



**Public Utilities Department
Engineering and Project Management Division**

**GOLDEN GATE MASTER PUMP STATION
& SITE IMPROVEMENTS PROJECT**

**Prepared By:
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SECTION I

PROJECT DESCRIPTION

Golden Gate Master Pump Station & Site Improvements

In an effort to improve the Collier County wastewater system, the Engineering and Project Management Division (EPMD) is proceeding with the Golden Gate Master Pump Station & Site Improvement Project. This station is located within the Golden Gate Wastewater Treatment Plant at 4931 32nd Ave SW. This phase of construction shall consist of civil site work, underground utility work, and mechanical process piping work. The work includes the installation of all piping, valves, and any other material or component necessary to place the pump station into operation.

The Contractor is also required to coordinate all electrical efforts with the County's procured electrical Contractor (see project Fact Sheet), who is responsible for the installation of all electrical components.

The project shall include, but not be limited to:

- Removal and reinstallation of chain-link fencing along the perimeter of the facility.
- Installation of a new construction trailer.
- Installation of a new administration trailer.
- Installation of new above grade piping assembly.
- Installation of new below grade piping assembly.
- Installation of new concrete driveway and concrete pad.
- Installation of new No. 57 stone pump pad.

All construction shall be in accordance with the construction plans, Collier County Water-Sewer District Utilities Standards Manual, Roadway and Traffic Standards (latest edition), Collier County Development Standards and Specifications, and the State of Florida Department of Transportation (FDOT) standards (latest edition). In the event of conflict between and/or these specifications and drawings, the more stringent requirement shall apply.

SCHEDULE

Time is of the essence for this project and disruption to homeowners must be kept minimal. The project will commence upon notice to proceed (NTP) from the County and be in effect until completion of the project as follows:

- Substantial completion must be reached for all aspects of the project no later than three hundred and thirty-five (335) days from the issued Notice to Proceed.
- Final completion must be reached for all aspects of the project no later than three hundred and sixty-five (365) days from the issued Notice to Proceed.

END OF SECTION

NO. 2 - Bid Schedule

(SEE SEPARATE FILE)

SECTION III

MEASUREMENT AND PAYMENT

Golden Gate Master Pump Station & Site Improvements

DESCRIPTION

- A. This section describes the method used to determine quantities of Work performed or materials supplied for which a price is given in the Bid. It establishes the basis upon which payment will be made for Payment Items.
- B. Subject to the provisions in General Conditions, all Work and payment for the Work is represented by Payment Items and associated unit prices.

PAYMENT

- A. Subject to all other contract requirements, the Contractor shall be paid for "as built" quantities of Work for which a price is given in the bid.
- B. Quantities on the Bid Schedule are estimated and may be increased or decreased without limit.
- C. No separate payment will be made for one Payment Item as Work incidentally required to complete the Work of another.
- D. Payment for Work performed shall be made in accordance with the unit prices in the Bid.

MEASUREMENT FOR PAYMENT

- A. Methods of Measurement:
 1. Measurements of lengths, widths, slope angles, and depths or elevations shall be made to determine "as-built" quantities of lengths, areas and volumes pertinent to Payment Items.
 - a. Unless otherwise specified, all lengths shall be horizontal distances.
 - b. Slope angles and elevations shall be measured using land surveying equipment.
 2. Graphic representations of measured quantities shall be drafted to scale using the Drawings where convenient and appropriate. Additional drawings shall be drafted if required.
 - a. Irregular shapes representing areas and volumes shall be measured using a compensating polar planimeter or a computer digitizer.
 - b. Regular shapes shall be scaled.
 3. Use of Drawings:
 - a. Unless otherwise agreed upon between the Contractor and Owner, the Drawings shall be used as the basis to establish existing grades and other existing topographic features.

PAYMENT ITEMS

- A. No separate payment will be made for the following Work, and its cost shall be included in the Bid Price of the Payment Item to which it is associated:
 1. Trench excavation, sheeting, shoring and bracing.
 2. Dewatering.
 3. Clearing and grubbing.

4. Excavation, fill, backfill, pipe bedding (including 57 stone), compaction, and grading, including furnishing and installing imported material as required.
5. Erosion and sedimentation control, silt fencing, and turbidity screening.
6. Excavation of all material encountered, including rock, organic, inorganic, and unsuitable material and all material transportation and disposal.
7. Removal and temporary replacement of driveways and roadways disturbed during construction to maintain usable condition until permanent restoration is completed.
8. Tree trimming.
9. Temporary restoration.
10. Removal, repair, and replacement of existing irrigation.
11. Cleanup and daily site dust control.
12. Testing, including all materials, fees, certifications, and equipment.
13. Maintenance of utility service.
14. Appurtenant work.
15. Saw cutting.
16. Proposed/existing swale grading/re-grading and grading.
17. All transportation, storage, and labor.
18. Right-of-way, site, and all disturbed area restoration including the removal, replacement and restoration of sod, mulch, plantings, trees, landscape, etc. Sod type shall be determined by the type of sod that constitutes 50% or more of the property to be restored.

B. Measurement and Payment Items as listed in the Bid Schedule:

SECTION 1: GENERAL

1. Master Pump Station Construction and Site Improvements

- A. Measurement for the Master Pump Station and Site Improvements will not be made for payment, and all items shall be included in the lump sum price.
- B. Payment for the Master Pump Station and Site Improvements will be made at the Contract lump sum price. Payment shall include the preparatory work and operations in mobilizing for beginning work on the Project as well as demobilizing for ending work on the Project, all necessary labor, materials, equipment, permitting, services, and all work for the demolition, construction, restoration, and maintenance testing and placing in trouble-free operation the pump station. Work shall include but not be limited to providing all necessary tools, labor, equipment and materials for demolition, cleanup, removal and disposal (or transport, as directed, to Collier County inventory). This item also includes the establishment of field offices, buildings, safety equipment, first aid supplies, sanitary and other facilities, as required by these specifications, State and local laws and any other preconstruction expense necessary for the state of the Work the cost of field engineering, including permits and fees, construction schedules, shop drawings, temporary facilities, lay down storage area, construction aids, work associated with Contractor support during Owner/Engineer testing, reviews inspection, and re-inspection. Also included shall be the cost of any hauling and/or disposal fees along with the filling and compaction as required with soil to the proposed grade or existing grade. The work shall include temporary by-pass pumping and the maintenance of wastewater flow and shall include but not be limited to

providing all necessary tools, labor, equipment and materials for maintaining wastewater collection and conveyance service.

END OF SECTION

SECTION IV

SPECIAL PROJECT PROVISIONS

Golden Gate Master Pump Station & Site Improvements

1. Time is of the essence on this project and construction activities from mobilization to demobilization, including final restoration, must be completed within 365 days (Final Completion) from the issued Notice to Proceed. The resulting contract will commence on issuance of a notice to proceed (NTP) and be in effect until completion of the project.
2. Experience on similar projects is requested in this solicitation, including experience with installation of underground utilities, underground electrical, 480VAC electrical panels, fiber and cellular communications.
3. No payment shall be made for stored materials.
4. Work shall be limited to 7:00 AM to 7:00 PM Monday through Friday. Prior approval for Saturday work is required. Contractor to provide 48 hours' notice (minimum) for any planned Saturday work. No work shall be permitted on Sundays and County Holidays without prior approval. Please see the following link for Collier County's Holidays: <https://collierclerk.com/administration/>
5. Contractor's site superintendent(s) must attend all meeting relating to the project, including, but not limited to; progress meetings, on-site meetings, and any other meeting deemed necessary by Collier County.
6. All Collier County Water-Sewer District, Utilities Standards (design criteria, specifications, and details) are applicable to this project and are made part of the Contract Documents by reference to current County Utilities Standards, located at the following web address: <https://www.colliercountyfl.gov/government/public-utilities/water-sewer-district/engineering-and-project-management/resources>
In the event of a conflict between the County Utility Standards and these specifications and drawings, the more stringent requirement shall apply.
7. Contractor shall be responsible for all inspection and testing unless otherwise specified. For tests to be made by the Contractor, the testing personnel shall make the necessary inspections, furnish all material and equipment to properly perform the testing, and furnish all results to Collier County for acceptance of all equipment and installation as required.
8. Contractor is responsible for providing **SIGNED AND SEALED ENGINEERING DRAWINGS** from a **Florida licensed engineer** for the trailer(s) installation and anchoring in accordance with all current applicable building codes.

9. Contractor is responsible for providing **SIGNED AND SEALED ENGINEERING DRAWINGS** from a **Florida licensed engineer** for the trailer(s) aluminum walkways and access stairs.
10. All items identified on the Construction Trailer Equipment List are “or approved equal”. If the Contractor wishes to submit applicable items as substitutes, provide all necessary information to the EOR and Collier County Project Manager in order to allow a determination to be made.
11. The Administration and Construction/office trailer do not come pre-wired with CAT6e data wiring. The Contractor is required to furnish and install CAT6e wire throughout both trailers from the IT closet to each office or as indicated in the trailer drawings. Wiring must be concealed and cannot be laid across the flooring. Contractor must coordinate with Collier County’s IT.
12. Contractor shall be responsible for coordinating as required with FPL for connections to the existing transformer on-site.
13. Contractor shall be responsible for providing all required licensing in order to operate all equipment.
14. Contractor shall be responsible for the cost of all testing as required.
15. The Contractor shall be responsible for maintaining all work areas in a safe and clean manner as identified in the County Utilities Standards Manual.
16. The Contractor shall prepare and provide for review by the Owner and Engineer an, Tropical Storms and Hurricanes Plan, and Safety Program/Risk Management Program.

END OF SECTION

NO. 5 - Master Pump Station Supplemental Specifications



SUPPLEMENTAL SPECIFICATIONS

GOLDEN GATE MASTER PUMP STATION & SITE IMPROVEMENTS

May 2024

The following Supplemental Specifications for the Collier County Golden Gate Master Pump Station project dated May 2024 were prepared under my direction and supervision.

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013300 Submittals

DIVISION 33 – UTILITIES

333201 Sewage pumps

Alexander P. Dunko, P.E. Date
Florida Professional Engineer No. 88695

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COLLIER COUNTY
MASTER PUMP STATION SUPPLEMENTAL SPECIFICATIONS

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SECTION 013270

SCHEDULES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. The progress schedule required under the General Conditions shall be prepared using the bar chart method as described herein.

PART 2 PRODUCTS

- A. Contractor shall submit a detailed bar chart schedule of the proposed construction operations before Work is started as required in the General Conditions.

PART 3 EXECUTION

Submit Work Schedule and Submittal Schedule to Engineer and Owner no later than ten (10) calendar days after Notice-To-Proceed for approval.

3.1 WORK SCHEDULE

- A. The progress schedule shall indicate the sequence of the Work, the time of starting and completing each part. At minimum, the progress schedule shall include the following main work items at a minimum: permitting, submittals, receipt of materials, mobilization, demolition of existing equipment, installation of proposed equipment, testing and inspection, substantial completion and final completion.
- B. Revise the schedule monthly to reflect changes in the progress of the Work.
- C. A progress report shall be furnished to the Owner with each application for a progress payment. If the work falls behind schedule, Contractor shall take steps to get the project back on schedule and complete the Work within the contract time.
- D. Each progress report shall include sufficient narrative to describe current and anticipated delaying factors, their effect on the construction schedule, and proposed corrective actions. Any Work reported complete, but which is not readily apparent to Owner, must be substantiated with satisfactory evidence.
- E. Each progress report shall also include three prints of the accepted graphic schedule marked to indicate actual progress.

3.2 SUBMITTAL (SHOP DRAWING) SCHEDULE

- A. The submission schedule of shop drawing, product data, samples, and other submittals required by Section 013000 shall be a table listing the specific shop

drawing, product data, sample and other submittal with: number for each shop drawing (submittal), related section of technical specifications or sheet number of project plans, date reviewed by the Contractor, and date submitted to the Owner.

- B. For each submittal or re-submittal of shop drawing, product data, etc., the Owner will have 15 calendar days to review and return it to the Contractor. The Contractor is urged to schedule their submittals accordingly and in a way that will not delay the Work Schedule.

END OF SECTION

SECTION 013300

SUBMITTALS

PART 1 – GENERAL

1.1 DESCRIPTION OF REQUIREMENTS

- A. The types of submittals controlled by these general requirements include shop drawings, product data, samples, construction schedule and miscellaneous work-related submittals. The individual submittal requirements are specified in applicable sections for each unit of work.
 - 1. Unless otherwise noted, each item of submittal shall be submitted to the Engineer for review prior to construction or installation.
 - 2. Engineer's review is for general conformance with the design concept and Contract Documents.
- B. The submittal will not be accepted for review unless it is clear, legible and contains complete information and complies with the specifications. Submittals that are not accepted will be returned with attached notations of requirements necessary for acceptance. Resubmit after the material has been amended to comply with the comments.
- C. If submittals show deviations from Contract requirements because of standard shop practice or for other reasons, the Contractor shall clearly describe such deviations in his letter of transmittal. If the Contractor fails to describe such deviations, he shall not be relieved of the responsibility of executing the work in accordance with the Contract, even though such submittals have been reviewed.

1.2 DEFINITIONS

- A. The work-related submittals of this section, in addition to the definitions of the General Conditions and elsewhere in the Contract Documents, are defined as follows:
 - 1. Shop drawings include custom-prepared data of all forms, including drawings, diagrams, pipe laying schedule, performance curves, data sheets, schedules, templates, patterns, reports, calculations, instructions, measurements and similar information not in standard printed form applicable to other projects.
 - 2. Product data includes standard printed information on materials, products and systems not custom-prepared for this project, other than the designation of selections from available choices.
 - 3. Samples include both fabricated and un-fabricated physical examples of materials, products and work; both as complete units and as smaller portions of units of work; either for limited visual inspection or (where indicated) for detailed testing and analysis.
 - 4. Mock-ups are a special form of samples, which are, because of size, usually constructed on the project site.

