuous or intermittent operation. Equipment shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details.
- E. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, which shall be of sturdy and durable construction and be suitable for long, trouble free service.
- F. Electronic equipment shall be suitable for the specified environmental conditions.
- G. Optional or substituted equipment or both requiring changes in details or dimensions required to maintain

all structural, mechanical, electrical, control, operating, maintenance or design features incorporated in these specifications and drawings, shall be made at no additional cost to the Owner. In the event that the changes are necessary, calculations and drawings showing the proposed revisions shall be submitted for approval. The Contractor shall coordinate all changes with other affected trades and contracts and pay all additional charges incurred.

1.09 DEFINITIONS AND ABBREVIATIONS:

- A. The following definitions and abbreviations are used throughout the specifications and drawings when referring to instrumentation and control equipment, functions, and service. Definitions and abbreviations are not listed for those used in common industry practice except where to provide explicit meaning. Refer to ISA, IEEE, and other industry standard references for those not listed herein.

CSIControl System Integrator
ICSInstrumentation and Control System
OITOperator Interface Terminal
HMIHuman-Machine Interface
OWSOperator WorkStation
PIDProportional-Integral-Derivative
Control
SCADASupervisory Control and Data
Acquisition
SSPSCADA System Programmer
TVSSTransient Voltage Surge Suppression
RTURemote Telemetry Unit
PLCProgrammable Logic Controller

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS:

- A. All materials, equipment and devices shall, as a minimum, meet the requirements of UL, where UL Standards are established for those items, and the requirements of NFPA-70. All items shall have the U.L. seal where possible and all control panels shall be U.L. labeled. All items shall be new unless specified or indicated otherwise.
- B. Properly store, adequately protect and carefully handle equipment and materials to prevent damage before and during installation. Handle, store and protect equipment and materials in accordance with the

- C. All equipment shall be the latest and proven design. Specifications and drawings call attention to certain features, but do not purport to cover all details entering into design of the instrumentation system. The completed system shall be compatible with functions required and the equipment furnished by the Contractor.
- D. All electrical components of the system shall operate on 120 volt, single phase, 60 Hz power source, except as otherwise noted in the Specifications. Drawings and Specifications indicate the energy sources that will be provided. Any other devices necessary to obtain proper operation of the instrumentation and control system from these energy sources shall be furnished with the system.
- E. All necessary fuses or switches required by the instrumentation manufacturer for his equipment shall be provided with the equipment. All instruments requiring internal power supply shall have internal on-off switches.
- F. The mechanical, process and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as field mounted equipment provided by others. The instrumentation subcontractor shall examine the mechanical, process and electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract. The CSI shall inspect all equipment, panels, instrumentation, controls and appurtenances either existing or furnished under other Divisions of the Specifications to determine all requirements to interface same with the ICS. The Contractor shall coordinate the completion of any required modifications with the associated supplier of the item furnished.
- G. Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines and electrical equipment.
- H. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 °C; relative humidity forty to eighty percent (40% - 80%) without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (i.e., for dust).

- I. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 °C with relative humidity between forty and ninety-five percent (40% - 95%).
- J. Field equipment, including instrumentation and panels, may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient temperatures from -20 to 40 °C and relative humidity from ten to one hundred percent (10% - 100%). All supports, brackets and interconnecting hardware shall be aluminum, 316 stainless steel, or as shown on the installation detail drawings.

2.02 TOOLS, SUPPLIES, AND SPARE PARTS:

- A. Provide special tools, other than those normally found in an electronic technician's toolbox, required to test, diagnose, calibrate, install, wire, connect, disconnect, assemble and disassemble any digital equipment, instrument, panel, rack, cabinet or console mounted equipment for service and maintenance (i.e. connector pin insertion and removal tools, wire crimping tool, special wrenches, special instrument calibrators, indicator lamp insertion and removal tools, etc.).
- B. Provide tools and test equipment together with items such as instruction manuals, carrying/storage cases, unit battery charger where applicable, special tools, calibration fixtures, cord extenders, patch cords and test leads, which are not specified but are necessary for checking field operation of equipment supplied under this Section.
- C. The CSI shall provide supplies as needed or as required by the Owner during the specified warranty period. All fuses consumed during installation, testing, startup, the system availability demonstration, and the warranty period shall be replaced by the Contractor.
- D. Provide spare parts for items of ICS equipment as recommended by the manufacturer and in accordance with the Contract Documents.
- E. Furnish all spares in moisture-proof boxes designed to provide ample protection for their contents. Label all boxes to clearly identify contents and purpose.
- F. Refer to individual product specifications for additional requirements specific to those devices.

2.03 SIGNAL TRANSMISSION:

- A. The Contractor shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the ICS equipment.
- B. The Contractor shall be responsible for coordinating signal types and transmission requirements between the various parties providing equipment under this Contract. This shall include, but not be limited to, distribution of appropriate shop drawings among the equipment suppliers, the electrical subcontractor, the HVAC subcontractor and the CSI.
- C. The CSI shall provide 24 VDC power supplies for signals and instruments where applicable and as required inside control panels, etc. Where two-wire instruments transmit directly to the instrumentation and control system, the CSI shall provide power supplies at the PLC-equipped control panels for those instruments. Where four-wire instruments with on-board loop power supplies transmit directly to the instrumentation and control system, the CSI shall provide necessary signal isolators or shall otherwise isolate the input from the ICS loop power supply. Similar provisions shall be made when a third element such as a recorder, indicator or single loop controller with integral loop power supply is included in the loop.
- D. Analog signal transmission between electric or electronic instruments, controllers, and all equipment and control devices shall be individually isolated, linear 4-20 mA and shall operate at 24 VDC. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating. All cable shields shall be grounded at one end only, at the control panel, with terminals bonded to the panel ground bus. Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls, panels and appurtenances.
- E. Non-standard analog transmission systems such as pulse duration, pulse rate and voltage regulated shall not be permitted except where specifically noted in the Contract Documents. Where transmitters with non-standard outputs do occur, their outputs shall be converted to an isolated, linear, 4-20 mA signal prior to transmission to other devices.
- F. All discrete inputs to equipment and PLC's, from field devices, starters, panels, etc., shall be dry contacts in the field device or equipment, powered from the PLCs,

- G. All discrete outputs from local control panels and Instrumentation and Control System PLCs, to field devices, starters, panels, etc., shall be 120 VAC / 28 VDC 5A dry contacts. Output contacts may be powered from the field equipment or powered from 24 VDC / 120 VAC sourced from PLCs cabinet power system, as required to interface with field equipment. Outputs to solenoid valves, horns, and strobe lights shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise.
- H. Discrete signals between starters, panels, etc. where 120 VAC is utilized shall be clearly identified in the starter, panel, etc. as being powered from a different power supply, than other starter/panel components. Where applicable, warning signs shall be affixed inside the starter, panel, etc., stating that the panel is energized from multiple sources. Output contacts in the starter, panel, etc. which are powered from other locations shall be provided with special tags and/or color coding. Disconnecting terminal strips shall be provided for such contacts. The above requirements shall apply to all starters and panels, regardless of supplier.

2.04 NAMEPLATES:

- A. All items of equipment listed in the instrument schedule, control panels and all items of digital hardware shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include the equipment identification number and description. Abbreviations of the description shall be subject to the Engineer's approval.
- B. Control panel nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16-inch high on a black background.
- C. Field mounted nameplates shall be engraved 316 stainless steel, 22 gauge minimum thickness.
- D. Nameplates shall be attached to metal equipment by stainless steel screws and to other surfaces by an epoxy based adhesive that is resistant to oil and moisture.

PART 3 EXECUTION

3.01 INSTALLATION:

- A. The CSI shall provide the Contractor a periodic written report detailing progress of startup. This report shall include specific tabulations of devices on which startup has been completed.
- B. Equipment shall be located so that it is accessible for operation and maintenance. The CSI shall examine the Contract Drawings and Shop Drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of ICS equipment.
- C. Instrumentation and Control System equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by the Engineer during construction. Obtain in the field, all information relevant to the placing of process control work, and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.
- D. The CSI shall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the CSI shall be required to ship his material in sections sized to permit passing through restricted areas in the building. The CSI shall also investigate, and make any field modifications to, the allocated space for each cabinet, enclosure and panel, to assure proper space and access (front, rear, side).
- E. Two (2) complete sets of approved shop drawings shall be kept at the job site during all on-site construction. Both sets shall be identically marked up to reflect any modifications made during field installation or startup. All markings shall be verified and initialed by the Engineer or his designated representative. Following completion of installation and the operational readiness test, one (1) set of the marked up drawings shall be provided to the Engineer, the other retained by the CSI for incorporation of the mark-ups into final as-built documentation.

- F. All work shall be in strict accordance with codes and local rulings. Should any work be performed contrary to said rulings, ordinances and regulations, the CSI shall bear full responsibility for such violations and assume all costs arising there from.
- G. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed in a workmanlike manner and not interfere with any other equipment.
- H. The Contractor shall take steps to keep electrical and control enclosures clean and free of contaminants throughout installation. Cleaning after installation only is not acceptable. Under no circumstances are electrical and control enclosures to be cleaned using compressed air to blow out dust, causing contaminants to be forced into sensitive electronics.
- I. Provisions shall be made to completely capture filings (metal, etc.) when drilling into enclosures, to prevent contamination of electrical equipment.
- J. Upon completion of the instrumentation and control work, the Contractor shall thoroughly clean all soiled surfaces of installed equipment and materials and remove all surplus materials, rubbish and debris that has accumulated during the construction work. The entire area shall be left neat, clean and acceptable to the Owner.

3.02 WIRING AND GROUNDING:

- A. The following wiring practice guidelines shall be used in order to minimize ground loops, to minimize electromagnetic interference/radio frequency interference (EMI/RFI) to this equipment, and to provide maximum practical immunity from damage resulting from lightning-induced transients.
- B. Common wires or conductors shall not be utilized (either within panels or external to panels or for grounding of field devices) for signal shield or signal grounding, and for safety grounds.
- C. Exposed wire lengths extending from within shielded signal cables shall be minimized to reduce pick-up of EMI/RFI by signal circuits. Exposed lengths of less than one inch are preferred, and a maximum exposed length of two inches may be permitted where necessary. No splicing of signal wires is permitted.
- D. All signal wiring shall be shielded, both within panels and external to panels. Unless otherwise specified, all

- E. Signal wiring within outdoor or indoor field device enclosures shall conform to the same requirements as panel wiring.
- F. The shield on each process instrumentation cable shall be continuous from source to destination, and grounded at one end only. In general, grounding of signal cable shields shall be done at the control panel end. The signal cable for no signal shall share a common cable shield grounding wire with the signal cable shield for any other signal, and shall not share a common grounding wire with any other circuit. The length of no signal cable shield grounding wire shall not exceed two (2) inches, with less than one (1) inch maximum length preferred.
- G. All outdoor instruments and all outdoor enclosures shall be grounded using the practice defined in Section 800.40 of the National Electric Code.

3.03 TESTING, GENERAL REQUIREMENTS:

- A. The CSI shall test all equipment hardware and software at the factory prior to shipment. Unless otherwise specified in the individual specification sections, all equipment provided by the CSI shall be tested at the factory as a single fully integrated system.
- B. As a minimum, testing shall include the following:
 - 1. Unwitnessed Factory Testing.
 - 2. Operational Readiness Testing (ORT).
 - 3. System Acceptance Testing (SAT).
- C. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.
- D. All tests shall be conducted in accordance with prior Engineer approved procedures, forms and checklists. Each specific test to be performed shall be described and a space provided after it for sign off by the appropriate party after its satisfactory completion.

- E. Copies of these sign off test procedures, forms and checklists will constitute the required test documentation.
- F. Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment and data. Where it is not practical to test with real process variables, equipment and data, provide suitable means of simulation. Define these simulations techniques in the test procedures.
- G. The Contractor shall require the CSI to coordinate all of his testing with all affected Subcontractors and the Owner.
- H. The Engineer reserves the right to test or retest all specified functions whether or not explicitly stated in the prior approved test procedures.
- I. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.
- J. The CSI shall furnish the services of technicians, all special calibration and test equipment, and labor to perform the field tests.

3.04 UNWITNESSED FACTORY TESTING:

- A. Prior to the shipment of equipment to the project site, the CSI shall perform an unwitnessed factory test.
- B. The purpose of this test is to inspect and test the system to ensure it is operational and ready for shipment.
- C. This test will include all of the components of the site testing and the CSI shall provide documentation of the completion of this testing as part of the approval process to ship equipment to the site.

3.05 OPERATIONAL READINESS TESTING (ORT):

- A. The entire system shall be certified (inspected, calibrated, tested and documented) that it is ready for operation. Each specified function shall be verified on a paragraph-by-paragraph, loop-by-loop and site-by-site basis.
- B. The Engineer, or his designated representative(s), reserves the right to witness any test, inspection, calibration or startup activity. Acceptance by the Engineer of any plan, report or documentation relating

- C. The CSI shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.
- D. Each instrument shall be calibrated at zero, twenty-five, fifty, seventy-five and one hundred percent (0%, 25%, 50%, 75% and 100%) of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracies as set forth by the National Institute for Standards and Technology (NIST).
- E. The CSI shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.
- F. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.
- G. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations or shocks, and shall be installed in

- H. After completion of instrumentation installation and calibration, the CSI shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.
- I. Loop/Component Inspections and Tests: The entire system shall be checked for proper installation, calibrated and adjusted on a loop-by-loop and component-by-component basis to ensure that it is in conformance with related submittals and the Contract Documents.
 - 1. The Loop/Component Inspections and Tests shall be implemented using Engineer approved forms and check lists.
 - 2. The Contractor shall require the CSI to maintain the Loop Status Reports and Components Calibration sheets at the job-site and make them available to the Engineer/Owner at any time.
 - 3. These inspections and tests do not require witnessing. However, the Engineer will review and initial all Loop Status Sheets and Component Calibration Sheets and spot-check their entries periodically and upon completion of the Operational Readiness Tests. Any deficiencies found shall be corrected.