5. Construction schedule includes custom-prepared data for the construction of said project. All stages of work shall be included. Contractor shall revise during the course of construction as needed, and submit to the Engineer with monthly application payment.
- B. Miscellaneous submittals related directly to the work, (non administrative) include extended warranties or guarantees, maintenance agreements, project photographs (DVD format), survey data and reports, physical work records, statements of applicability, quality testing, calculation and certifying reports, copies of industry standards, record drawings, operating and maintenance materials, overrun stock and similar information, devices and materials applicable to the work.

1.3 GENERAL SUBMITTAL REQUIREMENTS

- A. The CONTRACTOR shall review, approve, and submit, with reasonable promptness and in such sequence as shown on the Shop Drawing Submittal Schedule so as to cause no delay in the Contract Work or in the Work of the OWNER or any separate contractor, all shop drawings, product data, working drawings and samples required by the Contract Documents.
- B. Submittals shall be electronic in *.pdf format of descriptive or product data submittals to complement shop drawings for the ENGINEER. The ENGINEER will review the submittal and return to the CONTRACTOR a set of marked-up reproducibles with appropriate review comments. If in the opinion of the ENGINEER a submittal is nonreproducible, the CONTRACTOR shall submit four (4) additional sets of blue-line shop drawings. Once submittals are approved and require no additional submittal, electronic copies of each submittal will be forwarded to the OWNER.
- C. All submittals shall be made directly to the ENGINEER with a copy via email to the OWNER.
- D. Shop drawings, product data, working drawings and samples shall be furnished with the following information:
 1. Number and title of the drawing.
 2. Date of drawing or revision.
 3. Name of project building or facility.
 4. Name of contractor, subcontractor, and manufacturer submitting drawing.
 5. Clear identification of contents, location of the work, and the sheet numbers where the product is found in the contract drawings.
 6. Contractor Certification Statement.
 7. Submittal Identification Number.
 8. Contract Drawing Number Reference.
- E. In accordance with subparagraph 1.07 A below, each shop drawing, working drawing, sample, and catalog data submitted by the CONTRACTOR shall have affixed to it the following Certification Statement, signed by the CONTRACTOR:

"Certification Statement: By this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers, and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all contract requirements."

- F. The CONTRACTOR shall utilize a 10-character submittal identification numbering system in the following manner:
1. The first character shall be a D, S, P, M, or R, which represents Shop/Working Drawing and other Product Data (D), Sample (S), Preliminary Submittal (P), Operating/ Maintenance Manual (M), or Request for Information (R).
 2. The next five/six digits shall be the applicable Specification Section Number.
 3. The next three digits shall be the numbers 001-999 to sequentially number each initial separate item or drawing submitted under each specific Section Number.
 4. The last character shall be a letter, A-Z, indicating the submission, or resubmission of the same drawing, i.e., A=1st submission, B=2nd submission, C=3d submission, etc. A typical submittal number would be as follows:

D-0330504-008-B

| | | |
|--------|---|--|
| D | = | Shop Drawing |
| 330504 | = | Specification Section for Ductile Iron Pipe (DIP) & Fittings |
| 008 | = | The eighth initial submittal under this specification section |
| B | = | The second submission (first resubmission) of that particular shop drawing |

- G. The CONTRACTOR shall submit a copy of each submittal transmittal sheet (for shop drawings, product data, working drawings and samples) to the Resident Project Representative simultaneously with the CONTRACTOR'S submission of said drawings, data, samples or manual packages to the ENGINEER and OWNER.
- H. All items specified are not necessarily intended to be a manufacturer's standard product. Variations from specified items will be considered on an "or equal" basis. If submittals show variations from Contract requirements because of standard shop practice or for other reasons, the CONTRACTOR shall describe such variations in his letter of transmittal and on the shop drawings along with notification of his intent to seek contract adjustment. If acceptable, proper adjustment in the Contract shall be implemented where appropriate. If the CONTRACTOR fails to describe such variations he shall not be relieved of the responsibility for executing the work in accordance with the Contract, even though such drawings have been reviewed. Variations submitted but not described may be cause for rejection. Any variations initiated by the CONTRACTOR will not be considered as an addition to the scope of work unless specifically noted and then approved as such in writing by the ENGINEER.
- I. Data on materials and equipment shall include materials and equipment lists giving, for each item thereon, the name and location of the supplier or

manufacturer, trade name, catalog reference, material, size, finish, and all other pertinent data.

- J. For all material furnished, the CONTRACTOR shall provide a list including the material name, address, and telephone number of the manufacturer's representative and service company so that service and/or spare parts can be readily obtained.
- K. The CONTRACTOR shall use the color "green" to make his remarks on the Submittals. Only the ENGINEER will utilize the color "red" in marking submittals.
- L. Before final payment is made, the CONTRACTOR shall furnish to ENGINEER one (1) set of record shop drawings as described in Section 017839. These record shop drawings shall be in conformance with the approved documents and should show any field conditions that may affect their accuracy.

END OF SECTION

SECTION 260511

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: General administrative, procedural requirements, and installation methods for electrical installations specified in Division 26.
- B. The Drawings are schematic and are not intended to show every detail of construction.
 - 1. In general, conduits/raceways, transitions and offsets shown on Drawings indicate approximate locations in plan and elevation where the systems are intended to be run.
 - 2. Contractor shall fully coordinate electrical Work with other trades to avoid interferences.
 - 3. In the event of interferences, Contractor shall request clarification from Engineer in writing.
- C. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Sections, apply to Work of this Section.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with requirements of Section 013323, Shop Drawings covering the items included under this Section of Work. Shop Drawing submittals shall include:
 - 1. Submit product data covering the items included under this Section of Work.
- B. Conforming to Construction Drawings: Submit a complete set of Drawings showing the locations of the piping, ductwork, etc., as actually installed. Such Drawings shall be submitted to Engineer on tracing cloth, mylar, or sepia paper from which blueprints can be obtained.
- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 260510, operation and maintenance manuals for items included under this Section. Include following information for equipment items:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

1.03 RECORD DOCUMENTS

- A. Prepare Record Documents in accordance with requirements in Section 017700. In addition, Contractor shall submit, prior to final payment, Drawings conforming to construction records of systems it has installed. Vendor drawings shall be sized as manufacturers' standard.
- B. Provide typewritten data sheets on motor control circuits with following information on each branch feeder: Load name, horsepower or KVA (transformer), fuse size, starter size, service factor of motor, motor nameplate currents, power factor correction capacitor size (if used), and thermal overload part number.

1.04 QUALITY ASSURANCE

- A. National Electrical Code: Comply with NFPA 70, National Electrical Code.
- B. UL Compliance and Labeling: Use products and components labeled by UL.

1.05 PERMITS, INSPECTIONS, AND LICENSES

- A. Contractor shall procure all necessary permits and licenses, observe and abide by all applicable laws, codes, regulations, ordinances, and rules of the State, territory, or political subdivision thereof, wherein Work is done, or any other duly constituted public authority, and further agrees to hold Owner harmless from liability or penalty which might be imposed by reason of an asserted violation of such laws, codes, regulations, ordinances, or other rules.
 1. Upon completion of Work, Contractor shall secure certificates of inspection from the inspector having jurisdiction and shall submit 3 copies of the certificates to Owner. Contractor shall pay the fees for the permits, inspections, licenses, and certifications when such fees are required.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to Project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification. Equipment shall be packaged to prevent damage during shipment, storage, and handling. Do not install damaged units; replace, and remove damaged units from Site.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL ELECTRICAL INSTALLATION

- A. Provide electrical materials and equipment enclosures appropriate for areas in which they are installed. Each area will be designated on Drawings with a type of construction such as NEMA 4, 4X, 7 or 9 if it is other than NEMA 12. An area designated by a name and elevation includes space bounded by floor, ceiling, and enclosing walls.
 - 1. Exception: Provide manufacturer's standard construction for indoor or outdoor application where equipment is not manufactured to NEMA specifications (e.g., switchgear, transformers, high voltage capacitors, bus duct, and light fixtures; materials and equipment used in finished areas such as offices, laboratories, etc.).
- B. Provide stainless steel electrical materials and equipment enclosures in NEMA 4X areas; watertight NEMA 4 and equipment enclosures for outdoor applications and indoor applications below grade; explosion-proof NEC Class I, Division 1, Group D equipment for NEMA 7 areas; explosion-proof NEC Class II, Division 2, Group F equipment for NEMA 9 areas.
- C. Coordinate with power company high voltage and/or low voltage metering requirements. Furnish, install, and connect metering equipment not furnished, installed or connected by power company.
- D. Provide chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- E. Supporting devices and sleeves shall be set in poured-in-place concrete and other structural components as they are constructed.
- F. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom possible. Locate light fixtures at approximately 8 feet above floor and where fixtures may be readily serviced.
- G. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- H. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by Drawings recognizing that portions of Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to Engineer.
- I. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components where installed exposed in finished spaces.

- J. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.
- K. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.02 RACEWAY INSTALLATION

- A. Outdoors, use the following materials:
 - 1. Exposed Conduit: Rigid aluminum conduit and fittings.
 - 2. Underground Direct Buried Conduit: PVC schedule 80 conduit.
 - 3. Underground Concrete Encased Conduit: PVC schedule 40 conduit.
 - 4. Conduit Used to Connect to Vibrating Equipment including transformers and hydraulic, pneumatic or electric solenoid or motor-driven equipment: Liquidtight flexible metal conduit.
- B. Indoors, use the following wiring materials:
 - 1. Connection to Vibrating Equipment, including transformers and hydraulic, pneumatic or electric solenoid or motor-operated equipment: Liquidtight flexible metal conduit.
 - 2. Conduit shall be concealed within walls and below slab. Conduit shall not run on drywall walls.
 - 3. Exposed Conduit: Aluminum conduit.
 - a. Exceptions:
 - 1) Areas indicated as NEMA 7 or NEMA 9 (such as grit and raw sewage rooms), use PVC externally coated rigid steel conduit.
 - 4. Concealed Conduit: Aluminum conduit.
- C. Minimum size conduit shall be 1 inch unless shown otherwise.
- D. Instrument Signal Conduit Requirements: Shielded signal wires for 4-20 mA type instruments or thermocouple wires assigned to the same control panel may be run in the same conduit. Shielded instrument signal wires, thermocouple wires, and shielded 2-wire intercom wires may be run in the same conduit. No other wires will be permitted in an instrument signal/2-wire intercom conduit.
- E. Conduit Thread Paint: Make threaded conduit joints watertight by coating threaded portions with a spray-on or brush-on zinc-bearing paint. Provide paint containing 90 percent minimum

by weight of metallic zinc powder in the dried film. Clean field-cut threads of oil using the recommended solvent prior to coating threads.

- F. Install expansion fittings in all exposed rigid nonmetallic conduit runs of 20 feet or more.
- G. Install expansion/deflection fittings where conduit passes a building expansion joint or where conduits are attached to two structures joined by a concrete expansion joint.
- H. Exposed or Concealed Construction: Install conduit exposed inside buildings except for areas with finished walls (e.g., offices, laboratories, lavatories, locker rooms, etc.) unless otherwise indicated.
- I. Concealed Raceways: Raceways embedded in slabs shall be installed in the middle third of the slab thickness where practical and leave at least 1-inch concrete cover. Tie raceways to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in the concrete. Run 1-inch and smaller raceways with a minimum of bends in the shortest practical distance. Run larger conduit parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Where nonmetallic conduit used, raceways must be converted to PVC externally coated rigid metal conduit before rising above floor.
- J. Exposed Raceways: Install parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. Make bends and offsets so the inside diameter is not effectively reduced. Keep the legs of a bend in the same plane and the straight legs of offsets parallel. Conduits shall slope away from loads to keep moisture from entering the load. Run parallel or banked raceways together. Make bends in parallel or banked runs from the same centerline so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run, such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.
- K. Space raceways, fittings, and boxes 0.25 inch from mounting surface in NEMA 4 and NEMA 7 areas. Spacers shall be one-piece construction of stainless steel, galvanized steel, PVC, ABS, or other noncorrosive material.
- L. Sleeves: Install in concrete floor slabs except where conduit passes through a housekeeping pad. Install in exterior walls below grade.
- M. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid metal conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this Contract, install screwdriver-operated threaded flush plugs with floor.

- N. Flexible Connections: Use short length (maximum 6 feet for lighting fixtures; maximum 3 feet for all other equipment) of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement, and all motors. Use liquidtight flexible conduit in wet locations and rated flexible connections for hazardous locations. Install separate ground conductor across flexible connections.
- O. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.
- P. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate metal conduit, use threaded rigid metal conduit fittings. For PVC externally coated rigid metal conduit, use only factory-coated fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.
- Q. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL listed sealing compound. For concealed raceways, install each fitting in a flush metal box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
1. Where conduits enter or leave hazardous locations.
 2. Where conduits enter or leave NEMA 4X areas.
 3. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
 4. Where required by the NEC.
- R. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- S. Install device boxes at the height above the floor as follows for:
1. Light switches, 4 feet.
 2. Receptacles, 18 inches except in NEMA 4 and 4X areas, 4 feet.
 3. Thermostats, 4'-0".
- T. Avoid installing boxes back-to-back in walls. Provide not less than 6-inch (150 mm) separation.
- U. Position recessed outlet boxes accurately to allow for surface finish thickness.

- V. Fasten electrical boxes firmly and rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete masonry.
- W. Provide fire-retardant barriers in all pull and junction boxes containing circuits that are otherwise continuously separated in conduit. Securely fasten these barriers within box. Size barriers so that space between barrier and box wall does not exceed 0.125 inch anywhere around the perimeter of barrier.
- X. Support exposed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
- Y. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from building structure.
- Z. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box and tighten the chase nipples so no threads are exposed.
- AA. Complete installation of electrical raceways before starting installation of conductors within raceways and prevent foreign matter from entering raceways by using temporary closure protection. Cap spare conduit. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- BB. Install pull wires in empty raceways: Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-pound tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

3.03 WIRE AND CABLE INSTALLATION

- A. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant where necessary.
- B. Keep branch circuit conductor splices to minimum. Splice feeders only where indicated. Use a standard kit. No splices are allowed for instrument and telephone cables except at indicated splice points.
- C. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors which are compatible with conductor material and are UL listed as pressure type connectors.

- D. Provide adequate length of conductors within electrical enclosures and train conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at terminal.
- E. Terminate power conductors at equipment using pressure-type terminals specifically designed for type of terminations to be made. Terminate no more than 2 conductors No. 8 AWG and smaller within the same pressure-type terminal. These 2 conductors shall be no more than 4 wire gauge sizes apart. Terminate no more than 1 conductor larger than No. 8 AWG within any pressure-type terminal.
 - 1. Exception: Power factor correction capacitor conductors may be terminated at the motor disconnect switch load terminals.
- F. Seal wire and cable ends until ready to splice or terminate.

3.04 EQUIPMENT CHECKOUT AND TESTING

- A. In addition to testing recommended by equipment or material supplier and called for in equipment or material specification, perform the following.
- B. Motor Testing: Motor insulation shall be tested by using a 500 VDC (minimum) megger and applying test until a constant megohm reading of the following magnitude is obtained:
 - $R_{min.} = 4 (KV + 1)$ at 25 degrees C winding temp.
 - $R_{min.} = IV + 1$ at 40 degrees C winding temp.
 - 1. If motors do not meet requirements of megger test, blow hot air through motors to dry out and repeat until test is passed. If desirable, drying can be done by applying an electrical potential to equipment. However, in no case, induced or direct, shall voltage or current exceed continuous rating of equipment being dried.
 - 2. After passing megger test, motors shall be hi-pot tested at 200 percent rated voltage for a minimum of 1 minute.
- C. Check-out Procedures. In general, check-out procedures (as listed below) which are applicable for a particular item of equipment shall be performed:
 - 1. Vacuum interior of cubicles and remove foreign material.
 - 2. Wipe clean with a lint-free cloth insulators, bushings, bus supports, etc.
 - 3. Check and adjust time delay, under-voltage devices, phase relay, over-current relays, etc., as required by coordination study or Engineer.
 - 4. Fill motor bearings requiring oil.
 - 5. Check and change, as required, thermal overload heater elements to correspond with motor full-load current and service factors of installed motor.

6. Check direction of rotation of motors and reverse connections if necessary. Check rotation with motor mechanically uncoupled where reverse rotation could damage equipment.
7. Equipment with two or more sources of power connected by tie breakers, transfer switches, or generator receptacles shall be checked for rotation from each possible combination of power sources. Power sources must have the same phase sequence for each source throughout entire facility.
8. Check exposed bolted power connections for tightness.
9. Check operation of breakers, contactors, etc., and control and safety interlocks.
10. Check tightness of bolted structural connections.
11. Check leveling and alignment of enclosures.
12. Check operating parts and linkages for lubrication, freedom from binding, vibration, etc.
13. Check tightness and correctness of control connections at terminal blocks, relays, meters, switches, etc.
14. Clean auxiliary contacts and exposed relay contacts after vacuuming.

END OF SECTION

SECTION 260513

WIRES AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Low-Voltage Wire and Cable.
 - 2. Instrument Cable.
 - 3. Multiconductor Control Cable.
 - 4. Local Area Network Wiring (LAN).

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Include Shop Drawings of wires, cables, connectors, splice kits, and termination assemblies.
- B. Reports of field tests prepared as noted in Section 260510.

1.03 QUALITY ASSURANCE

- A. UL Compliance: Provide components which are listed and labeled by UL. For cables intended for use in air handling space comply with applicable requirements of UL Standard 710, "Test Method for Fire and Smoke characteristics of cables used in Air Handling Spaces."
- B. IEEE Compliance: Provide components which comply with the following standard.
 - 1. Standard 82, Test procedures for Impulse Voltage Tests on Insulated Conductors.
- C. Network Wiring Experience: Contractor must be able to prove to the satisfaction of Owner that it has significant experience in the installation of Local Area Network cable systems. Installation must include installation of Network cable, cable termination, knowledge of interconnect equipment, and a thorough knowledge of testing procedures.
- D. Labeling: Handwritten labels are not acceptable. All labels shall be machine printed on clear or opaque tape, stenciled onto adhesive labels, or typewritten onto adhesive labels. The font shall be at least 1/8 inch in height, block characters, and legible. The text shall be of a color contrasting with the label such that it may be easily read. If labeling tape is utilized, the font color shall contrast with the background. Patch panels shall exhibit workstation numbers or

some type of location identifier, in sequential order, for all workstations or devices attached. Each Network cable segment shall be labeled at each end with its respective identifier.

- E. Network Wiring Interconnect Equipment (Patch Panels): Interconnect equipment shall be used in all Local Area Network cable installations. Patch panels shall be mounted in the equipment racks or panel mounted. Interconnect equipment mounted in racks shall be affixed to the rack by at least 4 screws. All interconnect devices shall be assembled and installed in accordance with the manufacturer's instructions and recommendations.
- F. Patch Cords: Patch cords shall be provided for each Local Area Network port on the patch panel. Patch cords shall meet or exceed technical specifications of all installed Local Area Network cable. Patch cord connectors shall be matched with patch panel connector type and network module connector type as required.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Low-Voltage Wire and Cable:
 - a. American Insulated Wire Corp.
 - b. General Cable.
 - c. The Okonite Co.
 - d. Southwire Co.
 - 2. Connectors for Low-Voltage Wires and Cable Conductors:
 - a. AMP.
 - b. O-Z/Gedney Co.
 - c. Square D Company.
 - d. 3M Company.
 - 3. Instrument Cable:
 - a. Belden (Trade Nos. 1120A and 1118A).
 - 4. Local Area Network Cable:
 - a. Belden 7882A/7883A, or equal.

2.02 LOW-VOLTAGE WIRES AND CABLES

- A. Conductors: Provide stranded conductors conforming to ASTM Standards for concentric stranding, Class B. Construction of wire and cable shall be single conductor (1/c) unless

multiconductor cable is shown by notation in form (x/c) where x indicates the number of separate insulated conductors per cable.

- B. Conductor Material: Copper. Minimum size power wire shall be No. 12 AWG.
- C. Insulation: Provide XHHW insulation for single- and 3-phase circuits.
 - 1. Provide VFD cable for power conductors between VFD's and motors.
 - 2. Provide THHN/THWN, insulation for grounding conductors installed in raceways.
 - 3. Provide THHN/THWN insulation for control conductors.

2.03 CONNECTORS FOR LOW-VOLTAGE WIRES AND CABLES

- A. Provide UL listed factory fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types, and classes for applications and services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

2.04 INSTRUMENT CABLE

- A. Instrument Cable: 600-volt minimum insulated shielded cable with two or more twisted No. 16 AWG stranded copper conductors; PVC, nylon, or polyethylene outer jacket; and 100 percent foil shielding. Cable routed in conduit underground shall be wet location rated.

2.05 MULTICONDUCTOR CONTROL CABLE

- A. Multiconductor Control Cable: Concentrically cabled No. 14 AWG stranded copper conductors with saturated interstitial fillers; overall binder of nylon or similar material; and PVC jacket. Quantity of conductors shall be as indicated on Drawings. Provide Type 2010 individual conductor insulation unless otherwise indicated on Drawings as one of the following:
 - 1. Type ISS: 15 mils polyethylene with 5 mils nylon.
 - 2. Type 2010: 20 mils polyethylene with 10 mils PVC.
 - 3. Type 3015: 30 mils polyethylene with 15 mils PVC.

2.06 LOCAL AREA NETWORK CABLE

- A. Category 6 (Ethernet) Data and Patch Cable:
 - 1. Paired, 4-pair, 24 AWG, solid bare copper conductors with polyethylene insulation, overall aluminum foil-polyester tape shield with 24 AWG stranded tinned copper drain wire, 100 percent shield coverage, PVC jacket.
 - 2. UL verified to Category 6.

3. Provide plenum rated cable where installed exposed.
4. Cable routed in conduit underground shall be wet location rated.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Prior to energizing, check installed 480 volt, 3-phase power circuits and higher wires and cables with a 1,000-volt megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Minimum acceptable megohm meter reading is 100 megohms held at a constant value for 15 seconds. A certified copy of megohm meter tests shall be submitted to Engineer. Test reports shall include ambient temperature and humidity at time of testing. Notify Engineer 48 hours prior to test with schedule.
- B. Local Area Network (LAN) Cable Tests: Testing of all cable segments shall be completed in compliance with EIA/TIA-568-B.1 Standards. Testing shall be done by Contractor with at least 5 years of experience in testing Network cabling systems.
 1. TESTING: Contractor shall test each network cable segment. **Owner reserves the right to have representation present during all or a portion of the testing process. Contractor must notify Owner 5 days prior to commencement of testing.** If Owner elects to be present during testing, test results will only be acceptable when conducted in the presence of Owner.
 2. DOCUMENTATION (Network Cable): Contractor shall provide documentation to include test results and as-built Drawings. Network Cable Results: Handwritten results are acceptable provided the test is neat and legible. Copies of test results are not acceptable. Only original signed copies will be acceptable.
 - a. Each cable installed shall undergo complete testing in accordance with TIA/EIA-568-B.1 to guarantee performance to this Standard.
 - b. All required documentation shall be submitted within 30 days at conclusion of the project to Owner.
 - c. Test Criteria: Pass rate to conform to latest TIA/EIA-568-B.1 Standards that incorporate link performance testing through entire path, including cable, couplers, and jumpers.
 3. ACCEPTANCE: Acceptance of the Data Communications System, by Owner, shall be based on the results of testing, functionality, and receipt of documentation.
- C. Reports (non-LAN cable): Testing organization shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Testing organization shall submit written reports to Engineer.

END OF SECTION

SECTION 260526

GROUNDING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Electrical grounding and bonding Work as follows:
 - 1. Solidly grounded.
- B. Applications of electrical grounding and bonding Work in this Section:
 - 1. Underground metal piping.
 - 2. Underground metal water piping.
 - 3. Underground metal structures.
 - 4. Metal building frames.
 - 5. Electrical power systems.
 - 6. Grounding electrodes.
 - 7. Separately derived systems.
 - 8. Raceways.
 - 9. Service equipment.
 - 10. Enclosures.
 - 11. Equipment.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL Compliance: Comply with applicable requirements of UL Standards No. 467, "Electrical Grounding and Bonding Equipment," and No. 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits, and equipment. In addition, comply with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL listed and labeled for their intended usage.

2. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141, and 142 pertaining to grounding and bonding of systems, circuits, and equipment.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING

A. Materials and Components:

1. Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type component product meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.
2. Conductors: Electrical copper grounding conductors for grounding system connections that match power supply wiring materials and are sized according to NEC.
3. Grounding Electrodes: Steel with copper welded exterior, 3/4-inch diameter by 20 feet.
4. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

- A. Connect grounding conductors to underground grounding electrodes using exothermic weld process or mechanical compression type connectors.
- B. Ground electrical service system neutral at service entrance equipment to grounding electrodes.
- C. Ground each separately derived system neutral to effectively grounded metallic water pipe, effectively grounded structural steel member, and separate grounding electrode.
- D. Connect system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

- E. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug, bus, or bushing.
- F. Connect grounding electrode conductors to 1-inch diameter or greater, metallic cold water pipe using a suitably sized ground clamp. Provide connections to flanged piping at street side of flange.
- G. Connect building reinforcing steel, building steel beam, building steel roof and walls and duct bank and vault reinforcing steel to ground mat using No. 2/0 AWG bare copper grounding cable.
- H. Bond bare No. 2/0 AWG grounding cable in duct banks to grounding cable in vaults and to power equipment ground bus at ends of each duct bank.
- I. Bond strut and other metal inside of electrical manholes and vaults to bare No. 2/0 AWG grounding cable carried in duct bank.
- J. Bond grounding cables to both ends of metal conduit or sleeves through which such cables pass.
- K. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque-tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- L. Install braided type bonding jumpers with code-sized ground clamps on water meter piping to electrically bypass water meters.
- M. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible while following building lines to minimize transient voltage rises. Protect exposed cables and straps where subject to mechanical damage.
- N. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed and are subjected to corrosive action.
- O. Uninsulated conductors shall be bare copper in accordance with ASTM B3.
- P. Use tinned-coated in corrosive environments including when buried in earth or embedded in concrete.

END OF SECTION

SECTION 260529

SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each type of product specified.

1.03 QUALITY ASSURANCE

- A. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Slotted Metal Angle and U-Channel Systems:
 - a. Allied Tube & Conduit.
 - b. American Electric.
 - c. B-Line Systems, Inc.
 - d. Cinch Clamp Co., Inc.
 - e. GS Metals Corp.
 - f. Haydon Corp.
 - g. Kin-Line, Inc.

- h. Unistrut Diversified Products.
- 2. Conduit Sealing Bushings:
 - a. Bridgeport Fittings, Inc.
 - b. Cooper Industries, Inc.
 - c. Elliott Electric Mfg. Corp.
 - d. GS Metals Corp.
 - e. Killark Electric Mfg. Co.
 - f. Madison Equipment Co.
 - g. L.E. Mason Co.
 - h. O-Z/Gedney.
 - i. Producto Electric Corp.
 - j. Raco, Inc.
 - k. Red Seal Electric Corp.
 - l. Spring City Electrical Mfg. Co.
 - m. Thomas & Betts Corp.