3.06 SYSTEM ACCEPTANCE TEST (SAT):

- A. Successful completion of the operational readiness test, as determined by the Engineer, shall be the basis for starting the witnessed system acceptance test. The Engineer shall approve the ORT test results and the Engineer and Owner shall be given two (2) weeks notice prior to the start of the System Acceptance Test.
- B. The system acceptance test shall repeat loop and functional testing done during the operational readiness test in order to demonstrate to the Owner and Engineer that the system has been started up, is operating, and is in compliance with these Specifications. Each specified function shall be

- C. The following documentation shall be made available to the Engineer during the test:
 - 1. All Contract Drawings and Specifications, addenda, and change orders.
 - 2. Master copy of the test procedure.
 - 3. One (1) copy of all O&M Manuals shall be made available to the Engineer at the job-site both before and during testing.
- D. Any malfunction during the tests shall be analyzed and corrections made by the CSI. The Engineer and/or Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.
- E. After all functions have been tested and all corrections made, the system shall operate continuously for fifteen (15) days without failure before this test will be considered successful.
- F. The total availability of the system shall be greater than ninety-nine and one-half percent (99.5%) during this test period. Availability shall be defined as "Avail. = (Total Time-Down Time,) / Total Time x 100%". Down times due to power outages or other factors outside the normal protection devices or back-up power supplies provided, shall not contribute to the availability test times above.

3.07 TRAINING:

- A. The CSI shall provide project specific classroom training at the Owner's site or designated location. Training shall be provided for the operation and maintenance of all equipment provided, as well as site specific installation configuration training for the system as a whole.
- B. Each student shall be provided with training materials. All training materials shall be provided in hardcopy as well as on a training CD, with all materials in Microsoft Office or Adobe PDF file format. When a large volume of training materials is to be provided (i.e. software documentation, etc.), only electronic copies need to be provided per Engineer's approval. When providing training materials as electronic copies only, the CSI must ensure that the training attendees will be able to use computers during the training to access information, whether provided by the Owner or not. All training CD's shall be updated with final configurations

- C. Scheduling for the training sessions shall be specified by, and at the convenience of, the Owner. The CSI shall coordinate the scheduling, and shall provide written notice of available training dates, with a minimum of two (2) weeks prior notice. Candidates for training will be selected by the Owner.
- D. Operator training shall be provided to familiarize operators with the system as a whole and to instruct on the function and operation of each component of the system. Training shall consist of the day-to-day operation of the system and all other operator site specific functions for this project. Instruction shall include a site walkdown of installed equipment. Two (2) courses lasting a minimum of two (2) days, with six (6) hours of instruction per day, shall be provided by the CSI.
- E. Maintenance training shall be provided to maintenance personnel so that each component may be maintained without the assistance of outside organizations. The training shall be extensive so that after training, personnel shall be able to identify component malfunctions and repair components to the board replacement level. One (1) course lasting a minimum of three (3) days with six (6) hours of instruction per day shall be provided by the CSI.
- F. Under the scope of this project, the CSI will not be responsible for providing PLC and HMI control programming and logic. Specific training should therefore include, but not be limited to the following: system architecture and interconnection; wiring; fiber optic systems, including maintenance and repair; field panels and equipment; radio systems; and field instrumentation and PLC hardware, including maintenance and troubleshooting.
- G. Refer to related specification sections for additional training requirements.

3.8 WARRANTY:

- A. The Contractor shall provide a 3 year warranty from substantial completion.
- B. During this warranty period, the CSI shall provide, at no additional cost to the Owner, the services of a trained, competent, field service engineer who shall arrive on site within thirty-six (36) hours of notification by the Owner or Engineer, to repair and/or

- C. All preventive and corrective activities shall be documented with service reports, which shall identify the equipment being serviced, state the condition of the equipment, describe all work performed, and list materials used. A copy of all service reports shall be delivered to the Owner on or before the next business day.
- D. Components shall be furnished to the manufacturer's standard for service intended, unless otherwise indicated in the Specifications or on the Contract Drawings.

END OF SECTION

SECTION 13310

INSTRUMENTATION AND CONTROLS, FIELD EQUIPMENT

PART 1 - GENERAL

1.01 THE REQUIREMENT:

- A. The Contractor shall furnish, test, install and place in satisfactory operation all equipment required to provide a complete and operable Instrumentation and Control System (ICS) as specified herein and as shown on the Contract Drawings, even if each needed item is not specifically specified or shown.
- B. The Control System Integrator (CSI) shall provide full onsite supervision of all equipment provided under this section, where installation is provided by others.
- C. Field equipment (i.e. primary elements, measuring devices, transmitters, field controllers, chart recorders, indicators, and other instrumentation and accessories) shall be provided with all components necessary for a fully functional device whether specifically mentioned in these specifications or not. This shall include, as applicable or recommended by the manufacturer: sample conditioning, sensors, sensor holder and mounting brackets, transmitter, all required cables, calibration equipment, chemicals, reagents and spare parts.
- D. Specialty cables between sensors/probes and their electronics/transmitters shall be furnished with each instrument. Special cables include any type of cable not specified in Division 16 - Electrical.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. In addition to the requirements specified in this section, the requirements of specification Section 13300 - Instrumentation and Controls, General Requirements, and the sections referenced therein shall be applied.

1.03 SUBMITTALS:

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples and as specified in Section 13300 - Instrumentation and Controls, General Requirements. In addition, the following specific submittals items shall be provided:

1. An ISA specification sheet for each instrument furnished and/or calibrated shall be submitted with the field equipment submittals. The ISA data sheet shall be in accordance with ISA Standards ISA S20 "Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves" and ISA TR20.00.01 "Specification Forms for Process Measurement and Control Instruments".
2. The CSI and the field equipment manufacturer shall review the proposed installation and configuration of all field equipment, prior to submittal for approval, and shall identify any condition which shall require corrective measures. The following as a minimum shall be reviewed for the installation configuration of each instrument:
 - a. Listed features
 - b. Material of construction
 - c. Consideration of process fluid
 - d. Environmental conditions
 - e. Installation location
 - f. Process connections
 - g. Ability to perform maintenance
3. Submit in writing in the field equipment submittal, that each piece of equipment is suitable for the proposed installation. Any proposed deviations shall be reviewed by the Engineer prior to execution.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS:

- A. Unless otherwise specified, instruments shall be provided with enclosures to suit the specified environmental conditions. Field-mounted devices shall be rugged and mounted on walls, equipment racks, or pipe stanchions. Where the field equipment's integral enclosure for a specified instrument is not available with the specified environmental rating, the field equipment shall be provided in a control enclosure as specified in Specification Section 13320 - Instrumentation and Controls, Control Enclosures.
- B. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted or shown on the Contract Drawings, installed adjacent or near to the sensor, in a readily accessible location. Special cables that are required for interconnection

between sensors or probes and transmitters shall be furnished with the instrumentation devices by the associated equipment manufacturer. Special cables shall be of the required length for the equipment locations and conduit routing paths shown on the Contract Drawings. No splicing of cables will be accepted.

- C. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Ambient conditions shall be -15 to 50° C and twenty to ninety-five percent (20% - 95%) relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid and corrosive service conditions.
- D. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz alternating current power source at a nominal 120 VAC, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
- E. All analog transmitter and controller outputs shall be isolated, 4-20 mA into a load of 0-750 ohms minimum, unless specifically noted otherwise.
- F. Process taps for primary sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the location, supports, orientation and dimensions of the connections and taps for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.
- G. All instrumentation exposed to sunlight shall be provided with sunshields constructed from 316 stainless steel or epoxy coated aluminum. Sunshields shall be designed to withstand regional wind and ice loads. Sunshield design shall be submitted for approval.
- H. All outdoor external sample/process piping, including valves and appurtenances, shall be insulated with weather-proof insulation, and heat-taped to prevent freezing. Heat taping shall be thermostatically controlled and self-regulating, and shall adjust its heat output to the temperature of the lines.

2.02 TOOLS, SUPPLIES AND SPARE PARTS:

- A. Tools, supplies and spare parts shall be provided as specified in Section 13300 - Instrumentation and Controls, General Requirements, and as specified for each equipment item. In addition, the following items shall be provided:
 - 1. One (1) remote handheld configuration device for communication with all "smart" equipment furnished under this Contract shall be provided. The device shall be capable of performing configuration, test, and format functions from anywhere on the 4-20 mA signal loop for a particular transmitter or by direct connection. For HART communications, the configuration device shall be Rosemount 375 or approved equal as manufactured by Endress & Hauser, or ABB. Provide at least one (1) spare fuse for the device.
 - 2. All instruments shall be supplied with one (1) year's worth of supplies, including chemicals and reagents, for the calibration, operation and maintenance of the device.

2.03 ACCESSORIES:

- A. Instrument tubing shall be 1/4 x 0.065-inch seamless, annealed, ASTM A-269 Type 316L stainless steel with Type 316 - 37° stainless steel flared fittings, or Swagelock or Parker-CPI flareless fittings.
- B. Diaphragm seals shall be provided to systems as shown on the Contract Drawings, as specified herein and/or for isolation of pressure gauges, switches and transmitters attached to systems containing chemical solutions or corrosive fluids. As a minimum, seals shall be of all 316 stainless steel construction. Diaphragms shall be 316L stainless steel for operating pressures at or above 15 psi, and elastomers for operating pressures below 15 psi. Diaphragm material shall be non-reactive with the process fluid. Refer to the Instrument Schedules for specific materials requirements. Seal shall have fill connection, 1/4-inch NPT valve flush port and capable of disassembly without loss of filler fluid. Where specified, diaphragm seals shall comply with the above requirements, and shall be provided with 316 stainless steel factory filled capillaries. Seals shall be Helicoid Type 100 HA, Mansfield & Green, Ashcroft, or equal.
- C. Isolating ring seals shall be provided for sensing elements measuring pressure in solids bearing fluids.
- D. For heavy solids/slurry applications, wherever the associated pressure instrument is used for control purposes, or where shown on the Contract Drawings, the sensor body shall be full line size wafer design, with 316 stainless steel housing and assembly flanges, and

Buna N flexible cylinder lining for in-line mounting. The wafer shall have through bolt holes or centerline gauge for positive alignment with the associated flanged piping. The captive liquid chamber and associated instrument(s) shall be furnished with threaded drain tap and plug. Isolating ring seals shall be RED Valve Series 40, Ronningen-Petter Iso-Ring, Moyno RKL Series W, or equal.

- E. For all other solids bearing fluids, pressure shall be sensed via a 1/2" diameter spool-type isolating ring seal, mounted on a 1/2" pipe nipple at 90 degrees from the process piping. An isolation ball valve shall be provided between the process piping and the ring seal, and a cleanout ball valve shall be provided between the ring seal and the atmosphere. The pressure instrument shall be back or side mounted to the ring seal such that the gauge or readout may be viewed normally. Isolating ring seals for normal solids service shall be Red Valve Series 42, Ronningen-Petter Iso-Spool, or equal.
- F. Isolation valves shall be 1/2-inch diameter ball valves with 316 stainless steel body, 316 stainless steel ball.

2.04 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS):

- A. TVSS shall be supplied for all field equipment power, signal, and communications wires that have any portion extending outside of a building. Refer to Specification Section 13320 - Instrumentation and Controls, Control Enclosures for requirements.

2.05 LEVEL TRANSMITTER, ULTRASONIC TYPE:

- A. Ultrasonic transmitters shall be provided for measurement of pond levels. Equipment shall be provided with features and accessories as described herein, suitable for the application.
- B. Ultrasonic level transmitters shall meet the following specifications as a minimum:
 - 1. NEMA 4X enclosure
 - 2. 120VAC, 60Hz input power
 - 3. Process display with keypad for menu driven configuration
 - 4. One (1) 4-20 mA output
 - 5. One (1) alarm relay output
 - 6. Non-volatile memory
 - 7. Accuracy: 0.25 %
- C. The CSI shall provide all mounting hardware and coordinate the details of the installation so that the instruments are installed in keeping with the best standard and recommended practices of the manufacturer and conforming to the requirements set forth by the Engineer.

- D. Level transmitters shall be fully programmable and configurable using a keypad. The final 'As-Built' documentation shall be provided with a tabulation of the Programming Parameters used in each level/flow transmitter so that the initial calibration can be reproduced if a spare transmitter is installed.
- E. Level transmitters shall be provided with optional integral analog signal isolators, as part of the transmitter assembly. All conduit connections shall be sealed to prevent damage or corrosion due to vapors or wetness.
- F. Ultrasonic Level Transmitters shall be Milltronics Hydroranger Plus with Echomax XPS-15 sensors. Refer to the Instrumentation Schedule Attachment for flange mounting requirements. Transmitters shall be installed using the appropriate transducer, suitable for the range of the installation. The cable provided with the transducer shall be ordered with sufficient length to provide installation without splicing the cable at any point.
- G. The CSI shall provide mounting hardware components and appropriate mounting assistance to install and secure the transducers in a manner in keeping with the recommendations of the manufacturer of the equipment and in keeping with the general details provided in the drawings. All hardware shall be fabricated from corrosion resistant materials and shall utilize stainless steel hardware. The mounting system shall be secure and permanent and shall allow easy access to the sensor for servicing. All cables shall be installed in suitable rigid conduit with only short lengths of flexible conduit allowed to complete the installation.
- H. In cases where the transducer is used to monitor a covered wetwell, the transducer shall be installed using a hinged protective enclosure. The enclosure shall be a special corrosion resistant instrument enclosure made of polyurethane, and stainless steel hardware. Enclosures shall be model C-6, as provided by O'Brien Corp, St. Louis, Missouri. The case shall be secured to the slab using heavy anchors over an appropriately sized hole cored through the slab. The enclosure shall also have a hole in the bottom to match the hole in the slab so that the transducer can be easily installed from above. The transducer shall be installed on a heavy aluminum plate which would lie in the bottom of the enclosure and allow the transducer to extend into the cored hole.
- I. In cases where the transducer is used to monitor a water storage tank or other type of location, the CSI shall provide a mounting design and mounting hardware to provide an installation which is appropriate for the

operation of the device and easily maintained. For storage tanks, the transducer shall be mounted above the tank or a suitable bracket extending out far enough from the tank sides to receive a strong signal over the entire level range without reflections off the tank sides. The transmitter shall be mounted outside of the wall at a convenient ground-level working height.

- J. In cases where the transducer is used in a highly turbulent area or as if stated in the contract drawings, the sensor shall be flange mounted to a stilling well to minimize incorrect responses to wave action in the liquid. The stilling well shall be a six (6) inch PVC pipe which shall extend the entire depth of the measured range and to below the normal low liquid level. The stilling well shall have holes drilled periodically along the length sufficient to allow adequate response to changes in liquid level. The stilling well shall be supported in a manner which produces a rigid installation minimizing the movement due to the turbulent liquid.
- K. Spare parts: Provide one (1) spare Ultrasonic Level Transmitter of each type used, and one (1) spare transducer of each type used (supplied with the longest cable utilized in the project).

2.08 ULTRASONIC FLOWMETERS (TRANSIT TIME) :

- A. Ultrasonic Flowmeters shall consist of a dual strap-on flowmeter sensor assembly with remote signal converter/transmitter that is capable of converting and transmitting the signal from the sensors.
- B. The transmitter shall utilize the characterized principles of acoustical wave travel in a water pipeline with measurements being the difference in time for signals transmitted both upstream and downstream into the flow.
- C. The flowmeter accuracy shall be $\leq \pm 0.5\%$ of reading from 2-100% meter capacity. Flow range sensitivity shall be up to 0.01 feet/sec.
- D. The flow system shall include but not be limited to the following:
 - 1. Submersible, non-intrusive encapsulated clamp-on dual-sensors with manufacturer supplied sensor cable of sufficient length as to not require splicing.
 - 2. SST clamps and mounting hardware
 - 3. The cables for interconnecting the flow tube to the transmitter shall be furnished by the manufacturer and of sufficient length as to not require splicing.

4. NEMA 4X / IP65 transmitter enclosure
 5. 120VAC, 60Hz input power
 6. Backlit 2-line, 40 character alphanumeric process LCD display with tactile keypad for menu driven configuration
 7. One (1) 4-20 mA output
 8. Up to four (4) alarm relay outputs
 9. Provide with configuration and operational tuning software
- E. Ultrasonic Transit Time Flowmeters shall be Thermo Scientific DCT 6088.

2.09 FLOW METER, ELECTRO-MAGNETIC

- A. A magnetic flow meter shall be provided which uses a pulsed DC electromagnetic technology, suitable for use in fixed site, unidirectional flow measurement. The flow meter shall consist of a flow tube and a converter, which shall indicate, totalize and transmit the flow signal as a 4-20 ma signal to the control panel.
- B. The spool shall be made of welded steel and the spool shall be 304 SST. Bolts shall be 316 SS. Each meter shall be equipped with two side mounted sensors, which shall be inserted through side flanged openings and removable for future maintenance without removing the flanged spool. Flow sensors shall contain a coil, a pair of sensing electrodes and an integral grounding electrode. The entire sensor shall be encapsulated in polyurethane that conforms to NSF standard 61.
- C. Each meter shall be designed to be suitable for the service and conditions for the specific application. Each meter shall be capable of operation in ranges from 0-2 ft/sec to 0-50 ft/sec. The flow ranges shall be calibrated as per the equipment schedule.
- D. The electronics shall be separable from the metering element, so that the meter itself can be submersible or otherwise in a remote location, while the indicator, totalizer, and signal transmitter may be remotely located away from the primary element. The supplier shall review each installation location and detail. On those meters where the meter is installed above ground at a workable height, the electronics shall be installed at the meter. On those meters where is meter is not above ground, or at a convenient workable height, the electronics shall be located remotely, using a suitable length of cable, to a convenient and suitable location.

- E. The converter shall utilize a local LCD indicating flow rate as a percent, and a 6-digit non-resettable LCD totalizer. The converter shall include magnetically actuated switches to simulate zero and full-scale calibration points. The signal output shall be an isolated 4-20 ma signal in proportion to flow. The converter shall be housed in a rugged lockable enclosure, rated NEMA 4X and IP65. The flow meter shall be the MagMaster series as manufactured by ABB, size requirements are shown in contract drawings.

2.10 SUNSHIELDS:

- A. All outdoor mounted transmitters shall be provided with a 316 stainless steel sunshield. Sunshields are to be sized so that the sunshield will extend a minimum of three (3) inches beyond the transmitter enclosure on all sides.
- B. The sunshield shall be sized to include protection for the transmitter and the surge arresting device.
- C. All sunshield and instrument mounting hardware shall be 316 stainless steel.

PART 3 - EXECUTION

3.01 REQUIREMENTS:

- A. In addition to the requirements specified in this section, refer to Section 13300 - Instrumentation and Controls, General Requirements.

3.02 INSTRUMENTATION LOOP REQUIREMENTS

- A. All instrumentation installed in this project requires TVSS as discussed in other sections. The surge protection is to be located at the instrumentation and the SCADA / Control panels.
- B. Southwest Field Equipment / Instrumentation Loop Descriptions:
 - 1. MOV-100 - Effluent Valve to MARS Valve
 - a. Provide and install wiring to monitor the status and control the operation of the motor operated valve via SP-12 SCADA panel. See contract drawings for the signals required.
 - b. Provide discrete surge protection in the SCADA panel for the signals.
 - c. See contract drawings for the signals required
 - 2. FLW-101 - Flow from Ponds to Effluent Pump Station

- a. Install analog wiring from I-1 (Instrumentation pull-box) to SP-1 SCADA panel located in Main Electrical Building.
 - b. Install analog and power surge protection at the existing transmitter. Install analog surge protection in the SP-1 SCADA panel.
 - c. The flow signal shall be verified in existing I-1 instrumentation pull-box to determine the exact location of the terminated flow signal.
3. FLW-102 - Flow from Ponds to Headworks
- a. Provide and install new strap-on flow meter per the contract drawings. Install grounding, analog wiring and power per the contract drawings.
 - b. Provide power and analog surge protection at the meter transmitter and analog surge protection in the SP-12 SCADA panel for the signal.
4. MOV-103 - Irrigation Site Valve
- a. Monitor the status and control the operation of the motor operated valve via SP-12 SCADA panel.
 - b. Provide discrete surge protection in the SCADA panel for the signals.
 - c. See contract drawings for the signals required.
5. FLW-104 - Flow to Irrigation
- a. Provide and install new strap-on flow meter per the contract drawings. Install grounding, analog wiring and power per the contract drawings.
 - b. Provide analog surge protection at the meter transmitter and in the SP-13 SCADA panel.
6. FLW-105 - Flow to North Pond
- a. Provide and install new strap-on flow meter per the contract drawings. Install grounding, analog wiring and power per the contract drawings.

- b. Provide analog surge protection at the meter transmitter and in the SP-11 SCADA panel.
- 7. MOV-106 - North Pond Influent Valve
 - a. Monitor the status and control the operation of the motor operated valve via SP-12 SCADA panel.
 - b. Provide discrete surge protection in the SCADA panel for the signals.
 - c. See contract drawings for the signals required.
- 8. LIT-107 - North Pond Level
 - a. Provide and install analog wiring to terminate the existing North Pond Level signal to the new SP-12 SCADA panel.
 - b. Provide analog and power protection for the transmitter. Provide analog surge protection for the SCADA panel.
- 9. LIT-108 - Middle Pond Level
 - a. The existing level signal is installed in the Dataflow System. Modify the existing Modbus to Allen-Bradley TCP converter to allow the additional signal to be mapped to the control room PLC. No hardware is required, software modification to the Hypertac server required only.
- 10. LIT-109 - South Pond Level
 - a. The existing level signal is installed in the Dataflow System. Modify the existing Modbus to Allen-Bradley TCP converter to allow the additional signal to be mapped to the control room PLC. No hardware is required, software modification to the Hypertac server required only.
- 11. FLW-111 - Filters 3, 4 & 5 Flow from Ponds
 - a. Install analog wiring from I-1 (Instrumentation pull-box) to SP-1 SCADA panel located in Main Electrical Building.

- b. Install analog and power surge protection at the existing transmitter. Install analog surge protection in the SP-1 SCADA panel.
 - c. The flow signal shall be verified in existing I-1 instrumentation pull-box to determine the exact location of the terminated flow signal.
- 12. FLW-112 - Filters 1 & 2 Flow from Ponds
 - a. Install analog wiring from I-1 (Instrumentation pull-box) to SP-1 SCADA panel located in Main Electrical Building.
 - b. Install analog and power surge protection at the existing transmitter. Install analog surge protection in the SP-1 SCADA panel.
 - c. The flow signal shall be verified in existing I-1 instrumentation pull-box to determine the exact location of the terminated flow signal.
- 13. North Pond Controls
 - a. The existing controls allows for the operators to operate the pumps from a local control panel located by the lake filters.
 - b. Modify the existing pump control panel to allow for control via the new SP-12 SCADA panel. Add interposing relays and contact blocks as necessary.
 - c. See contract drawings for the signals required. Provide all necessary hardware (relays, terminals, etc) to accommodate the I/O required.
- 14. Middle Pond Pump Controls
 - a. The existing pump controls are installed in the Dataflow System. Modify the existing Modbus to Allen-Bradley TCP converter to allow the additional signal to be mapped to the control room PLC. No hardware is required, software modification to the Hypertac server required only. Operations shall be able to control and monitor the pumps via the PLC SCADA network.
- 15. South Pond Pump Controls
 - a. The existing pump controls are installed in the Dataflow System. Modify the existing Modbus to Allen-Bradley TCP converter to allow the additional signal to be mapped to the control room PLC. No hardware is required, software modification to the Hypertac server

required only. Operations shall be able to control and monitor the pumps via the PLC SCADA network.

C. Southeast Field Equipment / Instrumentation Loop Descriptions:

1. MOV-100 - Effluent Valve to MARS Valve
 - a. Provide and install wiring to monitor the status and control the operation of the motor operated valve via existing SP-3 SCADA panel located in the Blower Building No. 3. See contract drawings for the signals required.
 - b. Provide discrete surge protection in the SCADA panel for the signals.
 - c. See contract drawings for the signals required
2. MOV-101 Effluent Interconnect Valve
 - a. Provide and install wiring to monitor the status and control the operation of the motor operated valve via existing SP-1 SCADA panel located in the Main Electrical Building. See contract drawings for the signals required.
 - b. Provide discrete surge protection in the SCADA panel for the signals.
3. MOV-102 MARS Valve
 - a. Provide and install wiring to monitor the status and control the operation of the motor operated valve via existing SP-1 SCADA panel located in the Main Electrical Building. See contract drawings for the signals required.
 - b. Provide discrete surge protection in the SCADA panel for the signals.
 - c. See contract drawings for the signals required
4. FLW-103 - Existing Lake Filter Flowmeter
 - a. Provide and install analog wiring to terminate the existing Lake Filter Flowmeter signal to the existing SP-1 SCADA panel located in the Main Electrical Building.
 - b. Provide analog and power protection for the existing transmitter. Provide analog surge protection for the SCADA panel.
5. MOV-104 - Flow to Lake Filters from Lakes Valve

- a. Provide and install wiring to monitor the status and control the operation of the motor operated valve via existing SP-1 SCADA panel located in the Main Electrical Building. See contract drawings for the signals required.
 - b. Provide discrete surge protection in the SCADA panel for the signals.
- 6. MOV-105 - Flow to Splitter Box from Ponds Valve
 - a. Provide and install wiring to monitor the status and control the operation of the motor operated valve via existing SP-1 SCADA panel located in the Main Electrical Building. See contract drawings for the signals required.
 - b. Provide discrete surge protection in the SCADA panel for the signals.
- 7. FLW-106 - Flow From Lakes / Effluent Pump Stations to Plant Splitter Box
 - a. Provide and install transit-time flow meter and analog wiring to terminate the flow signal to the existing SP-1 SCADA panel located in the Main Electrical Building.
 - b. Provide analog and power protection for the transmitter. Provide analog surge protection for the SCADA panel.
- 8. FLW-107 - Flow to Reject Pond
 - a. Provide and install electro-magnetic flowmeter and analog wiring to terminate the flow signal to the existing SP-2 SCADA panel located in the Blower Building No. 2.
 - b. Provide analog and power protection for the transmitter. Provide analog surge protection for the SCADA panel.
- 9. FLW-108 - Flow to South Lake #1
 - a. Provide and install transit-time flow meter and analog wiring to terminate the flow signal to the new Dataflow RTU-3 installed as part of this project.
 - b. Provide analog and power protection for the transmitter. Provide analog surge protection for the RTU panel.

10. BPV-109 - South Lake #1 Influent Valve
 - a. Provide and install wiring to monitor the status and control the operation of the motor operated valve via new Dataflow RTU-3 installed as part of this project. See contract drawings for the signals required.
 - b. Provide discrete surge protection in the SCADA panel for the signals.
11. BPV-110 - East Pond Influent Valve
 - a. Provide and install wiring to monitor the status and control the operation of the motor operated valve via existing dataflow RTU located at the East Pond. See contract drawings for the signals required. Add additional I/O cards or modules as required.
 - b. Provide discrete surge protection in the SCADA panel for the signals.
12. FLW-111 - Flow to East Pond
 - a. Provide and install transit-time flow meter and analog wiring to terminate the flow signal to the new Dataflow RTU-3 installed as part of this project.
 - b. Provide analog and power protection for the transmitter. Provide analog surge protection for the RTU panel.
13. FLW-112 - Flow from South Lake #1 to Lake Filters
 - a. Provide and install transit-time flow meter and analog wiring to terminate the flow signal to the new Dataflow RTU-4 installed as part of this project.
 - b. Provide analog and power protection for the transmitter. Provide analog surge protection for the RTU panel.
14. LIT-113 - South Lake #1 Level
 - a. Provide and install level transmitter per the contract specifications and drawings.
 - b. Provide and install analog wiring to terminate the level signal to the new Dataflow RTU-4 panel.

- c. Provide analog and power protection for the transmitter. Provide analog surge protection for the SCADA panel.
- 15. FLW-114 - Flow from East Pond to lake Filters
 - a. Provide and install transit-time flowmeter and analog wiring to terminate the existing flow signal to the existing Dataflow RTU-2 panel located at the East Pond.
 - b. Provide analog and power protection for the transmitter. Provide analog surge protection for the SCADA panel.
- 16. MOV-115 - Schroeder Ranch Valve
 - a. Provide and install wiring to monitor the status and control the operation of the motor operated valve via new Dataflow RTU-5 installed as part of this project. See contract drawings for the signals required.
 - b. Provide discrete surge protection in the SCADA panel for the signals.
- 17. MOV-116 - Rosedale Valve
 - a. Provide and install wiring to monitor the status and control the operation of the motor operated valve via new Dataflow RTU-5 installed as part of this project. See contract drawings for the signals required.
 - b. Provide discrete surge protection in the SCADA panel for the signals.
- 18. LIT-117 - South Lake #2 Level
 - a. The existing level signal is installed in the Dataflow System (RTU-6 or west side of South Lake #2 RTU). As part of this project a Modbus to Allen-Bradley TCP converter is being installed. The level signal shall be mapped into one of the Modbus / ABTCP registers so it can be accessed.
- 19. FLW-118 - South Lake #2 Influent Flow
 - a. Provide and install transit-time flow meter and analog wiring to terminate the flow signal to the new Dataflow RTU-5 installed as part of this project.
 - b. Provide analog and power protection for the transmitter. Provide analog surge protection for the RTU panel.