2.02 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors or indoor wet conditions, in NEMA 4 areas, or embedded in concrete shall be stainless steel.

2.03 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners. Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: Steel springhead type.
 - 3. Hanger Rods: 0.375-inch diameter minimum, steel.

- C. Conduit Sealing Bushings: Factory fabricated, watertight conduit sealing bushing assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable iron casting with hot-dip galvanized finish.
- E. Stainless Steel U-Channel Systems: 12 gauge or 0.105-inch-thick steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center in top surface. Provide fittings and accessories that mate and match with U-channel and are of same manufacturer.

2.04 FABRICATED SUPPORTING DEVICES

- A. Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide a waterstop on pipe sleeves. Provide pipe sleeves of 2 standard sizes larger than conduit/pipe passing through it and of one of the following:
 - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gauge metal for sleeve diameter noted:
 - a. 3-inch and smaller: 20-gauge.
 - b. 4-inch to 6-inch: 16-gauge.
 - c. Over 6-inch: 14-gauge.
 - 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
 - 3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 260533

RACEWAYS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Raceways for electrical wiring. Types of raceways in this Section include the following:
 - 1. Liquidtight flexible conduit.
 - 2. Rigid aluminum conduit.
 - 3. Rigid nonmetallic conduit.
 - 4. Conduit bodies.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for the following products:
 - a. Conduit.
 - b. Conduit bodies.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
 - 2. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL, ETL, or CSA.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in Work include:

1. Conduit:

- a. Allied Tube.
- b. Carlon.
- c. Johns Mansville.
- d. Occidental Coatings.
- e. Orangeburg.
- f. Perma-Cote Industries.
- g. Republic Steel.
- h. Robroy Industries.
- i. Steelduct Co.
- j. Triangle Conduit.
- k. Wheatland Tube.
- l. Youngstown Sheet and Tube.

2. Liquidtight Conduit:

- a. Anamet, Inc.
- b. Carlon.
- c. Electric-Flex.
- d. Thomas and Betts.

3. Conduit Bodies:

- a. Adalet-PLM.
- b. American Electric.
- c. Appleton Electric Co.
- d. Carlon.
- e. Crouse-Hinds Division, Cooper Industries, Inc.
- f. Delta Industrial Products.
- g. Killark Electric Mfg. Co.
- h. Kraloy Products Co.
- i. O-Z/Gedney Co.
- j. Perma-Cote Industries.
- k. Robroy Industries.
- l. Spring City Electrical Mfg. Co.

4. Conduit Thread Paint:

- a. CRC Chemicals, USA.
- b. Sherwin Williams.

c. ZRC Chemical Products Co.

2.02 METAL CONDUIT AND TUBING

- A. Rigid Aluminum Conduit: ANSI C 80.1.
- B. Liquidtight Flexible Metal Conduit and Fittings: UL 360. Fittings shall be specifically approved for use with this raceway.

2.03 NONMETALLIC CONDUIT AND DUCTS

- A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.
- B. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

2.04 CONDUIT BODIES

- A. Provide matching gasketed covers secured with corrosion-resistant screws. Use cast covers in NEMA 4 areas and stamped steel covers in NEMA 1 and 12 areas. Use nonmetallic covers in NEMA 4X areas and threaded, ground joint covers in NEMA 7 and NEMA 9 areas.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies as follows:
 - 1. Rigid Aluminum Conduit: Use aluminum conduit bodies and threaded hubs.
 - 2. Nonmetallic Conduit and Tubing: Use nonmetallic conduit bodies conforming to UL 514 B.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 260535

CABINETS, BOXES, AND FITTINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Cabinets, boxes, and fittings for electrical installations and certain types of electrical fittings not covered in other Sections. Types of products specified in this Section include:
1. Outlet and device boxes.
 2. Pull and junction boxes.
 3. Bushings.
 4. Locknuts.
 5. Conduit hubs.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Shop Drawings for floor boxes and boxes, enclosures, and cabinets that are to be shop-fabricated, (nonstock items). For shop-fabricated junction and pull boxes, show accurately scaled views and spatial relationships to adjacent equipment. Show box types, dimensions, and finishes.
 2. Product data for boxes, fittings, cabinets, and enclosures.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. UL Listing and Labeling: Items provided under this section shall be listed and labeled by UL.
 2. NEMA Compliance: Comply with NEMA Standard 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Outlet Boxes, Concealed Conduit System:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric, Emerson Electric Co.
 - c. Bell Electric, Square D Company
 - d. Eagle Electric Mfg. Co., Inc.
 - e. Midland-Ross Corp.
 - f. OZ/Gedney, General Signal Co.
 - g. Pass and Seymour, Inc.
 - h. RACO Div., Harvey Hubbell, Inc.
 - i. Thomas & Betts Co.
 2. Outlet Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type JB, GS, or SHE.
 - b. Crouse Hinds, Type GS or GRF.
 3. Device Boxes, Concealed Conduit Systems:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric; Emerson Electric Co.
 - c. Bell Electric, Square D Company.
 - d. Eagle Electric Mfg. Co., Inc.
 - e. Midland-Ross Corp.
 - f. OZ/Gedney, General Signal Co.
 - g. Pass and Seymour, Inc.
 - h. RACO Div., Harvey Hubbell, Inc.
 - i. Thomas & Betts Co
 4. Device Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type FS/FD.
 - b. Crouse Hinds, Type FS/FD.
 5. Junction and Pull Boxes, Concealed System:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric, Emerson Electric Co.
 - c. Arrow-Hart Div., Crouse-Hinds Co.
 - d. Bell Electric, Square D Company.
 - e. GTE Corporation.

- f. Keystone Columbia, Inc.
 - g. OZ/Gedney Co.; General Signal Co.
 - h. Spring City Electrical Mfg. Co.
6. Junction and Pull Boxes, Exposed Conduit System:
- a. Appleton Electric, Type FS/FD.
 - b. Crouse Hinds, Type FS/FD.
7. Bushings, Knockout Closures, Locknuts, and Connectors:
- a. Adalet-PLM Div., Scott Fetzer Co.
 - b. AMP, Inc.
 - c. Arrow-Hart Div., Crouse-Hinds Co.
 - d. Appleton Electric Co., Emerson Electric Co.
 - e. Bell Electric; Square D Co.
 - f. Midland-Ross Corp.
 - g. Midwest Electric, Cooper Industries, Inc.
 - h. OZ/Gedney Co., General Signal Co.
 - i. RACO Div., Harvey Hubbell, Inc.
 - j. Thomas & Betts Co., Inc.

2.02 CABINETS, BOXES, AND FITTINGS - GENERAL

A. Outlet Boxes: Suitable for the conduit system installation as follows:

1. Exposed Conduit: Provide cast or malleable iron, zinc, electroplated outlet boxes finished with aluminum lacquer or enamel. Provide cast metal covers with neoprene gaskets for NEMA 4 areas and stamped steel covers for NEMA 12 and undesignated areas.
 - a. Exception: Provide non-metallic outlet boxes for NEMA 4X areas. Provide the appropriate explosion-proof rating for outlet boxes installed in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated boxes where PVC-coated conduit is specified.
2. Concealed Conduit: Provide galvanized coated flat-rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct outlet boxes with mounting holes and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding. Provide cast metal outlet boxes for exterior outlets.

B. Device Boxes: Suitable for the conduit system as follows:

1. Exposed Conduit: Provide cast device boxes finished with aluminum lacquer or enamel. Provide exterior mounting lugs on device boxes.

- a. Exception: Provide non-metallic outlet boxes for NEMA 4X areas. Provide appropriate explosion-proof rating for device boxes installed in NEMA 7 and NEMA

9 areas. Provide factory PVC-coated device boxes where PVC-coated conduit is specified.

2. Concealed Conduit: Provide galvanized coated flat-rolled sheet-steel non-gangable device boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with cable-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices. Provide cable clamps and corrosion-resistant screws for fastening cable clamps, and for equipment type grounding. Provide cast metal device boxes for exterior devices.

C. Junction and Pull Boxes: Suitable for the conduit system installation as follows:

1. Exposed Conduit: For pull and junction boxes 50 cubic inches and smaller, provide cast or malleable iron, zinc electroplated boxes finished with aluminum lacquer or enamel. Provide exterior mounting lugs and cast covers with neoprene gaskets. For pull and junction boxes larger than 50 cubic inches provide watertight sheet metal boxes. Grind exposed edges smooth or roll edges to prevent scuffing of wire during installation. Provide code-gauge sheet steel construction for boxes smaller than 1,000 cubic inches. Provide 0.10-inch steel construction, hot-dip galvanized after fabrication for boxes larger than 1,000 cubic inches. Secure box covers using No. 8 or larger machine screws spaced at intervals not exceeding 6 inches. Provide a continuous neoprene or rubber gasket cemented to the box cover where it contacts the box body.
 - a. Exceptions: Provide stainless steel junction boxes in NEMA 4 and 4X areas. Provide appropriate explosion-proof construction for boxes located in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated boxes for areas where PVC conduit is used.
2. Concealed Conduit: Provide galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers.

D. Bushings, Knockout Closures, and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications. Provide watertight hubs on conduits terminated at sheet steel enclosures in NEMA 4 areas.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 260543

HANDHOLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of underground concrete encased conduit (ductbank) handhole work as indicated by Drawings, and is hereby defined to include those units which are utilized exclusively for installation of instrumentation, communication, and control media and equipment; and electrical power cables, wires, and equipment.
- B. Types of handholes in this Section include, but are not limited to:
 - 1. Electrical handholes.
 - 2. Concrete encased conduit (ductbank).

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Prefabricator's Data: Submit prefabricator's data on factory-fabricated handholes.
 - 2. Manufacturer's Data: Submit manufacturer's data on concrete encased conduit handhole components and associated specialty products.
 - 3. Submit Shop Drawings for vault system, showing raceway types and sizes, locations, and elevations for horizontal runs. Include details of underground structures, accessories, fittings, and connections.

1.03 QUALITY ASSURANCE

- A. Prefabricators: Firms regularly engaged in manufacture of factory fabricated vaults, manholes, and handholes, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Manufacturers: Firms regularly engaged in manufacture of handhole components and specialty products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 / 5 years.
- C. Codes and Standards:
 - 1. ANSI Compliance: Comply with requirements of ANSI C2, "National Electrical Safety Code," pertaining to construction and installation of concrete encased conduit handholes.

2. ASTM Compliance: Comply with applicable requirements of American Society for Testing and Materials (ASTM) standards pertaining to construction and materials for and handholes.
3. UL Compliance: Comply with applicable requirements of Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide handhole accessories which are UL listed and labeled.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 1. Advance Concrete.
 2. Or Equal.
- B. Prefabricated Units:
 1. Advance Concrete.
 2. Or Equal.
- C. Handhole Frames and Covers:
 1. James B. Clow & Sons.
 2. Neenah Foundry Co.
 3. Or Equal.

2.02 FACTORY FABRICATED HANDHOLES

- A. Handholes and Boxes: Provide handholes and boxes for pulling, splicing, and terminating conductors, in types and sizes indicated, with watertight cover and penta-head bolts and knockout access holes; equip base with sump/drainage box.
 1. Provide concrete body with cast iron cover and ring.
- B. Accessories: Provide handhole accessories, including pulling-in irons, embedded cable support accessories, cable rack arms, porcelain saddles, sump pump pits, ladders, mastics, and sealants as indicated or required.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Installer must examine areas and conditions under which concrete encased conduit, handholes are to be installed, and notify Contractor in writing of those conditions detrimental to proper completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 UNDERGROUND CONCRETE ENCASED CONDUIT

- A. Support conduit to be encased on approved spacers at the dimensions shown on Drawings.
- B. Reinforce concrete encasement as indicated.
- C. Slope duct runs a minimum of 0.5 percent in the direction indicated.
- D. Maintain a 12-inch minimum clearance between concrete encasement and yard piping.
- E. Provide 24-inch minimum clearance from top of concrete encasement to finished grade unless otherwise noted.
- F. Mandrel and clean all underground conduits prior to cable installation.

3.03 INSTALLATION OF HANDHOLES

- A. Install handholes as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that handholes comply with requirements.
- B. Coordinate with other Work, including electrical raceway and wiring Work, as necessary to interface installation of handholes with other Work.

3.04 INSTALLATION OF FIELD FABRICATED UNITS

- A. Fabricate handholes, of types and sizes indicated, watertight, and equip with manhole metal access cover, steps, access holes for raceways and cables, sump/drainage box, and bolting inserts.

3.05 INSTALLATION OF FACTORY FABRICATED UNITS

- A. Install handholes as indicated, in accordance with manufacturer's written instructions and recognized industry practices to ensure that vaults, manholes, and handholes comply with requirements and serve intended purposes.
- B. Precast Concrete Units: Place precast concrete sections as indicated. Where units occur in pavements, set tops of frames and covers flush with finish surface, unless otherwise indicated. Use epoxy bonding compound where steps are mortared into unit walls.

1. Install rubber joint gasket, complying with ASTM C 443, at joints between sections.
2. Apply bituminous mastic coating at joints between sections.
3. Coordinate dampproofing and waterproofing Work with installation of precast concrete units as necessary for proper interface.
4. Install dampproofing and waterproofing materials as indicated.

3.06 BACKFILLING

- A. Delay backfilling of excavations surrounding handholes until after initial inspection has been completed.

3.07 GROUNDING AND BONDING

- A. Provide equipment grounding and bonding connections for exposed metal parts in vaults, manholes, and handholes as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

END OF SECTION

SECTION 260553

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including, but not limited to, the following:
1. Buried electrical line warnings.
 2. Identification labeling for cables and conductors.
 3. Operational instruction signs.
 4. Warning and caution signs.
 5. Equipment labels and signs.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product Data for each type of product specified.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Colored Adhesive Marking Tape for Wires and Cables: Self-adhesive, vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.
- B. Underground Line Marking Tape: Permanent, bright colored, continuous printed, plastic tape compounded for direct-burial service not less than 6 inches wide by 4 mils thick. Printed legend indicative of general type of underground line below.
- C. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with pre-printed numbers and letter.