20. BPV-119 - South Lake #2 Influent Valve
 - a. Provide and install wiring to monitor the status and control the operation of the motor operated valve via new Dataflow RTU-5 installed as part of this project. See contract drawings for the signals required.
 - b. Provide discrete surge protection in the SCADA panel for the signals.
21. FLW-120 - South Lake #2 Flow to Lake Filters
 - a. Provide and install transit-time flow meter and analog wiring to terminate the flow signal to the existing Dataflow RTU-6 located on the west side of South Lake #2.
 - b. Provide analog and power protection for the transmitter. Provide analog surge protection for the RTU panel.
22. FLW-121 - Flow to Schroeder Manatee
 - a. Modify the existing Water Specialties propeller flow meter (S/N 203601-24) to have 24VDC loop-powered analog feedback of the current flow reading. Replace the existing transmitter currently installed on the flowmeter.
 - b. Provide and install flow meter additional hardware and analog wiring to terminate the flow signal to the new Dataflow RTU-5 installed as part of this project.
 - c. Provide analog surge protection for the flow meter. Provide analog surge protection for the RTU panel.
23. FLW-122 - Flow to Rosedale
 - a. Modify the existing Water Specialties propeller flow meter (S/N 20011597-12) to have 24VDC loop-powered analog feedback of the current flow reading.
 - b. Provide and install flow meter additional hardware and analog wiring to terminate the flow signal to the new Dataflow RTU-5 installed as part of this project.
 - c. Provide analog surge protection for the flow meter. Provide analog surge protection for the RTU panel.
24. LIT-124 - East Pond Level

- a. The existing level signal is installed in the Dataflow System (East Pond RTU-2). As part of this project a Modbus to Allen-Bradley TCP converter is being installed. The level signal shall be mapped into one of the Modbus / ABTCP registers so it can be accessed.
25. FLW-125 - MARS Flow
- a. Provide and install transit-time flow meter to replace the existing flow meter. Use the existing twisted shielded cable installed at the existing meter. The signal currently is terminate to SP-3 Blower Building no. 3.
 - b. Provide analog and power protection for the transmitter. Provide analog surge protection for the RTU panel.

END OF SECTION

SECTION 13320

INSTRUMENTATION AND CONTROLS, CONTROL ENCLOSURES

PART 1 GENERAL

1.01 THE REQUIREMENT:

- A. The Contractor shall furnish, test, install and place in satisfactory operation all control enclosures (i.e. field panels, control panels, cabinets, consoles, boxes, etc.) required to provide a complete and operable Instrumentation and Control System (ICS) as specified herein and as shown on the Contract Drawings, even if each needed item is not specifically specified or shown.
- B. The Contractor shall also be responsible to provide modifications to existing control panels as described herein or as indicated in the PLC Input/Output Schedule Attachment. Modifications to existing control panels shall also conform to the requirements of these specifications.
- C. All components and all necessary accessories (e.g. mounting hardware, conditioning equipment, TVSS, fuses, circuit breakers, terminals, ground bars, relays, contactors, starters, indicators, control operators, power supplies, signal conditioning, connectors, digital hardware, etc.) that may be required to complete the system, shall be provided.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. In addition to the requirements specified in this section, the requirements of specification Section 13300 - Instrumentation and Controls, General Requirements and the sections referenced therein shall be applied.
- B. Instrumentation and Controls Schedules. Refer to Instrumentation Schedule and PLC Input/Output Schedule Attachments for a listing of major equipment, enclosure construction and signal monitoring requirements.

1.03 SUBMITTALS:

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples and as specified in Section 13300 - Instrumentation and Controls, General Requirements. In addition, the following specific submittals items shall be provided:
 - 1. Cabinet sizing in relation to heat dissipation and cooling/heating system sizing calculations shall be

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS:

- A. Either manufacturer-standard or custom enclosures may be furnished, subject to the requirements of the Contract Documents and favorable review by the Engineer.
- B. All enclosures shall fit within the allocated space as shown on the Drawings. The Contractor shall examine plans and/or field inspect new and existing structures as required to determine installation requirements and shall coordinate the installation of all enclosures with the Owner and all affected contractors. The Contractor shall be responsible for all costs associated with installation of enclosures, including repair of damage to structures (incidental, accidental or unavoidable).
- C. A minimum estimated size is shown on the Drawings. The Contractor shall furnish enclosures of the size and quantity required to house the manufacturers' equipment supplied and all other electrical components installed in the enclosure. In addition, provide useful space and power supply capacity as spare for future expandability to a minimum of one (1) item per item type installed or twenty percent (20%) of quantity of each type item installed, whichever yields the greater spare space.
- D. Enclosures (cabinets, panels, boxes, etc.) shall be formed or welded construction, reinforced with Unistrut, Powerstrut or equal to facilitate mounting of internal components or equipment. Sufficient access plates and doors shall be provided to facilitate maintenance and testing of the supplier's equipment. Doors shall be removable. Enclosures with any dimension thirty-six (36) inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. No screws or bolts shall protrude through from the interior enclosure.
- E. All steel enclosures shall be free from dirt, grease and burrs, and shall be treated with a phosphatizing metal conditioner (phosphate conversion coating) before painting. All surfaces shall be filled, sanded, and finish coated by spraying a 1-2 mil epoxy prime coat and smooth, level, high grade textured finish between flat

and semi-gloss shine. The colors shall be selected by the Owner from a minimum of six (6) color samples provided. All stainless steel enclosures shall be polished to a No. 4 finish.

- F. Enclosures shall be prefabricated cabinets and panels by Hoffman, Rittal or Vynckier. The Contractor may optionally provide enclosures custom fabricated by a reputable panel fabrication shop acceptable to the Engineer.
- G. All enclosures with any dimension twenty-four (24) inches or larger shall be provided with drawing pockets for as-built panel drawings. One (1) laminated copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.
- H. All metallic enclosures with door mounted equipment shall have the door grounded by means of flexible ground strap.
- I. The enclosure and all interior and exterior equipment shall be identified with nameplates. The equipment shall be mounted such that service can occur without removal of other equipment. Panel mounted equipment shall be flush or semi-flush mounted with flat black escutcheons. All equipment shall be accessible such that adjustments can be made while the equipment is in service and operating. All enclosures shall fit within the allocated space as shown on the Contract Drawings.
- J. Enclosures shall provide mounting for UPS, power supplies, control equipment, input / output subsystems, panel mounted equipment and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. Louvered openings fitted with dust filters near the bottom and top of the cabinet shall be provided for NEMA 12 enclosures. If required, cabinets shall be provided with filtered fans, heat exchangers or air conditioners. Only closed loop cooling systems shall be provided for NEMA 4X cabinets. Cooling systems shall be by the cabinet fabricator, McLean Midwest, Noren Products, or approved equal.
- K. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a branch circuit will trip only the branch breaker but not the main breaker. Circuit breakers shall be provided for the following internal branch circuits distributed within the panel:

1. Receptacles and power strips
 2. Lighting
 3. UPS
 4. HVAC equipment
- L. Enclosures shall be provided with 120 volt duplex receptacles for service equipment and fluorescent service lights. Loads not requiring transient voltage surge suppression (i.e. receptacles, lighting, HVAC, branch circuits to remote equipment, etc.) shall be connected ahead of the enclosure TVSS device.
- M. Locate equipment, devices, hardware, power supplies, instrumentation and controls, electrical equipment and wiring to be installed inside the enclosures and/or as facial features on the enclosures, so that connections can be easily made and so that there is ample room for servicing each item. Every component in and on the enclosures shall be able to be removed individually without affecting the other components and without the need to move other components. Support and restrain all internally, as well as panel mounted components to prevent any movement.
- N. All cabinets and/or enclosures shall be NEMA rated for the environment in which it is to be installed and as noted in the Drawings.
- O. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials are available.
- P. Control panels shall be built in accordance with UL508A Industrial Control Panels and NEC Article 409 Industrial Control Panels. Control panels for areas classified as Hazardous shall be built in accordance with UL698 Industrial Control Equipment for Use in Hazardous Locations. Control panels shall be UL508A and/or UL698 labeled and marked as defined in NEC 409.110 with the following:
1. Manufacturer's name and contact information (i.e. address, phone, website, email, etc.).
 2. Supply voltage, phase, frequency and full-load current.
 3. Short-circuit current rating of the industrial panel based on one of the following:
 - a. Short-circuit current rating of a listed and labeled assembly

- b. Short-circuit current rating established utilizing an approved method
- 4. Electrical wiring diagram numbers or the index sheet to the electrical wiring diagrams.
- 5. The enclosure type number (i.e. NEMA 1A, 3R, 12, 4X, 7, 9, etc.)
- 6. If the industrial control panel is intended as service equipment, it shall be marked to identify it as being suitable for use as service equipment.

2.2 TOOLS, SUPPLIES, AND SPARE PARTS:

- A. Tools, supplies, and spare parts shall be provided as specified in Section 13300 - Instrumentation and Controls, General Requirements and as specified for each equipment item. In addition, the following items shall be provided:
 - 1. One (1) of each type of panel mounted equipment (i.e., indicators, signal converters, etc.) provided under this Contract. This does not include large LCD display electronic operator interface devices.
 - 2. Three (3) of each type of interposing relay provided under this Contract.
 - 3. Five (5) of each type of power TVSS device used
 - 4. Ten (10) of each type of signal TVSS device used
 - 5. Two (2) of each type of communication TVSS device used.
 - 6. Three (3) pints of each type or color of touchup paint for the control enclosures provided under this Contract.

2.3 OUTDOOR ENCLOSURES:

- A. All outdoor enclosures shall be rated NEMA 4X, constructed of 316 stainless steel with a white powder epoxy coating finish unless specified otherwise. Outdoor enclosures shall have a hinged and gasketed door. Door latches shall be all stainless steel, fast operating clamp assemblies (quick release), which do not require bolts or screws to secure. Gaskets shall be polyurethane.
- B. Outdoor panels shall be fitted with pad-lockable latch kits.

- C. Outdoor enclosures with internal digital electronics, exterior indicators or exterior indicator lights shall have external sun shields or sun shades, constructed of the same materials as the associated enclosure, unless otherwise specified.
- D. Outdoor enclosures shall be designed for ambient conditions of -15 to 50°C and twenty to ninety-five percent (20% - 95%) relative humidity, unless otherwise specified. Outdoor enclosures shall be provided with thermostatically controlled space heaters to provide condensation protection.

2.4 INDOOR ENCLOSURES:

- A. Indoor enclosures located in the same area (i.e. room, etc.) as open process tanks, open process channels, closed process piping or process equipment containing wet liquids or possible airborne powders, shall be rated NEMA 4X, constructed of 316 stainless steel, fiberglass, fiberglass reinforced polyester, or polycarbonate, unless specified otherwise. Enclosures shall have a hinged and gasketed door. Door latches shall be all stainless steel, fast operating clamp assemblies (quick release) which do not require bolts or screws to secure. Gaskets shall be polyurethane.
- B. Indoor enclosures located in a dry area (i.e. electrical room, etc.) shall be NEMA 12 steel, unless specified otherwise. Enclosures shall have a hinged and gasketed door. Door latches shall be three (3) point door latches with handle for all enclosures with a dimension of twenty-four (24) inches or larger, or otherwise shall be fast operating clamp assemblies which do not require bolts or screws to secure. Gaskets shall be polyurethane.
- C. Indoor enclosures in a non-air conditioned space shall be designed for ambient conditions of 0 to 40°C and twenty to ninety-five percent (20% - 95%) relative humidity, unless otherwise specified. Indoor enclosures in an air conditioned space shall be designed for ambient conditions of 20 to 30°C and twenty to eighty-five percent (20% - 85%) relative humidity, unless otherwise specified.

2.5 PLC, RTU AND OTHER DIGITAL EQUIPMENT ENCLOSURES:

- A. Enclosures shall be prefabricated cabinets and panels by Hoffman, Rittal, or Vynckier. The Contractor may optionally provide enclosures custom fabricated by a reputable panel fabrication shop acceptable to the Engineer.

- B. Enclosures shall be sized to provide a minimum of fifteen percent (15%) spare sub-panel mounting space for future equipment.
- C. A minimum of ten percent (10%) spare terminals for each type of wiring (power, signal, DC control, AC control, etc.) shall be mounted within each control panel.
- D. Outdoor enclosures shall be provided with thermal insulation and thermostatically controlled space heaters to provide condensation protection.
- E. Enclosures with any dimension greater than thirty-six (36) inches which contain a programmable logic controller (PLC) shall be provided with a folding laptop programmer shelf on the inside of the door.
- F. NEMA 12 enclosures shall be provided with filtered louvered openings at the top and bottom of the cabinet, if required for heat dissipation.
- G. Enclosures shall be provided with copper ground bars for terminating cable shields.
- H. The temperature inside each enclosure containing digital hardware (i.e. cabinet, panel or console) shall be continuously monitored, and shall generate an alarm to the nearest PLC if the temperature rises to an adjustable, preset high temperature.

2.6 TERMINALS:

- A. Terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails, securely bolted to the cabinet sub-panel. Terminals shall be of the screw down pressure plate type as manufactured by Phoenix Contact, Wieland, Square D, or equal. Power terminal blocks shall be single tier with a minimum rating of 600 volts, 30 amps. Signal terminal blocks shall be single tier with a minimum rating of 600 volts, 20 amps.
- B. Fused terminal blocks or miniature thermal circuit breaker terminal blocks shall be supplied for protection and isolation of enclosed equipment, or as specified in the Contract documents. Blown fuse indicators shall be provided and/or tripped breaker status shall be clearly visible. Fused or miniature thermal circuit breaker terminal blocks shall be provided for, but not limited to each of the following:
 - 1. Each piece of equipment provided with a power supply (integral, internal or external) with the

exception of devices with internal fusing plugged into a receptacle.

2. Each PLC module requiring external power

- C. Terminals shall be marked with a black waterproof, permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal.

2.7 WIRING:

- A. All wiring shall be bundled and run open or enclosed in vented plastic wireway, as required. All conductors run open shall be bundled and bound with nylon cable ties, at regular intervals, with intervals not to exceed twelve (12) inches. Adequately support and restrain all wiring runs to prevent sagging or other movement. Care shall be taken to separate communication, network, electronic signal, AC discrete signal, DC discrete signal and power wiring. Wiring to equipment mounted on doors or where movement of the equipment will take place shall be installed in nylon spiral wrapping sheaths.
- B. Wires shall be color coded as follows:
 - 1. Equipment Ground - GREEN
 - 2. 120 VAC Power Distribution - BLACK
 - 3. 120 VAC Power Neutral - WHITE
 - 4. 120 VAC Control (Internally Powered) - RED
 - 5. 120 VAC Control (Externally Powered) - YELLOW
 - 6. 24 VAC Control - ORANGE
 - 7. DC Power (+) - RED
 - 8. DC Power (-) - BLACK
 - 9. DC Control - BLUE
 - 10. Analog Signal (+) - BLACK
 - 11. Analog Signal (-) - WHITE
- C. All wiring shall comply with accepted standard instrumentation and electrical practices. Field wiring for power, control and signal wires shall comply with Division 16 of the specifications. For each pair of parallel terminal blocks, the field wiring shall be between the blocks.
- D. Internal panel wiring shall be as follows:

1. AC power wiring: 14 AWG minimum, stranded copper conductors, THHN/THHW wire rated for 600 volts and 90 °C. For wiring carrying more than 15 amps, use sizes required by NEC.
2. AC control and DC power and control wiring: 16 AWG minimum, stranded copper conductors, THHN/THHW wire rated for 600 volts and 90 °C.
3. Instrument signal wiring: 18 AWG stranded conductors, tinned copper, twisted pair or triad, overall one hundred percent (100%) aluminum foil shield with 20 AWG stranded drain wire, plenum rated 300V 60°C FEP insulated wire with FEP jacket, equal to Belden 88760.
4. All stranded wire shall have a minimum of sixteen (16) strands, except for drain wires.

2.8

IDENTIFICATION:

- A. Provide a laminated black nameplate with beveled edges and 1/2-inch white letters to identify each console, panel or cabinet on the front of the enclosure.
- B. Provide laminated, beveled edge, plastic legend plates and nameplates, with 1/4-inch letters, for each front panel mounted device as shown on the Drawings. Legend plates and nameplates shall be the size as shown on the Drawings. Color shall be black lettering on white background except caution/warning nameplates which shall be white lettering on a red background. Attach front panel nameplates with both a permanent adhesive and stainless steel machine screws into tapped holes.
- C. Tag all interior instruments and other components with engraved, laminated plastic nameplates with 1/8-inch, minimum, lettering. Legends shall be consistent with wiring and layout drawings. Nameplates shall be attached with permanent adhesive to the panel, near the device or on the device itself or as otherwise approved by the Engineer.
- D. Number and label each wire in the systems. Every unique wiring node shall have its own individual unique number. Numbers shall be shown on all submitted drawings. All wires shall be labeled at each termination and junction of the wire and at 30-inch intervals along the wire. All multi-conductor cables shall be labeled at each end and at 30-inch intervals with CBL-XXX and also label each conductor at both ends. Labeling shall be self laminating white/transparent self extinguishing vinyl strips (Brady DAT 7 292 or equal) with clear heat shrink tubing over the markers. Length shall be sufficient to

provide at least two and one-half (2 1/2) wraps. All labels shall be machine-printed with wire and/or cable numbers.

2.9 ACCESSORIES:

- A. Control operators such as pushbuttons (PB), selector switches (SS), and pilot lights (PL) shall be Allen Bradley 800H, Square D Company Type SK or equal. Control operators shall be 30.5 mm, round, heavy-duty, oil tight NEMA 4X corrosion resistant.
- B. Pushbuttons and selector switches shall be non-illuminated, spring release type. Pushbuttons shall include a full guard. Panic stop/alarm pushbuttons shall be red mushroom type with manual-pull release. Pilot lights shall be of the proper control voltage, LED type (indoor) and lamp type (outdoor).
- C. Control operators shall have legend plates as specified herein, indicated on the Contract Drawings, or otherwise directed by the Engineer. Legend plates shall be plastic, white field (background) with black lettering. Engraved nameplates shall be securely fastened above each control operator. If adequate space is not available, the nameplate shall be mounted below the operator.
- D. Control operators for all equipment shall be as specified herein and of the same type and manufacturer unless otherwise specified or indicated on the Contract Drawings. Modifications to existing panels using control operators and indicators of the same type and manufacturer shall be allowed with Engineer's approval.
- E. Where required to interface between motor control centers, equipment controls, and control panels, interposing relays and associated control wiring circuitry shall be furnished and installed to provide the monitoring and/or control functions specified herein. Interposing relays shall be miniature type with DPDT contacts rated a minimum 10 amp @ 120 VAC, push-to-test button, and status indicator. Relay coils shall be 120/240 VAC or 24 VDC as required. Relays shall be as manufactured by Idec, Square D, Omron, Allen-Bradley or approved equal.

2.10 POWER SUPPLIES:

- A. Power supplies shall be enclosed and sized per the guidelines of UL508 and UL508A. Power supplies shall be Phoenix Contact, Model Quint-PS-X, or approved equal.

- B. External PLC power supplies provided for loop and/or PLC power shall be redundant and alarm to the PLC upon failure.

2.11 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) :

- A. Transient voltage surge suppressors shall be provided at the following minimum locations:
 - 1. At any connections between AC power and electrical and electronic equipment, including panels, assemblies and field mounted instruments.
 - 2. At both ends of all analog signal circuits that have any portion of the circuit extending outside of a protecting building.
 - 3. At both ends of all copper-based communications cables that extend outside of a building.
 - 4. At all specified spare analog inputs and outputs in PLCs and RTUs.
- B. These protective devices shall be external to and installed in addition to any protective devices built into the equipment. Power and signal protection shall be installed either in a NEMA 4X enclosure or in the enclosure that houses the equipment to be protected.
- C. All surge arrestors shall be mounted and wired per the manufacturer's recommendations including local grounding for surge energy dissipation. For surge suppressors use No. 8 cable for ground connection or install suppressor directly on ground bus using grounding screw. Provide 1-inch wide by 1/8-inch thick copper ground bus as a minimum.
- D. Panel-mounted power circuit protectors shall be provided in all enclosures powered by 120 VAC. The protector shall be a 3-stage hybrid, solid-state power line protector with noise filtering, common mode and normal mode suppression and nanosecond reaction time. The unit shall include a replaceable fuse to remove the load (protected equipment) from the line if the unit is either overloaded or the internal protection fails. TVSS devices shall be EDCO HSP-121BT-1RU or approved equal.
- E. Panel-mounted signal circuit protectors shall be made for mounting on a terminal block rail. Each TVSS shall include a moveable grounding link to allow each signal cable shield to be individually grounded to the panel via the mounting rail through the TVSS for that cable without the use of any additional grounding wire or to

be isolated from ground at the TVSS. Each mounting rail shall be grounded to the panel by the use of rail mounting screws at approximately one-foot intervals. Protection shall be from line to line and from each line to ground. Protection shall also be from shield to ground where the shield is not grounded at the protector. Each TVSS shall have the ability to protect against surge currents greater than 10,000 amperes. Each TVSS shall add no more than 22 ohms per signal wire to the total signal loop resistance of the analog signal loop in which it is installed. TVSSs shall not introduce error-producing ground loop currents into the instrumentation signal circuits. TVSS devices shall be EDCO DRS-036, Phoenix Contact or approved equal.

- F. Signal circuit TVSS for 2-wire field instruments shall be a conduit connected/pipe nipple type and shall have characteristics equal to the panel mounted devices. Units shall be mounted to a transmitter conduit entry point where available. When not available or practical, then these devices shall be mounted in NEMA 4X enclosures located at the field devices. TVSS devices shall be EDCO SS65-036, Phoenix Contact or approved equal.
- G. Signal circuit TVSS for 4-wire field instruments shall be a separate enclosure unit capable of providing protection on both the power and signal side. The unit shall contain the characteristics of the line power protector and signal circuit protectors discussed above. Units shall be enclosed in a manufacturer assembled NEMA 4X polycarbonate enclosure with a clear polycarbonate cover. TVSS devices shall be EDCO SLAC-12036, Phoenix Contact or approved equal.
- H. TVSS devices antenna cable signal protection shall be an in-line panel mount type unit rated for 50 Ohms and with dc blocking. Unit shall be rated for the appropriate frequency range and have an insertion loss of 0.1 dB. TVSS device shall be a Polyphaser IS-50 series or approved equal.
- I. TVSS device specifications and ratings for signal or communications types not defined herein shall be as specified elsewhere or of a type recommended by the manufacturer of the device being protected. TVSS devices shall be Phoenix Contact, EDCO, Polyphaser or Innovative Technology.

PART 3 EXECUTION

3.01 REQUIREMENTS:

- A. In addition to the requirements specified in this section, refer to Section 13300 - Instrumentation and Controls, General Requirements.
- B. Floor mounted enclosures shall be installed on 1/4-inch thick rubber type pads. These pads shall completely cover the area of the base that is against the floor.
- C. Keep enclosures clean at all times. Keep enclosure doors closed except when actually working in the enclosure. Protect all equipment during installation, including hole punching for conduit connection. Remove all filings and thread cuttings from enclosures. Careful attention must be paid to provide installations which are both functional and aesthetically acceptable.
- D. All conduits used in conjunction with control panels or instrumentation of any kind shall be sealed using a suitable duct-sealing compound to minimize the possible damage caused by vapors or wetness. It shall be the responsibility of the CSI to verify that this is accomplished early in the project, so that corrosion damage does not occur during the time of construction.
- E. The Contractor shall provide the Engineer a periodic written report detailing construction progress. This report shall include specific tabulations of equipment on which construction/installation has been completed.
- F. Equipment shall be located so that it is accessible for operation and maintenance. The CSI shall examine the Contract Drawings and Shop Drawings for various items of equipment in order to determine the best arrangement for the work as a whole and shall supervise the installation of all equipment.
- G. All UPS units shall be mounted on raised platforms so as to not rest on the panel bottom.

3.02 WIRING AND GROUNDING:

- A. The following wiring practice guidelines shall be used in order to minimize ground loops, minimize the effects of electromagnetic interference/radio frequency interference (EMI/RFI) and to provide maximum practical immunity from damage resulting from lightning-induced transients.

- B. Common wires or conductors shall not be utilized (either within panels or external to panels, or for grounding of field devices) for signal shielding, signal grounding, or safety grounds.
- C. Exposed wire lengths extending from within shielded signal cables shall be minimized to reduce pick-up of EMI/RFI by signal circuits. Exposed lengths of less than one inch is preferred with a maximum exposed length of two inches only permitted where necessary. No splicing of signal wires shall be permitted.
- D. All signal wiring shall be shielded, both within panels and external to panels. Unless otherwise specified, all signal wiring shall be No. 16 AWG stranded tinned two-conductor twisted pair with 100 percent coverage of aluminized Mylar or aluminized polyester shield and tinned copper drain wire.
- E. The shield on each process instrumentation cable shall be continuous from source to destination, and grounded at one end only. In general, grounding of signal cable shields shall be done at the control panel end. No signal cable shall share a common cable shield grounding wire with any other signal cable or other circuit. The exposed length of cable shield grounding wires shall not exceed two inches prior to termination with less than one-inch maximum length preferred.
- F. All outdoor instruments and all outdoor enclosures shall be grounded using the practice defined in Section 800.40 of the National Electric Code.

END OF SECTION

SECTION 13330

INSTRUMENTATION AND CONTROLS, SCADA HARDWARE

PART 1 GENERAL

1.01 THE REQUIREMENT:

- A. The Contractor shall furnish, test, install and place in satisfactory operation all equipment required to provide a complete and operable Supervisory Control and Data Acquisition (SCADA) system, as specified herein and as shown on the Contract Drawings, even if each needed item is not specifically specified or shown.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. In addition to the requirements specified in this section, the requirements of specification Section 13300 - Instrumentation and Controls, General Requirements and the sections referenced therein shall be applied.

1.03 SUBMITTALS:

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples and as specified in Section 13300 - Instrumentation and Controls, General Requirements.
- B. In addition, the following specific submittals items shall be provided:
 - 1. Battery backup and UPS sizing calculations

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS:

- A. The SCADA hardware configuration as specified herein, as specified in related sections and as shown on the Contract Drawings depicts overall system configuration requirements. Unless otherwise specified, designs which vary from this concept will be rejected.
- B. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level.
- C. PLC-to-PLC communication protocols shall be Ethernet based.

2.02 TOOLS, SUPPLIES, AND SPARE PARTS:

- A. Tools, supplies and spare parts shall be provided as specified in Section 13300 - Instrumentation and Controls, General Requirements, and as specified for each equipment item. In addition, the following items shall be provided:
 - 1. One (1) of each type of Micrologix PLC, including base and CPU furnished under this Contract.
 - 2. Two (2) of each type of input/output module for PLC and remote I/O equipment furnished under this Contract.
 - 3. Two (2) of each type and size of PLC and remote I/O and equipment power supply furnished under this Contract.
 - 4. Two (2) spare Ethernet Radios of the type furnished under this contract.

2.03 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS):

- A. Refer to specification Section 13320 - Instrumentation and Controls, Control Enclosures for TVSS requirements.
- B. Provide TVSS protection for all specified spare analog inputs and outputs.

2.04 PROGRAMMABLE LOGIC CONTROLLERS (PLC), GENERAL:

- A. The CSI shall furnish programmable logic controllers (PLCs) as specified herein and as shown on the Drawings. PLCs shall be provided complete with rack, power supply, I/O cards, special function cards, instructions, memory, input/output capacity and appurtenances to provide all features and functions as described herein. PLC I/O cards may be supplied by third party vendors if approved by the PLC manufacturer and the Engineer. No substitutions will be permitted.
- B. All components of the PLC system shall be of the same manufacturer, who shall have fully tested units similar to those being furnished, in an industrial environment with associated electrical noise. The PLC system shall have been tested to meet the requirements of NEMA Standard ICS 2-230 (Arc Test) and IEEE C37.90.1 (SWC). The processing unit shall perform the operations functionally described herein, based on the program stored in memory and the status of the inputs and outputs.