- D. Aluminum, Wraparound Cable Marker Bands: Bands cut from 0.014-inch-thick aluminum sheet, fitted with slots or ears for securing permanently around wire or cable jacket or around groups of conductors. Provide for legend application with stamped letters or numbers.
- E. Engraved, Plastic Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in white letters on black face and punched for mechanical fasteners.
- F. Baked Enamel Warning and Caution Signs for Interior Use: Pre-printed aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.
- G. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, pre-printed cellulose acetate butyrate signs with 20-gauge galvanized steel backing, with colors, legend, and size appropriate to location. Provide 1/4-inch grommets in corners for mounting.
- H. Fasteners for Plastic Laminated and Metal Signs: Self-tapping stainless steel screws or Number 10/32 stainless steel machine screws with nuts and flat and lock washers.
- I. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18 inch minimum width, 50-pound minimum tensile strength, and suitable for a temperature range from minus 50 to 350 degrees F. Provide ties in specified colors when used for color coding.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification Work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by Code.
- B. Underground Electrical Line Identification: During trench backfilling for exterior nonconcrete encased underground power, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench, do not exceed an overall width of 16 inches; install a single line marker.
- C. Install line marker for underground wiring, both direct buried and in raceway.
- D. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the Project secondary electrical system following OWNER's method of phase identification or as follows:

| <u>Phase</u> | <u>480/277 Volts</u> |
|--------------|----------------------|
| A | Yellow |
| B | Brown |
| C | Orange |
| Neutral | White |
| Ground | Green |

1. 208 Volt, 3-Phase Power:
 - a. Black.
 - b. Red.
 - c. Blue.

2. 240/120 Volt, 1-Phase Power:
 - a. Black.
 - b. Red.
 - c. White Neutral.

3. Motor Leads, Control Cabinet/MCC:
 - a. Black, numbered L1-T1, etc.

4. Control Wiring:
 - a. Red Control circuit wiring that is de-energized when the main disconnect is opened.
 - b. Yellow Control circuit wiring that remains energized when the main disconnect is opened.
 - c. Blue DC.
 - d. Green Ground.

- E. Use conductors with color factory applied entire length of conductors except as follows:
 1. The following field applied color coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
 - a. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last 2 laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.

- b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply 3 ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.
- F. Power Circuit Identification: Securely fasten identifying metal tags of aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with 1/4-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-pound test monofilament line or one-piece self-locking nylon cable ties.
- G. Install wire/cable designation tape markers at termination points, splices, or junctions in each circuit. Circuit designations shall be as indicated on Drawings.

END OF SECTION

SECTION 260573

SHORT-CIRCUIT STUDIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.02 ACTION SUBMITTALS

A. Product Data:

- 1. For computer software program to be used for studies.
- 2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.
 - a. Short-circuit study input data, including completed computer program input data sheets.
 - b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
 - 1) Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
 - 2) Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data:

- 1. For Power Systems Analysis Software Developer.
- 2. For Power System Analysis Specialist.
- 3. For Field Adjusting Agency.

- B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
 - 1. Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.
 - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- D. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- E. Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- F. Field Adjusting Agency Qualifications:
 - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
 - 2. A member company of NETA.
 - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. Comply with IEEE 399 and IEEE 551.
 - 1. Analytical features of power systems analysis software program shall have capability to calculate "mandatory" features as listed in IEEE 399.
- B. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.02 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
 - 6. Derating factors and environmental conditions.
 - 7. Any revisions to electrical equipment required by the study.
- D. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.
- E. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstands ratings exceed available short-circuit current at equipment installation locations.
 - 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 - 3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
- F. Short-Circuit Study Input Data:
 - 1. One-line diagram of system being studied.
 - 2. Power sources available.
 - 3. Manufacturer, model, and interrupting rating of protective devices.

4. Conductors.
 5. Transformer data.
- G. Short-Circuit Study Output Reports:
1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.
 2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
 3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.

- g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.01 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the study.
- B. Gather and tabulate the required input data to support the short-circuit study. Comply with requirements in Section 01 78 39 "Record Documents" for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

3.02 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is indicated on Drawings.
- E. Begin short-circuit current analysis at the service, extending down to system overcurrent protective devices as follows:
 - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 - 2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.
- H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- I. Include in the report identification of any protective device applied outside its capacity.

END OF SECTION

SECTION 260574

COORDINATION STUDIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1.02 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.
 - a. Coordination-study input data, including completed computer program input data sheets.
 - b. Study and equipment evaluation reports.
3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power System Analysis Software Developer.
2. For Power Systems Analysis Specialist.
3. For Field Adjusting Agency.

- B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications:
 - 1. Computer program shall be designed to perform coordination studies or have a function, component, or add-on module designed to perform coordination studies.
 - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Field Adjusting Agency Qualifications:
 - 1. Employer of a NETA ETT-Certified Technician Level III responsible for all field adjusting of the Work.
 - 2. A member company of NETA.
 - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. Comply with IEEE 242 and IEEE 399.
- B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report

device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

2.02 COORDINATION STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
 - 6. Any revisions to electrical equipment required by the study.
 - 7. Study Input Data: As described in "Power System Data" Article.
 - a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 73 "Short-Circuit Studies."
- D. Protective Device Coordination Study:
 - 1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays:
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.
 - b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, and ground).

- 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
- c. Fuses: Show current rating, voltage, and class.
- E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
 3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
 4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - c. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - d. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - e. Ground-fault protective devices.
 - f. The largest feeder circuit breaker in each motor-control center and panelboard.
 5. Maintain selectivity for tripping currents caused by overloads.
 6. Provide adequate time margins between device characteristics such that selective operation is achieved.
 7. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.02 POWER SYSTEM DATA

- B. Obtain all data necessary for conduct of the overcurrent protective device study.
 - 1. Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.
 - 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
- C. Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

3.03 COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at the service, extending down to system overcurrent protective devices as follows:
 - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 - 2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.

- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- H. Motor Protection:
 - 1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
 - 2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- J. Generator Protection: Select protection per manufacturer's written instructions and to IEEE 242.
- K. Include the ac fault-current decay from induction motors and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.
- L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

M. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Include in the report identification of any protective device applied outside its capacity.

3.04 MOTOR-STARTING STUDY

- A. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141, and, and voltage sags so as not to affect operation of other utilization equipment on system supplying the motor.

3.05 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" contract portion.
- B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.
- C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.
1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.06 DEMONSTRATION

- A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in the following:
1. Acquaint personnel in fundamentals of operating the power system in normal and emergency modes.
 2. Hand-out and explain the coordination study objectives, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting time-current coordination curves.

3. For Owner's maintenance staff certified as NETA ETT-Certified Technicians Level III or NICET Electrical Power Testing Level III Technicians, teach how to adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION

SECTION 260575

ARC-FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.02 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form:
 - 1. Arc-flash study input data, including completed computer program input data sheets.
 - 2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
 - 3. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 - 1. For Power Systems Analysis Software Developer.
 - 2. For Power System Analysis Specialist.
 - 3. For Field Adjusting Agency.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.
 - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arc-flash study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- G. Field Adjusting Agency Qualifications:
 - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
 - 2. A member company of NETA.
 - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

- A. Comply with IEEE 1584 and NFPA 70E.
- B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory" features as listed in IEEE 399.

2.02 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573 "Short-Circuit Studies."
- F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260574 "Coordination Studies."
- G. Arc-Flash Study Output Reports:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.
7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

2.03 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Electrical Identification" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
- B. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
1. Location designation.
 2. Nominal voltage.
 3. Protection boundaries.
 - a. Arc-flash boundary.
 - b. Restricted approach boundary.
 - c. Limited approach boundary.
 4. Arc flash PPE category.
 5. Required minimum arc rating of PPE in Cal/cm squared.

6. Available incident energy.
 7. Working distance.
 8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.02 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis.
1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573 "Short-Circuit Studies."
 2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260574 "Coordination Studies."
- C. Calculate maximum and minimum contributions of fault-current size.
1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
 2. Calculate arc-flash energy at 85 percent of maximum short-circuit current per IEEE 1584 recommendations.
 3. Calculate arc-flash energy at 38 percent of maximum short-circuit current per NFPA 70E recommendations.
 4. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.
- D. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

- E. Include low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.
- F. Calculate the limited, restricted, and prohibited approach boundaries for each location.
- G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
 - 1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
- H. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:
 - 1. When the circuit breaker is in a separate enclosure.
 - 2. When the line terminals of the circuit breaker are separate from the work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.03 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the arc-flash hazard analysis.
 - 1. Verify completeness of data supplied on one-line diagram on Drawings. Call discrepancies to Architect's attention.
 - 2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.

3.04 LABELING

- A. Apply arc-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.
- B. Each piece of equipment listed below shall have an arc-flash label applied to it:
 - 1. Motor-control center.
 - 2. Low-voltage switchboard.
 - 3. Switchgear.

4. Medium-voltage switch.
 5. Medium voltage transformers
 6. Low voltage transformers. Exclude transformers with high voltage side 240 V or less and less than 125 kVA.
 7. Panelboard and safety switch over 250 V.
 8. Applicable panelboard and safety switch under 250 V.
 9. Control panel.
- C. Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.
1. Indicate arc-flash energy.
 2. Indicate protection level required.

3.05 APPLICATION OF WARNING LABELS

- A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.06 DEMONSTRATION

- A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION

SECTION 262213

TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Types of transformers specified, and include the following:

1. Dry-type transformers .

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Product Data: Submit manufacturer's technical product data, including rated kVA, frequency, primary and secondary voltages, percent taps, polarity, impedance and average temperature rise above 40 degrees C ambient temperature, sound level in decibels, and standard published data.
2. Submit manufacturer's Drawings indicating dimensions and weight loadings for transformer installations.
3. Wiring Diagrams: Submit wiring diagrams for power distribution transformers.

1.03 QUALITY ASSURANCE

A. Codes and Standards:

1. NEMA Compliance: Comply with NEMA Standard Pub/Nos. ST 20, "Dry-Type Transformers for General Applications," TR 1, and TR 27.
2. UL Compliance: Comply with applicable portions of ANSI/UL 506, "Safety Standard for Specialty Transformers. Provide power/distribution transformers and components which are UL listed and labeled.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Acme Electric Corporation.

2. Cutler-Hammer.
3. General Electric Company.
4. Hevi-Duty Electric Div., General Signal Corp.
5. Square D Company.

2.02 POWER/DISTRIBUTION TRANSFORMERS

- A. Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.
- B. Dry-Type Distribution Transformers (75 kVA or less): Provide factory assembled, general purpose, air cooled, dry-type distribution transformers where shown; of sizes, characteristics, and rated capacities indicated. Three-phase, 60 hertz, 10 kV BIL, 4.0 percent impedance with 480-volts delta connection primary and 208/120 volts secondary wye connected. Provide primary winding with 4 taps; 2 to 2-1/2 percent increments above and below full-rated voltage for de-energized tap-changing operation. Insulate with Class 150 or 220-degree C insulation and rate for continuous operation at kVA, and limit transformer temperature rise to maximum of 115 or 150 degrees C, respectively. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections and electrical supply raceway terminal connector. Equip terminal leads with connectors installed. Limit terminal compartment temperature to 75 degrees C when transformer is operating continuously at rated load with ambient temperature of 40 degrees C. Provide wiring connectors suitable for copper or aluminum wiring. Cushion-mount transformers with external vibration isolation supports; sound-level ratings not to exceed 45 db as determined in accordance with ANSI/NEMA standards. Electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap. Provide transformers with fully enclosed sheet steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure.
- C. Finishes: Coat interior and exterior surfaces of transformer, including bolted joints, with manufacturer's standard color baked-on enamel.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 262416

PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Power distribution panelboards.
 - 2. Lighting panelboards.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Manufacturer's product data on panelboards and enclosures.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL Compliance: Comply with applicable requirements of UL 67, "Electric Panelboards," and UL's 50, 869, 486A, 486B, and 1053 pertaining to panelboards, accessories, and enclosures. Provide panelboard units which are UL listed and labeled.
 - 2. NEMA Compliance: Comply with NEMA Standards Pub/No. 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," Pub/No. PB 1, "Panelboards," and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."
 - 3. Federal Specification Compliance: Comply with FS W-P-115, "Power Distribution Panel," pertaining to panelboards and accessories.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Cutler-Hammer Products.
 - 2. Siemens, Inc.

3. Square D Company.

2.02 PANELBOARDS

- A. Except as otherwise indicated, provide panelboards, enclosures, and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; with design and construction in accordance with published product information. Equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.
- B. Power Distribution Panelboards: Provide dead-front safety type power distribution panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, and types shown; with anti-turn solderless pressure type main lug connectors approved for use with copper conductors. Select unit with feeders connecting at top of panel. Equip with tin-plated aluminum, or silver- or tin-plated copper bus bars braced for 65,000 rms symmetrical amperes fault current, and with full-sized neutral bus; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide as indicated, either molded-case bolt-on main and branch circuit breakers for each circuit with toggle handles that indicate when tripped. Where multiple pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Provide panelboards with bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate and match properly with panelboards.
- a. Power Monitor: Microprocessor-based device capable of measuring each phase current, line-to-line voltage, line-to-neutral voltage, watts, VARS, power factor, demand watts, and frequency. Unit shall contain kilowatt hour totalizer. 3-CT's and 3 (fused)-PT's shall be provided, and factory installed as required. Unit shall have two Form C, 2-amp rated output contacts, one to alarm upon abnormal voltage level and one to alarm on power failure.
- C. Lighting Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, and types shown; with anti-turn solderless pressure type lug connectors approved for use with copper conductors. Construct unit for connecting feeders at top of panel; equip with copper bus bars, full-sized neutral bar with bolt-in type heavy-duty, quick-make quick-break, single pole circuit breakers, and toggle handles that indicate when tripped. Provide suitable lugs on neutral bus for each outgoing feeder required and provide bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate and match properly with panelboards. Panelboards and circuit breakers shall be braced for 10,000 rms symmetrical amperes fault current unless otherwise indicated.
- D. Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code gauge, minimum 16-gauge thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed piano door hinges and door swings as indicated. Equip with interior circuit directory frame and card with clear

plastic covering. Provide baked gray enamel finish over a rust-inhibitor coating. Design enclosures for recessed or surface mounting as indicated. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.