- C. All PLC systems provided shall be modular in design and allow for future expansion. No fixed I/O or "brick" type PLC without expansion capabilities will be accepted. I/O shall not be allowed on CPU or processing modules.
- D. The programmable controller shall be designed to operate in an industrial environment. The PLC shall operate in an ambient temperature range of 0°-60°C and a relative humidity of five to ninety-five percent (5% - 95%), non-condensing. The PLC shall operate on supply voltages of 90-132 VAC at 47-63 Hz, or 24 VDC if provided with a battery backup system. Overcurrent and undervoltage protection shall be provided on the power supply.
- E. System configuration shall be as shown on the Contract Drawings. PLC types shall be designated on the Communications System diagram and correspond to the specifications herein. Only a single type of processor shall be supplied for all PLCs of a designated type. Memory, processor and PLC type shall be adequate for all control functions specified. Memory backup shall be provided during loss of power for the configuration, logic program and current operating parameters/addresses.
- F. The processor and its associated memory shall be enclosed in a modular enclosure. A multiple-position selector switch or equivalent shall be used to select processor operating mode. LED-type indicating lights shall be provided to indicate processor, memory and battery status. Errors in memory shall be recognized and shall activate the memory error indicating lights. The PLC processor shall monitor the internal operation of the PLC for failure and provide an alarm. Memory shall consist of battery-backed RAM or EEPROM, which shall retain the control program for at least one (1) year, in the event of power loss. Visual indication shall be provided if battery charge is insufficient to maintain the program in RAM memory for at least two (2) weeks.
- G. The instruction set for the PLC shall include the following, as a minimum:
1. Relay type instructions
 2. Counter and timer instructions
 3. Comparison instructions (equal, greater than, limit tests, etc.)
 4. Integer, long integer and floating point mathematical instructions
 5. Advanced math and trigonometric functions

6. Matrix and array instructions
 7. Logical instructions (and, not, or, etc.)
 8. Bit modification, moving and shift instructions
 9. Diagnostic instructions
 10. Sequencer instructions
 11. Program control instructions (jump, goto, subroutine, etc.)
 12. PID control loops
 13. Block read and write capability
 14. Master and slave communications capabilities
 15. Immediate I/O and communications update instructions
 16. Real-time clock and date
- H. In addition to a communications port for communications as shown on the Contract Documents, additional communication ports shall be provided for any other devices as required (i.e., operator interface unit, connection to a notebook computer for programming and configuration).

2.05 PLC EQUIPMENT for EXISTING SOUTHWEST PLC PANELS:

- A. PLC input/output systems and processing modules shall be of the same model series as the existing equipment.
- B. Discrete inputs (DI) shall be 24 VDC (integral to PLC), developed from dry field contacts. Units shall be Allen Bradley Model 1746-IB16, 16-point discrete input modules.
- C. Discrete outputs (DO) shall be 120 VAC / 28 VDC 5A dry contacts. Output contacts may be powered from the field equipment or powered from 24 VDC / 120 VAC sourced from PLC control panel's power system, as required to interface with field equipment. Outputs to solenoid valves shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise. Provide interposing relays as specified in Section 13320 - Instrumentation and Controls, Control Enclosures as required to meet dry contact rating. Units shall be Allen Bradley Model 1746-OW16, 16-point relay output modules.
- D. Analog input (AI) circuits shall be isolated, 12-bit (minimum) resolution type. Analog input hardware shall be provided as required for all types of analog inputs being transmitted to the PLC. In general, analog input modules shall be capable of receiving 4-20 mA signals.

Each input circuit shall have optical isolation to protect the equipment against high voltage transients. Units shall be Allen Bradley Model 1746-NI8, 8-channel analog input module.

- E. Analog outputs (AO) shall be coordinated with the receivers but shall generally be isolated 24 VDC, 4-20 mA outputs powered from the PLC. Each output circuit shall have optical isolation to protect the equipment against high voltage transients. Units shall be Allen Bradley Model 1746-NO8I, 8-channel analog output module.
- F. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms which can be disconnected to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals. The process interface modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. #22...#12 AWG (0.2...4 mm²) wire.
- G. Output failure mode shall be selectable so that upon station or communication system failure, all outputs shall be placed in the non-conducting mode or remain as they were prior to failure. Light-emitting diodes shall be provided for status indication for each input and output point.
- H. Signal and control circuitry to individual input/output boards shall be arranged such that board failure shall not disable more than one-half (1/2) of the control loops within any group of controlled equipment (e.g., one pump out of a group of three pumps, two pumps out of four, etc.). Where possible, individual control loops and equipment shall be assigned to individual boards such that failure of the board will disable only one (1) loop or piece of equipment.
- I. External power supplies shall be provided with the PLC as required to meet specified installed I/O power requirements, plus spares. Power supplies shall be modular units, shall be fully redundant and shall alarm to the PLC upon failure. Power supplies shall have a line regulation of 0.05% and meet the environmental and power requirements specified herein.
- J. Manufactured PLC cabling systems may be used to replace individual wiring of I/O to terminal blocks. Cabling system shall consist of an I/O module connector, multiconductor cable and an interface module consisting of terminals. The terminals shall accept 22-12 AWG wire

and be rated for the signals carried. If required, an interface module may consist of components (fuses, relays, surge protection, etc.) and terminals. PLC cabling systems shall be as manufactured by Allen-Bradley, Phoenix Contact, Weidmüller, or approved equal.

- K. Control circuits and signals entering hazardous areas shall be provided with intrinsically safe barriers meeting the requirements of the NEC and UL698.

2.06 PLC EQUIPMENT for EXISTING SOUTHEAST PLC PANELS:

- A. PLC input/output systems and processing modules shall be of the same model series as the existing equipment.
- B. Discrete inputs (DI) shall be 120 VAC (integral to PLC), developed from dry field contacts. Units shall be Allen Bradley Model 1746-IA16, 16-point discrete input modules.
- C. Discrete outputs (DO) shall be 120 VAC / 28 VDC 5A dry contacts. Output contacts may be powered from the field equipment or powered from 24 VDC / 120 VAC sourced from PLC control panel's power system, as required to interface with field equipment. Outputs to solenoid valves shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise. Provide interposing relays as specified in Section 13320 - Instrumentation and Controls, Control Enclosures as required to meet dry contact rating. Units shall be Allen Bradley Model 1746-OW16, 16-point relay output modules.
- D. Analog input (AI) circuits shall be isolated, 12-bit (minimum) resolution type. Analog input hardware shall be provided as required for all types of analog inputs being transmitted to the PLC. In general, analog input modules shall be capable of receiving 4-20 mA signals. Each input circuit shall have optical isolation to protect the equipment against high voltage transients. Units shall be Allen Bradley Model 1746-NI8, 8-channel analog input module.
- E. Analog outputs (AO) shall be coordinated with the receivers but shall generally be isolated 24 VDC, 4-20 mA outputs powered from the PLC. Each output circuit shall have optical isolation to protect the equipment against high voltage transients. Units shall be Allen Bradley Model 1746-NO8I, 8-channel analog output module.
- F. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms which can be disconnected to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel

from inadvertently touching the terminals. The process interface modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. #22...#12 AWG (0.2...4 mm²) wire.

- G. Output failure mode shall be selectable so that upon station or communication system failure, all outputs shall be placed in the non-conducting mode or remain as they were prior to failure. Light-emitting diodes shall be provided for status indication for each input and output point.
- H. Signal and control circuitry to individual input/output boards shall be arranged such that board failure shall not disable more than one-half (1/2) of the control loops within any group of controlled equipment (e.g., one pump out of a group of three pumps, two pumps out of four, etc.). Where possible, individual control loops and equipment shall be assigned to individual boards such that failure of the board will disable only one (1) loop or piece of equipment.
- I. External power supplies shall be provided with the PLC as required to meet specified installed I/O power requirements, plus spares. Power supplies shall be modular units, shall be fully redundant and shall alarm to the PLC upon failure. Power supplies shall have a line regulation of 0.05% and meet the environmental and power requirements specified herein.
- J. Manufactured PLC cabling systems may be used to replace individual wiring of I/O to terminal blocks. Cabling system shall consist of an I/O module connector, multiconductor cable and an interface module consisting of terminals. The terminals shall accept 22-12 AWG wire and be rated for the signals carried. If required, an interface module may consist of components (fuses, relays, surge protection, etc.) and terminals. PLC cabling systems shall be as manufactured by Allen-Bradley, Phoenix Contact, Weidmüller, or approved equal.
- K. Control circuits and signals entering hazardous areas shall be provided with intrinsically safe barriers meeting the requirements of the NEC and UL698.

2.07 PLC EQUIPMENT FOR SOUTHWEST SCADA PANELS (SP-11, SP-12 and SP-13):

- A. PLCs within SCADA panels as specified or shown in the Contract Documents shall meet the general requirements for PLCs and shall meet but not be limited to the following requirements:

1. Unit shall be provided with a minimum of two (2) communications ports; one port shall be dedicated for use with the network communications equipment, and one port shall be dedicated for use by a portable programming computer (not supplied as part of this project).
2. I/O modules shall be of a dedicated type, i.e. AI, AO, DI, DO. No mixed I/O modules shall be acceptable.
3. Memory and I/O shall be sized to meet functional requirements.
4. Base unit shall include ten (10) 120 VAC discrete input points, six (6) discrete relay output points and two (2) 0-10 VDC voltage input points.
5. PLC shall be Allen-Bradley, Micrologix 1100, 1763-L16BBB.
6. PC Programming/Configuration Cable shall be Allen-Bradley 1761-CBL-PM02.
7. Discrete Input Expansion Module shall meet the following requirements:
 - a. Sixteen (16) points per module
 - b. 24 VDC input
 - c. Discrete Input Expansion Module shall be Allen-Bradley 1762-IQ16.
8. Discrete Output Expansion Module shall meet the following requirements:
 - a. Sixteen (16) points per module
 - b. Relay Output
 - c. Discrete Input Expansion Module shall be Allen-Bradley 1762-OW16.
9. Analog Input Expansion Module shall meet the following requirements:
 - a. Four (4) points per module, 4-20 mA, 24 VDC.
 - b. Analog Input Expansion Module shall be Allen-Bradley 1762-IF4.

10. Quantity of I/O shall be sized according to the amount specified in the contract drawings with 20% spare capacity.

2.08 ETHERNET RADIO

- A. The Ethernet radio shall meet the following requirements:
 1. long ranged outdoor wireless access point / client bridge which can operate in the 5Ghz and 2.4Ghz frequency.
 2. The radio shall provide 54Mbps bandwidth capability.
 3. The units shall have WPA and WPA2 wireless security encryption.
 4. The configuration of the units shall be done via web browser.
 5. The unit shall be Power over Ethernet (PoE) capable which allows a single outdoor rated gel filled CAT6 cable installed from the unit to the proposed or existing Ethernet switch. PoE injector shall be included with each unit along with the power adapter for the injector.
- B. The radio shall be installed on a pole mounted to building and / or control panel structure for RTU-12 and RTU-13. The radio installed for RTU-11 shall be installed on top of the wooden utility pole(see contract drawings for installation detail).
- C. The units shall be EnGenius model number EOC-5610 or approved equal.
- D. Provide Ethernet CAT5e / CAT6 surge protection with (2) RJ-45 connections, (1) for equipment side and the other (1) for field. Manufacturer shall be Phoenix Contact.
- E. The Chemical Building shall be the Access Point and installed on the outside of the building with a single CAT6 Ethernet cable installed to SCADA Panel No. 2 existing Ethernet switch.
- F. The Remote SCADA panels shall be bridges and pointed towards the access point located at the chemical building.

- G. The Radios shall be mounted to where there is a direct line of sight with each other to maximize the signal strength.
- H. The CSI shall provide a radio test with the radios specified within the project to ensure the correct heights of the radios / antennas are correct to achieve the maximum performance of the radios (rated at 54mbps). The test should be provided for both frequencies which the radio is capable using.

2.09 ANTENNA POLES, WOODEN FOR REMOTES

- A. The wooden poles used for antenna support structures shall be new and of one type supplied in lengths as required for antenna mounting. Wooden poles shall be electric utility grade and capable of being supplied in distribution as well as transmission lengths. Wooden poles shall meet CSA dimensional and strength standards O15.1, O15.2 and O15.3.
- B. Wooden poles shall be Southern yellow pine and treated with chromated copper arsenate (CCA) in accordance with CSA standard O80.4.
- C. Wooden poles shall be provided with copper ground conductors run from top to below grade where they shall be tied to the system of ground rods for lightning protection and grounding of equipment. Conductors shall be installed after antenna orientation has been established so that they may be installed opposite to the side of the antenna mounting location.
- D. Poles shall be installed in accordance to the local electrical utilities' and the specified requirements for antenna support structures as a minimum. No guy wires shall be used for support. Poles shall be provided with foundations which have been designed and certified for intended application by a licensed structural engineer registered in the state of installation.

2.10 ACCESS-POINT RADIO MOUNTING STRUCTURE

- A. The Access-point shall be mounted on the west-side wall of the chemical building (see contract drawings for details) utilizing a wall bracket and pole.
- B. Shall be: Rohn, Andrew or approved equal

2.11 ETHERNET SWITCH

- A. Ethernet switches for mounting within control panels for communications connection to the network: The CSI shall

provide all communications equipment and shall install in all control panels.

- B. The switch shall be a unmanaged 10/100 Mbps switch with a minimum of five (5) Ethernet ports Ethernet ports shall be RJ45 and auto-sensing with indicators for status of each port.
- C. Switches shall be industrial grade and specifically meant for industrial control use and DIN rail mounting.
- D. Provide 24VDC power as called out in specification section 13320 ICS Control Enclosures, Section 2.10 Power Supplies.
- E. Subject to compliance with these specifications Ethernet switches for mounting within a control panel shall be Phoenix Contact, model FL SWITCH SFN 5TX or equal as approved by the Engineer.

2.12 UNINTERRUPTABLE POWER SUPPLIES (UPS)

- A. UPS units shall be provided for the Remote Terminal Units and as specified herein or shown elsewhere within the Contract Documents.
- B. UPS units shall be sized for a minimum of fifteen (30) minutes. Each UPS shall consist of a free standing UPS.
- C. UPS units provided for PLCs shall be provided with a dry contact output to alarm on UPS trouble or failure. This fail output shall be wired into the PLC I/O to represent UPS status.
- D. Where located in a control or PLC enclosure, the UPS shall be located at the bottom of the enclosure but mounted on a raised shelf or platform.
- E. Each UPS shall be sized to match the maximum power requirements of the associated digital equipment, control panel power supplies and accessories plus twenty (20) percent spare capacity. Upon loss of the AC supply, the inverter shall continue to supply normal power to the device, drawing DC from the batteries.
- F. Each UPS shall meet the following requirements:
 - 1. Input voltage shall be 117 VAC, single phase, 60 Hz.
 - 2. Voltage regulation shall be plus or minus five percent (+/-5%) for line and load changes.
 - 3. The output frequency shall be phase-locked to the input AC line on AC operation and shall be 60 hertz (+/-0.5%) when on battery operation.

4. The batteries shall be of the sealed, lead acid or lead calcium gelled electrolyte type, suitable for high temperatures.
 5. Sound absorbing enclosure.
 6. EMI/RF noise filtering.
 7. Surge protection shall be provided on the AC input circuit, which shall have a UL TVSS clamping voltage rating of 400 V with a <5 ns response time.
 8. Adjustment allowed to prevent UPS from going offline when on a standby generator supplied power source.
- G. UPS systems shall be APC, Powerware Ferrups, SOLA, Allen Bradley or approved equal.

PART 3 EXECUTION

3.01 REQUIREMENTS:

- A. In addition to the requirements specified in this section, refer to Section 13300 - Instrumentation and Controls, General Requirements.
- B. The CONTRACTOR/CONTROL SYSTEMS INTEGRATOR shall provide all labor, materials, equipment, and expertise required to carry out the installation, calibration, testing and start-up of all equipment, in a manner in keeping with the best standard practices available, and in accordance with the manufacturer's recommendations for each piece of equipment supplied.
- C. All work shall be scheduled in accordance with the COUNTY's staff, to minimize down time of any system. All modifications to existing and proposed wiring systems shall be carefully documented and included in the as-built documentation to be delivered at the end of the project.
- D. Careful attention should be paid to provide installations at each location, which are both functional and attractive.
- E. The SCADA / RTU panels shall be provided and installed in the location provided in the contract documents.

END OF SECTION

SECTION 13340

INSTRUMENTATION AND CONTROLS, DFS RTU EQUIPMENT

PART 1 GENERAL

1.01 THE REQUIREMENT:

- A. The Contractor shall furnish, test, install and place in satisfactory operation all equipment required to provide a complete and operable Supervisory Control and Data Acquisition (SCADA) system, as specified herein and as shown on the Contract Drawings, even if each needed item is not specifically specified or shown.
- B. The Contractor will provide a complete PLC/RTU Control Panel and Antenna RF System. The Contractor shall be responsible for the physical installation of the control panel including mounting and all field conduits and wiring per the contract drawings and specifications. CONTRACTOR will be responsible for providing and installing a complete antenna system including the mast, antenna and antenna cable.
- C. The Contractor shall provide all labor and materials for the antenna installation. Contractor shall coordinate tower and antenna requirements with the Contractor. A complete radio survey shall be conducted by Contractor to verify antenna requirements. It shall be the responsibility of CONTRACTOR to obtain any information necessary for the radio survey including the site's physical location information, GPS readings or street maps.
- D. At the Southwest and Southeast Water Reclamation Facility, where the existing Hyper SCADA Server is located, CONTRACTOR (DFS) will provide all software development (graphics, database, alarming, trending, communications, etc.) for complete communications, monitoring and control of all DFS sites.
- E. The Contractor shall provide, install and configure a Digi One IAP Protocol converter to convert the Hyper SCADA (Modbus) to Allen-Bradley TCP protocol at the Southeast Water Reclamation Facility. The converter shall be connected to the existing control room Ethernet network.
- F. These specifications are intended to cover the furnishing, the shop testing, the delivery, complete installation and field testing of all equipment and appurtenances for the complete PLC/RTU system herein specified, whether specifically mentioned in the Specifications or not. This includes all discrete and

- G. For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these specifications or not. This installation shall include field-testing of the entire installation and instruction of the regular operating personnel in the care, operation, and maintenance of all equipment.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. In addition to the requirements specified in this section, the requirements of specification Section 13300 - Instrumentation and Controls, General Requirements and the sections referenced therein shall be applied.

1.03 SUBMITTALS:

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples and as specified in Section 13300 - Instrumentation and Controls, General Requirements.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS:

- A. The RTU hardware configuration as specified herein, as specified in related sections and as shown on the Contract Drawings depicts overall system configuration requirements. Unless otherwise specified, designs which vary from this concept will be rejected.
- B. The Remote Terminal Unit (RTU) shall be properly sized and equipped to provide complete local automatic control. In addition to using the existing protocol converter for use in the Citect Human Machine Interface (HMI), all configurable operational parameters shall be selectable from the Control Room Hyper SCADA HMI terminal. The RTU shall incorporate a Radio Transceiver compatible with the owner's existing frequency and Input / Output (I/O) function modules required to meet the monitor and control requirements. Function module card connectors shall be gold-over-nickel plated to inhibit corrosion. The RTU shall be capable of operating in a temperature ranging from -10 to 60 Degrees Celsius (14 to 140 Degrees Fahrenheit).

C. SERVICE PORT

1. The RTU shall support a local serial interface service port for access to all the functions of the unit and local monitoring of the radio communications link. The RTU shall support an automatic antenna alignment function utilizing the local serial interface.

D. POWER SUPPLY MODULE

1. All function modules in the RTU shall run off DC voltage from +7.5 volts to +13 volts. The Power Supply Module (PSM) shall supply +12 volts. A battery backup shall be provided to operate the system in event of power failure. The PSM shall be surge protected. The PSM shall be short circuit protected by current limiting. Normal operation shall automatically resume when the short circuit overload is removed. The PSM shall be sized to operate the system with the battery removed. The PSM shall provide a battery backed, isolated bias voltage source. The circuit breaker for the PSM shall be part of the module. Neither the use of tools nor the disconnection of any wires shall be required to replace the PSM.

E. SURGE PROTECTION

1. Multiple staged surge protection shall be provided for all power supply and power monitoring circuits. This design shall provide a very high level of non-destructive transient immunity. With the exception of a direct lightning strike, the device shall protect the RTU power supply and power monitoring circuits from damage due to voltage transients. The unit shall provide circuit protection to withstand multiple transients in excess of 6,500 volts, 3,250 amps, without damage. Damage shall be limited to a blown fuse when exposed to larger transients. The device shall be transient-tested to ANSI standard C62.41. The unit shall be the Transient Filter Shield TFS001 as manufactured by Data Flow Systems. The AC power input protection shall be the Single Phase Suppressor, SPS001 as manufactured by Data Flow Systems. All surge protection shall be UL Listed.

F. BACKUP BATTERY

1. The RTU shall have the uninterruptible power supply (UPS) function built in. The unit's internal power supply module shall keep the battery at a float

charge. The battery shall not be damaged by deep discharges.

G. RADIO INTERFACE MODULE

1. The RTU shall require one radio interface module (RIM). The RIM shall control the terminal radio during the polling sequence. The RIM shall have a service port to provide communications link monitoring. The service port shall also provide the capability to directly monitor and/or control each module in the RTU. The RIM utilized at the RTU shall be interchangeable with the RIM at the central site. All radio communications shall be in ASCII and utilize an error detecting data transfer protocol. Each RIM shall have an FM radio transceiver mounted to it. Replacement of the RIM shall trigger an automatic configuration of the new module to accommodate the site address and function (plug & play).

H. FUNCTION MODULES

1. The function modules shall be designed so they do not have configuration switches or straps. The function modules shall be designed with surge suppression on all inputs and outputs. Replacement of a function module shall not require the use of tools or the removal of any interface wires. There shall be no components associated with the function module mounted to the motherboard (passive backplane). The function modules shall be backward compatible with all older modules of same type. All the function modules shall support central site computer access to the revision level of the module over the radio communications link.

I. DIGITAL MONITOR MODULE

1. The digital monitor module (DMM) shall accept 12 on/off or pulsed inputs of 12 to 30 volts AC or DC. Other AC or DC voltages shall be accommodated with the use of an inline voltage converter device. Status reporting of the digital inputs shall have an accuracy of ± 2 seconds to the time the event occurred at the RTU. The DMM shall have LEDs to indicate: the status of each input point; receive communications; transmit communications; CPU fault; and power status. The configuration of the monitor points as alarm points, monitor points (pump run time monitors), or pulsed input points shall be operator changeable at the central site. The custom configuration of the DMM shall not require any

software or firmware changes in the RTU. Replacement of the DMM shall trigger an automatic configuration of the new module by the central site (plug & play).

J. DIGITAL CONTROL MODULE

1. The digital control module (DCM) shall be available in two configurations, providing eight (8) digital outputs and four (4) digital inputs, or four (4) digital outputs and eight (8) digital inputs. Each control point shall accommodate 60 to 280 volt AC devices. Each control point shall be capable of driving a 0.5 amp load @ 280 volts AC (140 VA), with inrush current of 5 amps. Any discrete control point shall have the capability of being automatically controlled by any discrete monitor point, at the same RTU or at any other RTU. This shall be accomplished during configuration at the central site and shall be available for an unlimited number of control points. Each input shall accept ON/OFF inputs of 12 to 30 volts AC or DC. Other AC or DC voltages shall be accommodated with the use of an inline voltage converter device. Status reporting of the digital inputs shall have an accuracy of +/- 2 seconds to the time the event occurred at the RTU. The configuration of the monitor points as alarm points or monitor points (pump run time monitors) shall be operator selectable. The configuration shall not require any software or firmware changes in the system. The DCM shall have LEDs to indicate: the status of each output point; receive communications; transmit communications; CPU fault; and power status. Replacement of the DCM shall trigger an automatic configuration of the new module by the central site (plug & play).

K. ANALOG MONITOR MODULE

1. The analog monitor module (AMM) shall monitor up to 4 analog inputs, each capable of accepting 4-20 ma or 0-5 VDC. The analog input shall provide 12-bit accuracy. The analog inputs shall be individually optically isolated. The AMM shall have support-configurable reporting granularity and alarm thresholds. All configurable parameters shall be operator-controlled. The AMM shall have LEDs to indicate: the status of receive communications; transmit communications; CPU fault; and power status. The AMM shall be capable of supplying 24 VDC power source for 4-20 ma transmitters. Replacement of the AMM shall trigger an automatic

configuration of the new module by the central site (plug & play).

L. ANALOG CONTROL MODULE

1. The analog control module (ACM) shall control up to 4 analog outputs, each capable of producing 4-20 ma output driving a 0 to 1000 ohm load. The analog output shall have 12-bit accuracy. Each analog control shall have configurable engineering units. All configurable parameters shall be operator controlled. ACM shall have LEDs to indicate: receive communications; transmit communications; CPU fault; and power status. Any analog control point shall have the capability of being automatically controlled by any analog monitor point, at the same RTU or at any other RTU. This shall be accomplished during configuration at the central site and shall be available for an unlimited number of control points. The ACM shall be capable of supplying 24 VDC power source for 4-20 ma transmitters. Replacement of the analog control module shall trigger an automatic configuration of the new module by the central site computer (plug & play).

M. ENCLOSURE

1. The RTU will be installed indoors and be a NEM A12, painted, gasketed enclosure with three-point handle/latching mechanism. The enclosure shall be sized to accommodate the backplanes, PLC and functions modules needed to meet the requirements. The OIT shall be mounted on the front of the. All mounting hardware utilized shall be stainless steel. The enclosure shall be capable of being locked.

N. ANTENNA SUBSYSTEM

1. Data Flow Systems, Inc. shall perform a radio path analysis. The path analysis shall provide a minimum of 15 dB of fade margin. The 15 dB fade margin shall be demonstrated by inserting a 15 dB pad into the RTU coax cable, and thereafter maintaining communications with the central site. A high gain directional antenna shall be used to transmit and receive data at the RTU. The directional antenna shall have all welded aluminum elements, and a single radiator element connected to a type N female connector. The antenna shall be the RTA series as provided by Data Flow Systems, Inc. The antenna mast/pole shall be hot dipped galvanized for corrosion protection. All mounting hardware

shall be made of stainless steel. The coax cable shall be the type that utilizes an inert semi-liquid compound to flood the copper braid. The coax cable shall be of the RG-8 construction type and have the RF-loss characteristic of foam flex. The coax cable shall be RTC 400 as supplied by Data Flow Systems, Inc. Type N connectors shall be utilized at both ends of the coax. The Type N connectors shall be sealed with 3-inch sections of Alpha FIT321-1-0 sealant shrink-tubing. The coax cable shall be secured to the mast/pole with EVA-coated 316 stainless steel cable ties. The cable ties shall be AE112 cable ties manufactured by Band-It. The RTU shall be protected from electrical surge or transients entering through the coaxial cable by use of a coaxial cable surge protector. The coaxial cable surge protector shall be IS-B50LN-C2 manufactured by Polyphaser.

2.02 TOOLS, SUPPLIES, AND SPARE PARTS:

- A. Tools, supplies and spare parts shall be provided as specified in Section 13300 - Instrumentation and Controls, General Requirements, and as specified for each equipment item. In addition, the following items shall be provided:
 - 1. One (1) of each module used in the RTUs under this contract.

2.03 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS):

- A. Refer to specification Section 13320 - Instrumentation and Controls, Control Enclosures for TVSS requirements.
- B. Provide TVSS protection for all specified spare analog inputs and outputs.

PART 3 EXECUTION

3.01 REQUIREMENTS:

- A. In addition to the requirements specified in this section, refer to Section 13300 - Instrumentation and Controls, General Requirements.

3.02 INSTALLATION

- A. The Contractor shall install and place into operation a complete new RTU System at the site. This work shall include the new antenna system, all interconnecting wiring, conduit, and circuitry necessary to provide the owner with a fully operable control system / RTU.

- B. The Contractor shall install the equipment in accordance with the Contract Documents, manufacturer's instructions and shop drawings. Rigidly support and mount equipment level and plumb, and in such a manner as to provide accessibility; protection from damage; isolation from heat, shock, and vibration; and freedom from interference with other equipment, piping, and electrical components.
- C. Include the services of a factory trained and qualified employee of the equipment manufacturer to inspect the complete equipment installation to assure that it is installed in accordance with the manufacturer's recommendations, make all adjustments necessary to place the system into trouble-free operation and instruct the operating personnel in the proper care and operation of the equipment furnished. Provide services at both the field installation site as well as the central site.
- D. All workmanship utilized in the manufacture and installation of this system shall be of the highest quality and performed in a manner consistent with all accepted industry practices.

END OF SECTION

SECTION 15050

PIPE AND PIPE FITTINGS - GENERAL STATEMENT

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. General:

1. Furnish all labor, materials, tools, equipment, and services for all pipe and pipe fittings as indicated in accordance with provisions of 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. See Division 1 for General Requirements.