- E. Molded-Case Circuit Breakers: Provide factory assembled, molded-case circuit breakers of frame sizes, characteristics, and ratings, including rms symmetrical interrupting ratings indicated. Select breakers with permanent thermal and instantaneous magnetic trip, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position, and operating in an ambient temperature of 40 degrees C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.
- F. Ground Fault Protected Breakers: Provide UL Class A protected GFI breakers with 6 mA for personnel protection, and for general-purpose receptacles. For breakers dedicated to equipment (sump pumps, heat trace, etc.), provide breaker with 30 mA equipment protection.
- G. Accessories: Provide panelboard accessories and devices including, but not necessarily limited to, ground-fault protection units or circuit breaker locking hardware as indicated.
- H. Spares: In each panelboard provide 8 installed, single pole, 20A spare circuit breakers unless otherwise indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF PANELBOARDS

- A. Type out panelboard's circuit directory card upon completion of installation Work.

END OF SECTION

SECTION 262813

CIRCUIT AND MOTOR DISCONNECTS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each type of product specified.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Sections 017000, operation and maintenance manuals for items included under this Section, including circuits and motor disconnects.

1.02 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. Electrical Component Standards: Provide components which are listed and labeled by UL. Comply with UL Standard 98 and NEMA Standard KS 1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Allen-Bradley.
 - 2. Cutler-Hammer.
 - 3. Siemens, Inc.
 - 4. Square D Company.

2.02 CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Provide NEMA 4X enclosure to match the rating of the area in which switch is installed. For motor and motor starter disconnects through 100 horsepower, provide units with horsepower ratings suitable to loads. For motor and motor starter disconnects above 100 horsepower, clearly label switch, "DO NOT OPEN UNDER LOAD." Disconnect switches shall be provided with two normally open auxiliary contacts.

- B. Non-fusible Disconnects: (Heavy-duty) switches of classes and current ratings as indicated.

2.03 ACCESSORIES

- A. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:
 - 1. Stainless Steel for 4X switches.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 262923

VARIABLE FREQUENCY DRIVE UNIT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide complete simplex type variable frequency drive (VFD) units and appurtenances including by-pass starters, drive reactors, DC chokes, harmonic filters, dv/dT filters, enclosures, and certain auxiliary items, as indicated and as specified, to provide a complete operating system.
- B. Variable frequency drive unit shall be furnished, installed and electrically connected by the electrical subcontractor unless otherwise indicated in process or mechanical specifications and plans for skid or packaged equipment.
- C. VFD units shall be manufacturer's standard technology and in production for a minimum of 2 years.
- D. VFD units shall communicate via Ethernet.
- E. Provide control system operation, input and control signals, status signals and devices in accordance with Division 40.
- F. Provide Underwriter's Laboratories listed drive components where applicable.
- G. Provide VFD 3% load reactor when cable length between VFD and motor is greater than 100 feet and less than 200 feet, and dv/dt filters when cable length is 50 feet or greater in length to insure motor terminals do not experience overvoltage condition as defined by NEMA Standard MG-1, section 30.02.2.9.
- H. Each VFD unit to be provided is to exhibit less than 5% voltage total harmonic distortion and less than 3% voltage distortion on each harmonic at their immediate upstream distribution bus as verified by calculation and testing. Harmonic current distortion to be in accordance with Table 2.02A. This bus to be referred to as the point of common coupling (PCC). Provide 3%-line reactor on all 12 and 18 pulse VFD's and 5%-line reactor on all 6 pulse VFD's. Reactors may be reduced or eliminated if VFD vendor harmonic calculations show compliance with these specifications and IEEE 519 distortion limits.
- I. Contractor shall acquire the Collier County Public Utilities Division SCADA Standards, Section 1.3 Drives (Appendix A 1.3 Drives) and shall meet the Owner requirements in that standard.

1.02 RELATED WORK

- A. Division 1: General Requirements.

B. Sections 462140 and 462180.

1.03 REFERENCES

- A. Underwriter's Laboratories Inc. (U.L.):
 - 1. UL-508 Electrical Industrial Control Equipment.
- B. National Electrical Manufacturers Association (NEMA): MG 1.
- C. National Fire Protection Association (NFPA):
 - 1. NFPA-70 National Electric Code.

1.04 SUBMITTALS

- A. Shop Drawings: Submit the following in accordance with Section 013323 – Shop Drawings:
 - 1. Shop Drawings: Provide a complete list of equipment components, and materials, including manufacturer's descriptive and technical literature, and catalog cuts. Provide complete wiring, system interconnection and schematic diagrams for the equipment and controls furnished including external interlocked and controlled components, equipment layout, time versus current curves for protective devices and any other details required to demonstrate that the system and the required external controls has been coordinated and will properly function as designed.
 - a. Provide data to verify that drives can be used for motor lead lengths up to 60 feet without output filters or VFD cable. Include information from the VFD manufacturer or output filter or cable manufacturer (if required) stating that the motor terminal voltage limitations as defined by NEMA Standard MG-1, section 31.40.4.2, are met. For VFD's located more than a cable length is greater than 100 feet and less than 200 feet, and dv/dt filters when cable length is 200 feet or greater in length to insure motor terminals do not experience overvoltage condition as defined by NEMA Standard MG-1, section 30.02.2.9. Submit Harmonic Compliance Certificate based on theoretical calculations prior to raceway rough-ins for approval.
 - b. Each VFD unit to be provided is to exhibit less than 5% voltage total harmonic distortion and less than 3% voltage distortion on each harmonic at their immediate upstream distribution bus as verified by calculation and testing. Harmonic current distortion to be in accordance with Table 2.02A. This bus to be referred to as the point of common coupling (PCC). Provide 3% line reactor on all 12 and 18 pulse VFD's and 5% line reactor on all 6 pulse VFD's. Reactors may be reduce or eliminated if VFD vendor harmonic calculations show compliance with these specifications and IEEE 519 distortion limits.

- c. Provide enclosure drawings and details showing all dimensions and construction details.
2. Submit information relative to location and expertise of local service office and personnel.
3. For informational purposes only, provide installation and anchoring details to meet earthquake requirements as specified and indicated on structural drawings.
4. For informational purposes only, submit manufacturer's printed installation instructions.
5. Spare Parts Data: Submit a list of spare parts for the equipment specified.
6. Operating and Maintenance Instruction Manuals:
 - a. Furnish:
 - 1) Operating instruction manuals outlining step-by-step procedures required for system startup and operation.
 - 2) Manufacturer's name, model number, service manual parts list.
 - 3) Brief description of equipment and basic operating features.
 - 4) Maintenance instruction manuals outlining maintenance procedures.
 - 5) Troubleshooting guide listing possible breakdown and repairs.
 - 6) Point-to-point connection wiring diagram for the system.
 - 7) Performance Test Reports: Upon completion of installed system, submit in booklet form all shop and field tests performed to prove compliance with specified performance criteria.

1.05 QUALITY ASSURANCE

- A. Ensure that conduit size and wire quantity, size, and type are suitable for the equipment supplied. Coordinate all design information with the Electrical Contractor. Review the proper installation of each type of VFD unit with the equipment supplier prior to installation.
 1. Services of Service Engineer, specifically trained on type of equipment specified. Man-day requirements listed exclusive of travel time.
 - a. Assist in location of devices, methods of mounting, field erection, etc.:
1 man-day.

- b. Start-up and testing: 3 man-days.
- c. At the end of start-up service provide for a maximum of six members of the owners staff at the facility site to receive training from the startup/testing service Engineer: 1 man-day.
- d. Service-inspections during first year of operation, for use at Owner's request, and exclusive of repair, malfunction or other trouble-shooting service calls: 2 man-days.
- e. Man-day is defined as one 8-hour day, excluding travel time.

1.06 DELIVERY, STORAGE AND HANDLING

A. Shipping:

- 1. Ship equipment and materials, except where partial disassembly is required by transportation regulations or for protection, complete with identification and quantity of items.
- 2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.
- 3. Deliver spare parts after installation but as specified before start-up of drives. Deliver to Owner after completion of work.

B. Storage:

- 1. Inspect and inventory items upon delivery to site.
- 2. Store and safeguard equipment, material and spare parts.

1.07 WARRANTY AND SERVICE:

- A. Provide in accordance with Section 017833 and as specified.
- B. Guarantee components, parts, and assemblies supplied by manufacturer against defects in materials and workmanship for a period of 24 months and, in this time period, include onsite, parts and labor warranty. All labor to be performed by local factory trained service engineers. Warranty shall commence upon substantial completion.
- C. Ensure that equipment manufacturer has local branch office staff with trained, full-time employees who are capable of performing testing, inspecting, repair, and maintenance services.
- D. The manufacturer shall provide their standard parts warranty for eighteen (18) months from the date of shipment or twelve (12) months from the date of being energized, whichever occurs first.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturer shall have at least five years commercial experience in the manufacture, operation and servicing of equipment of type, size, quality, performance, and reliability equal to that specified.
- B. Variable Frequency Drive Units:
 - 1. Allen-Bradly Power Flex 753 (1.0 to 350 HP)
 - 2. Allen-Bradly Power Flex 755 (400 to 500 HP)
- C. VFD Input Filters and Output Filters/Reactors:
 - 1. Trans-Coil, Inc.
 - 2. MTE Corporation.
 - 3. Power Quality International.
 - 4. Or acceptable equivalent product.

2.02 PROVISIONS

- A. Service Conditions:
 - 1. Ambient Temperature Range: 0 deg. C to 40 deg. C.
 - 2. Operational Humidity: Up to 90 percent non-condensing.
 - 3. Environment: Enclosure NEMA 12.
 - 4. Altitude: Below 3,300 ft. above sea level.
 - 5. Input Power:
 - a. Nominal voltage - 460 volts (plus 10 percent or minus 10 percent), 3-phase, 3 wire.
 - b. Nominal Frequency - 60 Hertz (plus or minus 2 Hz.).
 - c. Service provided from feeder breaker on distribution bus.

B. Drive System: 0-500 HP Units

1. General:

- a. Furnish solid state variable frequency, microprocessor type with Pulse Width Modulated (PWM) output wave form converter. The VFD shall employ a full wave rectifier to prevent input line notching, a DC bus choke, DC bus capacitors and Insulated Gate Bipolar Transistors (IGBT) as the output switching device to convert nominal 480 volts, 3 phase, 60 Hertz, 3 wire input power into adjustable-frequency 3 wire system at 0 to 480 volts, 3 phase, 0 to 60 Hertz output power. Provide output speed control of required motor under variable torque load or constant torque as required by the driven equipment.
- b. Motor control circuits shall be wired in accordance with the requirements specified herein or indicated on the Drawings. Where not indicated, the control circuits shall be standard two-wire "start-stop" and the Contractor shall furnish wiring accordingly.
- c. Variable frequency drive manufacturer shall be responsible for the successful application and operation of the entire drive and control system serving the motor and driven equipment. This includes the responsibility for obtaining loads, torque, speed and performance requirements from the respective sources and integrating these into a variable frequency drive system that fulfills the requirements of this Specification.
- d. The Contractor and variable frequency drive system manufacturer are cautioned regarding the review and compliance with the total Contract Documents. Typical examples are circuit breakers, motor circuit protectors, magnetic starters, relays, timers, control and instrumentation products, pilot devices including pushbuttons, selector switches and pilot lights, enclosures, conduit, disconnect switches, terminal boxes, and other equipment.
- e. Provide flux vector control type drives, also known as field-oriented control, with hard-wired motor speed feedback encoder or tachometer, for full torque at zero speed capability.
- f. Provide VFD control which ensures accurate zero to full load torque control at low frequencies, including zero speed, with torque repeatability accuracy of 2% or better and torque response time less than 20 ms.
- g. Provide on drive, a disconnecting device and fixed diode input rectifier (for a constant power factor).
- h. For units rated greater than 50 Hp, provide VFD with the following type three phase PWM rectifier section: 18-pulse.

- 1) The design shall be optimized for harmonic rich and high neutral current environment.
- i. All components of the drive shall be designed and sized for the abnormal condition of continuous operation of the driven equipment specified herein at loads up to 15% above rated full load.
- j. RMS harmonic output of the drive not to provide more than 5 percent increase in motor heating over similar operation of the motor with zero harmonics in the current.
- k. The unit shall withstand drive output terminal line-to-line and line-to-ground short circuits without component failure during start-up and during operation. Drive to safely shutdown until short is cleared.
- l. NEMA 1 type cabinet for each drive unit.
- m. For inverter rated squirrel cage motors, per NEMA Standard MG-1, part 31.40.4.2, the following limit values at the motor terminals are to be observed:
 - 1) For motors with base rating voltage less than or equal to 600 volts, the peak instantaneous voltage must be limited to 1600 volts or less, with a voltage rise time greater than or equal to 0.1 micro-seconds.
- n. The VFD manufacturer shall guarantee that the above voltage limits will be met with the motor installed up to 100 cable feet from the VFD drive unit. If the VFD manufacturer is not able to guarantee that the above voltage limits will be met, provide a drive output filter or reactor, appropriately rated, located within the VFD enclosure and near the VFD output terminals, which shall ensure that the limitations listed above are maintained. A device located at the motor terminals is not acceptable.
- o. The drive unit shall be of modular design to provide for ease and speed of maintenance.
- p. Control circuits shall be isolated from power circuits. Unit to accept a 4-20 mA DC speed control signal from an isolated, ungrounded transmitter with unit in remote mode and from local door-mounted manual speed potentiometer or micro-processor type keypad with unit in local mode. The input 4-20 mA signal to be optically isolated from the drive run control circuit. Manual speed potentiometer or keypad controls to have adjustable minimum speed setting of 10 to 80% of full speed and maximum speed setting of 50 to 100% of full speed. The total speed setting to follow a linear time ramp, adjustable from 1-300 seconds for acceleration and deceleration control.
- q. Provide trap filters for the drive unit to meet the requirements of the harmonic study under paragraph 2.02. Filters shall be provided with contractors and controlled by the VFD to remove them from the line when the drive is not

operating. Contractors shall be provided with spare contacts for remote alarm and to energize status lamp at VFD enclosure.