B. Related specification sections include but are not limited:

1. 15062 - Ductile Iron Pipe and Fittings
2. 15100 - Valves and Appurtenances

1.02 SUBMITTALS

- A. All submittals shall be in accordance with Specification 01340 - Shop Drawings, Project Data and Samples.
- B. Verify on shop drawings, dimensions, schedule of pipe, linings, coatings, fittings, hangers, supports, and miscellaneous appurtenances. When special fittings are necessary, verify locations of items and include complete details.
- C. Include on fabrication drawings location of jointed sections to permit maintenance of connected equipment and to permit removal of connected equipment without disturbance of main piping system.

- D. Provide copies of any manufacturer's written directions regarding material handling, delivery, storage and installation.
- E. As work progresses and again when work is complete, submit "Record Drawings" of piping systems in project including project items and pre-existing items. Identify complete location, elevations, description of piping systems. Relate piping systems to identified structures and appurtenances. Submit four (4) copies.
- F. Submit written verification of required pressure testing.

1.03 WARRANTY

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

PART 2 PRODUCTS

2.01 GENERAL PIPING SYSTEMS

- A. Unless otherwise shown on drawings or drawing schedule, piping system materials, fittings, and appurtenances are subject to requirements of specific technical specifications and shall be as follows:

Service Category	Pipe Size Range in Inches	Piping System
RCW, SPW, REJ	4 to 48	Above ground - AWWA C115 and C151 Class 53 ductile iron, cement-lined, flanged, AWWA C110 and C111 flanged ductile iron fittings, cement-lined
	4 to 20	Below ground - AWWA C150 and C151 ductile iron pipe, push-on or mechanical joints, cement-lined, 350 psi pressure class
	24	Below ground-AWWA C150 & C151 DIP cement-lined, push-on joints, 200 psi pressure class
	30 to 48	Below ground-AWWA C150 & C151 DIP cement-lined, push-on joints, 150 psi pressure class

PART 3 EXECUTION

3.01 DELIVERY, INSPECTION AND STORAGE

- A. Inspect materials thoroughly upon arrival. Remove damaged or rejected materials from site.
- B. Observe manufacturer's directions for delivery and storage of materials and accessories.
- C. Store materials on-site in enclosures or under protective coverings above ground to keep them clean and dry.

3.02 HANDLING OF PIPE

- A. Protect pipe coating during handling using methods recommended by manufacturer. Use of bare cables, chains, hooks, metal bars, or narrow skids in contact with coated pipe is not permitted.
- B. Prevent damage to pipe during transit. Repair abrasions, scars, and blemishes. If repair of satisfactory quality cannot be achieved, replace damaged material immediately.
- C. Erect piping to accurate lines and grades and support as required on drawings or described in specifications. When temporary supports are used, ensure that sufficient rigidity is provided to prevent shifting or distortion of pipe. Install expansion devices, as necessary, to allow expansion and contraction movements.

3.03 PIPING - GENERAL

- A. Minimum bury. Unless otherwise shown on the drawings, provide a minimum of 36-inches earth cover over exterior buried piping systems and appurtenances conveying water, fluids, or solutions.

3.04 PIPING OUTSIDE BUILDINGS AND STRUCTURES

- A. Install piping as shown on drawings with ample clearance and allowance for expansion or contraction.
- B. Install flexible joint within two (2) feet of point where pipe enters or leaves structure. Provide balance of piping with standard laying lengths and in accordance with drawings.

3.05 PIPE INTERSECTIONS WITH STRUCTURES AND UNITS

- A. Enter and exit through structure walls by using wall seals specified or as shown on drawings.

3.06 EQUIPMENT PIPE CONNECTIONS

- A. Exercise care in bolting flanged joints so that there is no restraint on the opposite end of pipe or fitting which would prevent uniform gasket pressure at connection or would cause unnecessary stresses to be transmitted to equipment flanges. Where push-on joints are used in conjunction with flanged joints, final positioning of push-on joints shall not be made until flange joints have been tightened without strain.
- B. Tighten flange bolts at uniform rate which will result in uniform gasket compression over entire area of joint. Provide tightening torque in accordance with manufacturer's recommendations.
- C. Support and match flange face to uniform contact over their entire face area prior to installation of any bolt between the piping flange and equipment connecting flange.
- D. Permit piping connecting to equipment to move freely in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened. Align, level, and wedge equipment into place during fitting and alignment of connecting piping. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment. To provide maximum flexibility and ease of alignment, assemble connecting piping with gaskets in place and minimum of four (4) bolts per joint installed and tightened. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange. Realign as necessary, install flange bolts, and make equipment connection.
- E. Provide utility connections to equipment shown on drawings, scheduled or specified.
- F. Obtain rough-in data from approved shop drawings on equipment. Obtain rough-in data for relocating existing equipment and coordinate with Owner.
- G. Unless otherwise specified, make piping connections to equipment, including but not limited to installation of

brass and fittings, strainers, pressure-reducing valves, flow control valves, and relief valves provided with or as an integral part of equipment.

- H. Furnish and install sinks, brass, fittings, strainers, pressure-reducing valves, flow control valves, pressure relief valves, and shock absorbers which are not specified to be provided with or an integral part of equipment.

3.07 CLEANING

- A. Clean interior of piping systems thoroughly before installing. Maintain pipe in clean condition during installation.
- B. Before jointing pipe, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.
- C. At completion of work and prior to final acceptance, thoroughly clean work installed under these specifications. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing or from other causes. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner.

3.11 TESTING AND INSPECTION

- A. Upon completion of piping, but prior to application of insulation on exposed piping, test all piping systems.
- B. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.

3.12 LOCATION OF BURIED OBSTACLES

- C. Furnish exact location of buried utilities encountered and any below grade structures. Reference items to definitive reference point locations such as found property corners, entrances to buildings, existing structure lines, fire hydrants, and related fixed structures. Include such information as location, elevation, coverage, supports, and additional pertinent information which will be required by future

- contractors for replacement servicing, or adjacent construction around any buried facility.
- D. Incorporate information to "Record Drawings".

3.13 SPECIAL REQUIREMENTS AND PIPING SPECIALTIES

- E. Insulating joints: Provide insulating joints where dissimilar metals are joined together and where specifically indicated on drawings. Type of joint shall be as detailed and in accordance with the following requirements:
1. Insulating flanges: Provide each unit to consist of flat-faced rubber gaskets.
 2. Insulating unions: Provide "dielectric" union by Epco or equal.
 3. Insulating couplings: When joining larger diameter dissimilar metal pipe, use insulating coupling equal to Rockwell No. 416, Dresser Style 39, or equal. When pipes have different outside diameters, use insulating reducing couplings equal to Rockwell No. 417, Dresser Style 39-62, or equal.
- F. Protective coatings and linings:
1. Where specified, field paint pipe in accordance with Section 09900 - Painting and Coatings and Section 09902 - Pipe and Equipment Painting.
 2. Where specified, coat pipe 24-inch in diameter and smaller with extruded polyethylene coating equal to EnCoat.
 - a) Where specified, line pipe with a blend of high-density and low density polyethylene powders complying with ASTM D1248 and uniformly fused and bonded to the pipe to a minimum thickness of 40 mils.
- G. Underground alarming tape. Provide underground warning tape constructed of heavy gage 0.004-inch polyethylene film to identify all buried utilities except 3-inch and smaller irrigation pipe. Provide 6-inch wide tape as follows:

<u>Film Legend</u>	<u>Film Color</u>
Electric line below	Red
Telephone line below	Orange
Water line below	Blue
Sewer line below	Green
Nonpotable water below	Brown
Reclaimed Water Below	Purple

- H. Install tape directly above each buried utility at a as shown on the Drawings.

END OF SECTION

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 reclaimed water mains, 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, restrained, or flanged joints shall be used. Prior to commencing work, jointing systems for pipe shall be submitted to the Owner's Representative for approval.
- 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 standard size ductile iron cast in accordance with ANSI/AWWA C110/A21.10. 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 Inertol Tar Strop, 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, 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 and valves at the required locations unless otherwise approved by the Owner's Representative. Valve-operating stems shall be oriented to allow proper operation.
- 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, 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 reclaimed water lines. The Contractor shall provide temporary plugs and blocking necessary to maintain the required test pressure of 180 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

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 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. Butterfly Valves
 - 2. Globe Valves
 - 3. Air Release Valves
 - 4. Valve Boxes
 - 5. Flange Adapter Couplings
 - 6. Solid Sleeve Couplings
 - 7. Restraining Clamps
 - 8. Manual Valve Actuators

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 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, and equal to those manufactured by Henry Pratt Company, DeZurik, Mueller, KOR-FLO or approved equal. All valves shall be factory leak tested at 200 psi.
- 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. Valve seats shall be an EPDM elastomer. Valve seats 24 inches and larger shall be field adjustable and replaceable without dismounting 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 screws and 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 rubber seat is mounted on the valve body, the mating edge of the valve disc shall be 18-8 stainless steel or

Nickel-Chrome, 80-20%. Where the EPDM seat is mounted on the valve disc, the valve body shall be fitted with an 18-8 stainless steel seat offset from the shaft, mechanically restrained and covering 360 degrees of the peripheral opening or seating surface.

- D. The valve body shall be constructed of ductile iron or close grain cast iron per ASTM A126, Class B with integrally cast hubs for shaft bearing housing of the through boss-type. Butterfly valves of the "wafer": or "spool" type will not be accepted.
- E. The 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. Shaft shall be of either a one piece unit extending full size through the valve disc and valve bearing or it may be of a stub shaft design. Shaft bearings shall be teflon or nylon, self-lubricated type.
- F. All valves shall be subject to hydrostatic and leakage tests 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 pressure test for normal operation of valve.
- G. 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.
- H. Gearing for the operators shall be totally enclosed in a gear case in accordance with the above mentioned AWWA Standard Specification.
- I. Operators shall be capable of seating and unseating the disc against the full design pressure or 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.
- J. 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 handwheel and gear ratio sized on the basis of actual line pressure

and velocities. Operators 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 when valve is located above grade. They 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 chainwheel when 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 position without damage. Valves located above grade shall have handwheel operators, and valves located below grade shall be equipped with a two-inch (2") square AWWA operating nut located at ground level and cast iron extension type valve box. Valve operators shall conform to AWWA C504, latest revision.

- K. 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 standard.
- L. Where indicated on the Drawings, extension stems, floor stands, couplings, stem guides, and floor boxes as required shall be furnished and installed.

2.02 GLOBE VALVES

- A. The control valve shall be a hydraulically operated, diaphragm actuated, pilot controlled modulating globe valve. The valve shall seal by means of a corrosion-resistant seat, and resilient, rectangular 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 Y-strainer, separate opening and closing speed controls, and ball valves for isolating the control system from the main valve.

- B. The 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 bonnet 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 maximum working pressure of 250 psi. Main valve bonnet studs and nuts shall be stainless steel. All internal ferrous surfaces shall be coated with 10-12 mils dft of NSF61 certified epoxy, Tnemec Series N140. External surfaces shall be coated with 10-12 mils dft of the same epoxy. The main valve stem shall be stainless steel. The main valve seat ring and seat disc retainer plate shall be stainless steel per ASTM A743. Elastomers (diaphragms, resilient seats and O-rings) shall be Buna-N rubber. The solenoid pilot shall have a stainless steel body with a weatherproof enclosure per NEMA 4, suitable for operation on 120 VAC, 60 Hertz. All speed controls, isolation ball valves, control line tubing, solenoid valves, needle valves, and Y-strainers shall be stainless steel. The orifice plate and its body shall be 304 Stainless Steel. The body of the orifice plate shall contain two 1/8" NPT sensing ports, one for high pressure and the other for low pressure.
- D. Schedule of Globe Type Control Valves (SWWRF)
1. North Reclaimed Water Storage Pond Fill Modulating Control Valve (MOV-106)
 - a. Size: 24 inches
 - b. Flow Range: 0 to 11,300 (peak) GPM
 - c. Pressure Range: 90 psi (upstream), 0 to 5 psi (downstream)
 - d. Control Options
 - i. Back Pressure Sustaining Valve, 90 psi working pressure
 - ii. Flow Control Valve using SCADA signals from Flowmeter Assembly via PLC
 - e. Orifice plate down stream

E. Schedule of Globe type Control Valves (SEWRF)

1. Reclaimed Water Storage Pond Fill Modulating Control Valves (BPV-109, BPV-110, BPV-119)
 - a. Quantity: 3
 - b. Size: 16 inches
 - c. Flow Range: 0 to 5,000 (peak) GPM
 - d. Pressure Range: 90 psi (upstream), 0 to 5 psi (downstream)
 - e. Control Options
 1. Backpressure Sustaining Valve, 90 psi Working pressure
 2. Flow Control Valve using SCADA signals From Flowmeter Assembly via PLC.
 - f. Orifice plate downstream

F. The Valve shall be manufactured by Cla-Val, Golden-Anderson, Bermad, or approved equal.

2.03 AIR RELEASE VALVES

- A. Automatic Air Release Valves for Plant Effluent or 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.
 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 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. Resilient seats shall be replaceable and shall provide drop-tight shutoff to the full valve pressure rating.

5. The valve cover shall be bolted to the valve body and sealed with a flat gasket.
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. Each valve shall have an isolation ball valve on its inlet.
7. The body and cover shall be of stainless steel construction with all internal trim to be of 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	316 Stainless Steel

8. The air release valves shall be manufactured by Val-Matic Corp., Elmhurst, Illinois or approved equal. Valves required for the projects include:

a. Carrier Pipe Diameter: 12 inches

1. Val-Matic Model No. 25.5
2. Quantity: 1
3. Maximum Flow: 5,200 GPM
4. Design Cold Water Pressure: 150 psi
5. Inlet Size: 1 inch NPT
6. Outlet Size: ½ inch NPT
7. Orifice Size: 1/8 inch

b. Carrier Pipe Diameter: 16, 20, 24 and 30 inches

1. Val-Matic Model No. 38.2
2. Quantity: 8
3. Maximum Flow: 50,000 GPM
4. Design Cold Water Pressure: 150 psi
5. Inlet Size: 2 inch NPT
6. Outlet Size: ½ inch NPT
7. Orifice Size: 3/16 inch

2.04 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.

2.05 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, 180 psi minimum.

2.06 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.

2.07 RESTRAINING CLAMPS

- M. 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.

2.08 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. Butterfly valve actuators shall conform to the requirements of Section 3.8 of the AWWA Standard Specifications for Rubber Seated Butterfly Valves, Designation C504, insofar as applicable and as herein specified.
 - 4. 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.

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