- r. VFD shall be capable of full rated output when powered by incoming voltage with Total Harmonic Distortion (THD) in excess of 10%.
 - s. Furnish series choke and capacitors on dc bus to reduce ripple in rectifier output and to reduce harmonic distortion reflected into incoming power feeders.
 - t. Properly size enclosure to dissipate heat generated by VFD within limits of specified service conditions. Provide NEMA enclosure type as specified on drawings. Provide integral fans or cooling systems as required by the application. Circuit breaker interlocks to be able to be bypassed via lever on front door surface. NEMA 1 type enclosures to have keypad controls located on exterior of enclosure. Provide visual alarm indicator on cabinet door.
2. Performance characteristics:
- a. Output amps: 110 percent of rated, continuous.
 - b. Current limit: Range 0 to 130% for constant torque applications, 0 to 110% for variable torque applications, for 1 minute minimum.
 - c. Acceleration time to top speed, 1-300 seconds, minimum, adjustable.
 - d. Deceleration time from top speed, 1-300 seconds, minimum, adjustable.
 - e. Frequency stability: +/- 0.5% (at 25 degrees C, +/-10 degrees C) after reaching operating temperature.
 - f. Output voltage: Proportional to frequency with low speed boost.
 - g. Combined drive/and filtering efficiency, defined as motor shaft KW divided by VFD input KW, shall meet the following minimum requirements at the specified operating points:
 - 1) 97 percent at 60 Hz VFD output and 100 percent load.
 - 2) 92 percent at 50 Hz VFD output and 60 percent load.
 - h. VFD fundamental power factor shall be 0.98 or higher at all speeds and loads.
 - i. The VFD shall be capable of sustaining continued operation with a 30% dip in nominal line voltage. Output speed may decline only if current limit rating of the VFD is exceeded.

- j. Losses to be utilized in drive system efficiency calculation shall include the input isolation transformer, harmonic filter and power factor correction if applicable. Auxiliary controls such as internal VFD control boards and cooling fans shall be included in all loss calculations.
3. Drive Protection:
- a. General:
 - 1) Fault detection and trip circuits shall protect VFD and connected motor against line voltage transients, single-phase, power line overvoltage and undervoltage, output overvoltage and overcurrent, and VFD overtemperature. The VFD shall employ three (3) current limit circuits to provide trip free operation. The slow current regulation limit circuit shall be adjustable to a minimum 125% of the VFD's variable torque current rating. The rapid current regulation limit shall be adjustable to a minimum 170% of the VFD's variable torque current rating. The current switch off limit shall be fixed at a minimum 225% of the VFD's variable torque current rating.
 - b. Internal Protection: Minimum circuitry as follows:
 - 1) Current limiting, fast acting, semiconductor input fuses for protection of internal power semiconductors.
 - 2) Instantaneous output overcurrent trip max. - 200 percent.
 - 3) DC bus and control circuit transformer fusing.
 - 4) Grounded control chassis.
 - 5) Under and over voltage trip, 3 phases.
 - 6) Motor overload protection, with solid state relays.
 - 7) Fault reset push button.
 - 8) Line to ground faults.
 - 9) Input metal oxide varistor and input line reactor for transient protection.
 - 10) VFD overtemperature.
 - c. Troubleshooting: Diagnostic aids to indicate cause of fault; used to assist in troubleshooting circuit problems. Isolated Form C contacts for remote indication of alarms to include the following:
 - 1) Over/under voltage indication.

- 2) Overcurrent trip indication.
 - 3) DC bus charged indication.
 - 4) Fault detection indication.
 - 5) Recycle start indication (to indicate that the unit tried to pick up load for three previous tries and failed).
- d. Provide power loss ride through capability which will allow the logic to maintain control due to load inertia without faulting.
 - e. Provide a programmable automatic restart function which will provide a minimum with time delays between restarts of 3 restarts following a fault condition other than a ground fault, short circuit, internal fault, or user programmable fault condition. Restart type to be programmable for time delay or coasting motor restart.
- C. Auxiliary Systems:
1. Provide variable frequency drive unit with appropriate power circuitry and auxiliary contacts for energizing and controlling the following devices associated with the motor, if required:
 - a. Space heaters.
 - b. Solenoid valves.
 - c. Remote indication of motor start and stop (isolated contacts).
- D. Minimum Control Features:
1. Provide embedded digital and analog I/O.
 2. LOCAL-REMOTE selection of Start/Stop control.
 3. LOCAL/REMOTE selection of Speed Control.
 4. Accept a grounded, isolated, 4-20 mA input remote speed control signal from an external device.
 5. Provide a 4-20 mA output signal proportion to VFD output frequency for remote speed indication.
 6. Provide auxiliary Ethernet/IP communication module
 7. Provide Powerflex 750 Auxiliary Power Supply Module (20-750-APS)

E. Devices:

1. Provide operating, monitoring or alarm indicating devices, on keypad, with minimum as follows:
 - a. System control selector switch (RUN/OFF/REMOTE) (When in RUN position drive will run).
 - b. System speed control selector switch (LOCAL/REMOTE) (When in LOCAL position, speed controlled by manual speed potentiometer).
 - c. Keypad controls to set speed in manual mode.
 - d. Speed indicating meter in percent speed to indicate speed of the converter powered motor.
 - e. Run time meter.
 - f. Alarm and status lights.

2.03 SHOP TESTING (18 Pulse Units Only)

- A. Provide a factory performance test for each variable frequency drive unit. The test to consist of simulating the expected load to be driven. The drive to operate the actual motor load through the expected speed ranges. Test length to be a minimum of two hours.
- B. Provide a factory burn-in test for 24 hours minimum and a control and alarm test on each drive unit by simulating each control signal and each alarm function to verify proper and correct drive unit action.
- C. Provide typical prototype factory test data for short circuit testing of each type of drive supplied. Data to verify that each drive can be started into a line-to-line fault and line-to-ground fault on the drive terminals. Each drive can be operating at full load and be subjected to a line-to-line fault and line-to-ground fault on the drive terminals. All phases (A, B & C) to be included in test data.
- D. Provide certified documentation of all tests performed.
- E. Provide above stated tests in addition to routine factory tests.
- F. Owner to have option to witness all factory tests. Notify Owner two weeks before all tests.

2.04 SPARE PARTS:

- A. Provide in accordance with Section 01730 and as specified.

- B. Provide one spare board or card, three diodes, for each horsepower size drive. Spares will be color-coded or otherwise keyed to their original counterpart such that improper installation of spare cards is impossible. In addition to the cards, the manufacturer shall provide three spares for all expendable items such as pilot lamps, power fuses, and control fuses. Provide one keypad for every three VFD of the same model.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine VFD location for satisfactory preparation. Check conduits and raceway location for connection to units.
- B. Visually inspect delivered unit(s) and accessories for conformance with specification and drawings.
- C. Verify availability of appropriate pacing signal.
- D. Maintain variable frequency drive in upright position at all times.
- E. Protect variable frequency drive against damage. Store drive in clean, dry environment with temperature and humidity within range as specified by drive manufacturer. Energize space heaters during storage as recommended by manufacturer.

3.02 INSTALLATION

- A. Erect, install, and start-up equipment.
- B. The VFDs shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.
- C. Install VFDs to allow complete door swing required for component removal. This is specifically required where a VFD is set in the corner of a room.
- D. Factory-trained service personnel, other than sales representatives, shall supervise field installation, inspect, make final adjustments and operational checks, make functional checks of spare parts, and prepare a final report for record purposes. Adjust control and instrument equipment until this equipment has been field tested.

3.03 RUBBER MATS

- A. Three-foot-wide rubber mats shall be furnished and installed on the floor and in front of each VFD assembly. The mats shall be long enough to cover the full length of each VFD system. The mats shall be 1/2-inch-thick with beveled edges, canvas back, solid type with corrugations running the long way, and shall be guaranteed extra quality, free from cracks, blow holes or other defects detrimental to their mechanical or electrical strength.

The mats shall meet the requirements of ASTM D 178 for Type II, Class 4 insulating matting.

3.04 FIELD TESTING

- A. Provide in accordance with Section 017123.
- B. Perform testing checkout, and start-up for variable frequency drive equipment under technical direction of manufacturer's service engineer. Under no circumstances energize any portion of the drive system without authorization from manufacturer's technical representative.
- C. Field Tests:
 - 1. Test each drive over the total speed range that it will be required to operate through for the load being driven for a minimum of two hours. Determine for each drive, motor, and load combination the following at minimum speed, maximum speed, and at 1/3 and 2/3 points between the minimum and maximum speeds:
 - a. Input power (kW), voltage, current and RMS power factor on the line side of the drive isolation device.
 - b. Output to the driven load in kilowatts.
 - c. For each drive, measure the harmonic voltage distortion and harmonic current distortion for each harmonic at the main distribution bus for maximum and minimum load conditions.
 - d. Measure the total harmonic voltage distortion and total harmonic current distortion at each PCC for maximum and minimum load conditions.
 - 2. Test each drive by using the actual control signal for remote and local operation.
 - 3. Test each driver's alarm functions.
 - 4. Perform all tests in the presence of the Owner's representative.
 - 5. Perform the above test in addition to the manufacturer's normal field tests.
 - 6. Submit final test report with summary comparing field test data with harmonic analysis design calculated values for each drive.

3.05 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017833.

END OF SECTION

SECTION 333201
SEWAGE PUMPS

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish and install two complete horizontal centrifugal chopper pump systems including all appurtenances as specified. The pumps shall be specifically designed to pump waste solids at heavy consistencies. Materials shall be macerated and conditioned by the pump as an integral part of the pumping action. The pump type must have demonstrated the ability to chop through and pump high concentrations of solids such as plastics, heavy rags, grease and hair balls, wood, paper products and stringy materials without plugging, both in tests and field applications.

1.2 QUALITY ASSURANCE AND PERFORMANCE AFFIDAVIT

- A. The pump supplier shall submit manufacturer's standard warranty and a performance affidavit for all equipment to be furnished in accordance with this section. The warranty for workmanship and materials shall be manufacturer's standard for 1 year from startup, not to exceed 18 months from factory shipment. In the performance affidavit, the manufacturer must certify to the Owner, that the Contract Documents have been examined, and that the equipment supplied will meet in every way the performance requirements set forth in the Contract Documents for the application specified. Shop drawings will not be reviewed prior to the receipt by the COUNTY of an acceptable performance affidavit. The performance affidavit must be signed by an officer of the company manufacturing the equipment, and witnessed by a notary public. The performance affidavit must include a statement that the equipment will not clog or bind on solids typically found in the application set forth.

1.3 SUBMITTALS

- A. Submit shop drawings in accordance with the Contract Documents.
- B. Submit operating and maintenance instructions for pump system as specified in the Contract Documents. The instructions shall include a complete parts list and shall include all appurtenances and controls furnished with the pump.
- C. Submit pump characteristic curves showing capacity in GPM, NPSH, head, efficiency, and pumping horsepower from 0 GPM to 110 percent of design capacity.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURER

- A. Both Chopper Pumps shall be of Model HE8K10CS-101 as manufactured by Vaughan Co., Inc. or approved equal by the COUNTY.
- B. It is the express intent of these specifications to accurately describe equipment that is a regular production item of the specified manufacturer, and that has a proven record of performance in identical (not just similar) applications in other wastewater facilities. The chopper pump manufacturer shall have a minimum of twenty (20) years of documented experience in the design and production of chopper pumps of all types, and not less than five (5) years of experience in the production of the exact equipment as specified herein.
- C. Only equipment that is in service at the time of referral shall be considered valid. Pumps that have been removed from service for any reason will not be considered as references. Telephone numbers and contact names shall be provided for any/all references upon request from the OWNER. Provision of performance bonds or other means of circumventing the above

requirements for historical references and verification of past performance in identical applications are not considered an acceptable means of verifying the manufacturer's experience.

2.2 SERVICE CONDITIONS

The two identical chopper pumps specified in this section and shown in the drawings will operate under the following criteria:

| Single Pump Operation | |
|-----------------------|-------|
| Design Flow (gpm) | 1,500 |
| Design TDH (feet) | 7 |
| Motor Size (Hp) | 15 |
| Maximum Speed (rpm) | 1,170 |

2.3 PUMP CONSTRUCTION

- A. Casing and Back Pull-Out Adapter Plate: The pump casing shall be of semi-concentric design, with the first half of the circumference being cylindrical beginning after the pump outlet, and the remaining circumference spiraling outward to the 150 lb. flanged centerline discharge. Back pull-out adapter plate shall allow removal of pump components from above the casing, and allow external adjustment of impeller-to-cutter bar clearance. Casing and adapter plate shall be ductile cast iron with all water passages to be smooth, and free of blowholes and imperfections for good flow characteristics.
- B. Impeller: Shall be semi-open type with pump out vanes to reduce seal area pressure. Chopping/maceration of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings, with a set clearance between the impeller and cutter bar of .010" to .015". Impeller shall be cast steel heat treated to minimum Rockwell C 60 and dynamically balanced. The impeller shall be keyed to the shaft and shall have no axial adjustments or set screws required.
- C. Cutter Bar Plate: Shall be recessed into the pump bowl and shall contain at least 2 shear bars extending diametrically across the intake opening to within 0.010-0.015" of the rotating cutter nut tooth, for the purpose of preventing intake opening blockage and wrapping of debris at the shaft area. Chopper pumps utilizing individually mounted shear bars shall not be acceptable. Cutter bar shall be T1 plate steel heat-treated to minimum Rockwell C 60.
- D. Cutter Nut: The impeller shall be secured to the shaft using a special cutter nut, designed to cut stringy materials and prevent binding. The cutter nut shall be cast steel heat treated to minimum Rockwell C 60.
- E. Upper Cutter: Shall be threaded into the back pull-out adapter plate above the impeller, designed to cut against the pump-out vanes and the impeller hub, reducing and removing stringy materials from the mechanical seal area. Upper cutter shall be cast steel heat treated to minimum Rockwell C 60.
- F. Pump Shafting: The pump shaft and impeller shall be supported by ball bearings. Shafting shall be heat-treated steel, with a minimum diameter of 1.5 inches in order to minimize deflection

during solids chopping.

- G. Bearings: Shaft thrust in both directions shall be taken up by two back-to-back mounted single-row angular contact ball bearings. Two single-row radial bearings shall also be provided. Bearings shall be rated with a minimum B10 bearing life of 100,000 hours.
- H. Bearing Housing: Shall be cast iron, and machined with piloted bearing fits for concentricity of all components. Bearing housing shall have oil bath lubrication using ISO Gr. 100 turbine oil and a side mounted site glass to provide a permanently lubricated assembly. Viton® double lip seals riding on chromed stainless steel shaft sleeves are to provide sealing at each end of the bearing housing.
- I. Seal: Flushless Mechanical Seal system specifically designed to require no seal flush through the elimination of the stuffing box: The seal shall be cartridge-type with Viton O-rings and silicon carbide faces. The cartridge seal shall be pre-assembled and pre-tested so that no seal settings or adjustments are required. Any springs used to push the seal faces together must be shielded from the fluid to be pumped. The cartridge shall also include a 17-4PH, heat-treated seal sleeve and an ASTM A536 ductile iron seal gland. The mechanical seal faces shall be lubricated and cooled by a separate oil chamber. The oil chamber shall include a 10 psi pressure relief valve. The area between the seal oil chamber and bearing oil chamber shall be vented and drained to prevent contamination of the bearings.
- J. Inlet Manifold: The pump assembly shall be mounted horizontally with a 150 lb. standard inlet flange, drain, cleanout, and mounting feet.
- K. Shaft Coupling: Bearing housing and motor stool design is to provide accurate, self-aligning mounting for a C-flanged electric motor. Pump and motor coupling shall be T.B. Woods Sureflex elastomeric type.
- L. Stainless Steel Nameplates: Shall be attached to the pump and drive motor giving the manufacturer's model and serial number, rated capacity, head, speed and all pertinent data.

2.4 MOTOR REQUIREMENTS

- A. The identical pump drive motors shall be 30 HP, 1,760 RPM (over-speed to 2,000 RPM), 460 volts, 3 phase, 60 hertz, 1.0 service factor, 120V space heaters, Premium Efficient (NEMA12-12), 2:1 Constant torque, Inverter Duty, C-flange mounted, TEFC enclosure. The motor shall be sized for non-overloading conditions for all operating capabilities of the pump.

2.5 SURFACE PREPARATION

- A. The pump unit shall be degreased and coated with 1-3 MDFT of acrylic urethane (except motor).
- B. SSPC-SP5 commercial sandblast (except motor), primed and finish coated with 5-8 MDFT epoxy primer and finish coated with 2-4 MDFT acrylic (except motor).

PART 3 EXECUTION

3.1 INSTALLATION

- A. Installation shall be made by the contractor in complete accordance with manufacturer's recommendations.
- B. Provide, at no additional charge, manufacturer's information, instructions and supervision required for the proper maintenance and installation of the equipment. Upon completion of the installation of this unit, a test run for three (3) hours shall be conducted by a factory trained technician. At this time, adjustments shall be made to achieve correct operation of all the equipment and the following readings must be taken at 15 minute intervals:

1. Running Amps
 2. Voltage of all three phases
 3. Flow, inlet, and discharge pressure readings throughout the speed of the pump.
 4. Pump vibrations
- C. A second test run shall be made as part of the operator training.
- D. Supply eight (8) hours of operator/maintenance personal training after the pump is operating.
Arrange time with OWNER

3.2 TOOLS and SPARE PARTS

- A. The manufacturer shall furnish the following with the Sewage Pump System:
1. A recommended list of spare parts.
 2. Two (2) replacement mechanical seals
 3. An Operations and Maintenance manual for the pump.

3.3 FACTORY PAINTING

- A. Pump and base shall be shop primed and finish painted at the place of manufacturer.

3.4 WARRANTY

- A. The pump vendor shall furnish the following to the OWNER:
1. A copy of the pump manufacturer's parts and labor warranty.

END OF SECTION

SECTION 406113

BASIC INSTRUMENTATION REQUIREMENTS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up, and place in satisfactory operation a complete and operating instrumentation and control system.
2. The Work includes, but is not limited to, the following:
 - a. New master pump station control panel with Control Logix PLC, network switches, 9" PanelView, and fiber communication.
 - b. New field control panels with instrument transmitters, network switches, and fiber communication.
 - c. Update existing SCADA system and historian with master pump station.
 - e. Update SCADA system with screens for new pump station.
 - f. New field and panel mounted instruments.
 - g. Ethernet and Hardwiring cabling, terminations and testing.
 - h. Local area network hardware and software and media converters.
 - i. Ethernet/ Fiber network communication hardware and software required for interfacing various systems to provide one fully integrated system.
 - j. Work outlined in Section 406166 Software Services.
 - k. Package System Integration:
 - 1) Contractor is responsible for coordinating data exchange with vendor control panels on the plant network.
 - 2) Recreate all graphic screens for all vendor package system on the SCADA system. Obtain a copy of the graphic screens and PLC logic from the package system supplier for development of similar graphics on the plant SCADA system.

3. Contractor shall turn over all native, uncompiled source files for HMI's and PLC's for unrestricted use by Owner. Provide Files on USB drive. Provide a list of all usernames, passwords and IP addresses used as part of the documentation.
4. Integrator shall use County's tag naming convention as provided in the appendix of these specifications.

B. Coordination:

1. Existing Conditions:

- a. The existing wastewater treatment plant consists of four (4) PLC control panels and GE iFIX SCADA system. Connect the existing PLC's to the plant network. Migrate the existing SCADA system to the new SCADA system. Rebuilt/retag the existing data as needed. Build new "High Performance" SCADA screens for the existing plant.

2. Instrumentation and Controls:

- a. Providing Panels, cabling, termination for instruments, and controls are part of the Work by instrumentation and controls (I&C) Subcontractor. Programming of control logic and configuration of human machine interface (HMI) software is part of the Work. Functional description of process system and associated equipment is included in Section 406196.
- b. SCADA system input/output list identifies inputs and outputs required and is part of this Section. Input/output list is for coordinating signals between equipment provided by others and computer system Supplier, and identifying signals to be programmed by Contractor's configuration Subcontractor. Include Work for Contractor-furnished control options not on the input/output list at no additional cost to Owner.

3. The Plant Fiber Optic Network (SCADA) will be provided by the the I&C subcontractor.

3. To centralize responsibility, materials and equipment provided under this Section shall be furnished by a single Supplier.

4. With Contractor, Supplier shall assume the responsibility for adequacy and performance of materials and equipment provided under this Section.

5. To the greatest extent possible, provide materials and equipment from a single manufacturer.

6. Supplier's Responsibilities:

- a. Preparing all instrumentation and control equipment submittals in accordance with the Contract Documents.

- b. Proper interfacing of instrumentation and control equipment with field equipment, instruments, devices, panels, and required interfacing with the Site's electrical system.
- c. Review and coordination with manufacturers, Suppliers, and other contracts of Shop Drawings and other Contractor submittals for equipment, valves, piping, and appurtenances for ensuring proper interfacing of hardware, and locations and installation requirements of inline devices and instrument taps.
- d. Direct, detailed oversight of installation of instruments, panels, cabinets, wiring and other components, and related wiring and piping connections.
- e. Calibrating, configuration, source quality control, field quality control, and start-up of the system.
- f. Responsibility for correction period obligations for instrumentation and control system.
- g. Training of operations and maintenance personnel in operation and maintenance (including calibration and troubleshooting) of the instrumentation and control system.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/ASQ Z1.4, Sampling Procedures and Tables For Inspection By Attributes.
2. ASTM A269, Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
3. ASTM A312, Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
4. ASTM A403, Specification for Wrought Austenitic Stainless Steel Piping Fittings.
5. ASTM B88, Specification for Seamless Copper Water Tube.
6. IEEE 802.1 LAN/MAN Bridging & Management
7. IEEE 802.1X, Port Based Network Access Control.
8. IEEE 802.3, Standards Defining Physical Layer and Data Link Layer Media Access Control (MAC) Sublayer of Wired Ethernet.
9. ISA 5.1, Instrumentation Symbols and Identification.
10. ISA 5.4, Instrument Loop Diagrams.

11. ISA 20, Specification Forms for Process Measurement & Control Instruments, Primary Elements & Control Valves.
12. ISO 8802-3, Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
13. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
14. NFPA 70 (NEC), Article 770, Optical Fiber Cables and Raceways.
15. NFPA 79, Electrical Standard for Industrial Machinery.
16. NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
17. UL 50, Safety Enclosures for Electrical Equipment, Non-Environmental Considerations.
18. UL 508A, Industrial Control Panels.
19. UL 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
20. UL 2062, Enclosures for Use in Hazardous (Classified) Locations.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Supplier:

- a. Shall be financially sound with at least five years continuous experience in designing, implementing, supplying, and supporting instrumentation and control systems for municipal water and wastewater treatment facilities comparable to the instrumentation and control systems required for the Project, relative to hardware, software, cost, and complexity.
- b. Shall have record of successful instrumentation and control system equipment installations. Upon Engineer's request, submit record of experience listing for each project: project name, owner name and contact information, name and contact information for contractor, name and contact information for engineer, approximate contract value of instrumentation and controls Work for which Supplier was responsible,
- c. Shall have at time of Bid experienced engineering and technical staff capable of designing, supplying, implementing, and supporting the

instrument and control system and complying with submittal and training requirements of the Contract Documents.

- d. Shall be capable of training operations and maintenance personnel in instrumentation and control applications, and in operating, programming, and maintaining the control system and equipment.
- e. Shall have OR utilize a UL-approved panel shop.

2. Manufacturer: Manufacturers of instrumentation and control equipment furnished under this Section shall be experienced producing similar equipment and shall have the following qualifications:

- a. Shall manufacture instrumentation and control system components that are fully-developed, field-proven, and of standardized designs.
- b. Shall have system of traceability of manufactured unit through production and testing in accordance with ANSI/ASQ Z1.4.
- c. Shall have guaranteed availability clause (99.99 percent, minimum for one year) for microprocessor-based components and appurtenances.
- d. Shall have documented product safety policy relevant to products proposed for the Work.

B. Pre-submittal Conference

- 1. Schedule and conduct pre-submittal conference for instrumentation and control system within 30 days after acceptance of I&C Subcontractor by Owner.
- 2. Required attendance for pre-submittal conference: Contractor, I&C Subcontractor, Engineer, and Owner. Pre-submittal conference will be 4 hours. Conference will be held at Owner/ Engineer desired or approved location.
- 3. Purpose of pre-submittal conference is to review manner in which I&C Subcontractor intends to comply with requirements of the Contract Documents before submittals are prepared.
- 4. Prepare items listed below for presentation at pre-submittal conference. Submit information to Engineer two weeks prior to pre-submittal conference.
 - a. List of materials and equipment required for instrumentation and control system, and brand and model proposed for each item.
 - b. List of proposed exceptions to the Contract Documents along with brief explanation of each.
 - c. Sample of each type of submittal specified in this Section. These may be submittals prepared for other projects.

- d. Flow chart showing steps to be taken in preparing and coordinating instrumentation and control system submittals.
- e. General outline of types of tests to be performed to verify that all sensors and transducers, instruments, and digital processing equipment are functioning properly.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

a. Field Instruments:

- 1) Manufacturer's product name and complete model number of devices proposed for use, including manufacturer's name and address.
- 2) Instrument tag number in accordance with the Contract Documents.
- 3) Data sheets and manufacturer's catalog literature. Provide data sheets in accordance with ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets using a format similar to ISA 20.
- 4) Description of construction features.
- 5) Performance and operation data.
- 6) Installation, mounting, and calibration details; instructions and recommendations.
- 7) Service requirements.
- 8) Dimensions of instruments and details of mating flanges and locations of closed tanks, pipe sizes for insertion instruments, and upstream/downstream straight run pipe lengths required.
- 9) Range of each device and calibration information
- 10) Descriptions of materials of construction and listing of NEMA ratings for equipment

b. Panels and Cabinets:

- 1) Layout drawings that include:
 - a) Front and internal panel views to scale.

- b) Tag number and functional name of components mounted in and on panel or cabinet, as applicable.
 - c) Product information on panel components.
 - d) Nameplate location and legend including text, letter size and colors to be used.
 - e) Location of anchorage connections.
 - f) Location of external wiring and piping connections.
 - g) Mounting and installation details, coordinated with actual application.
 - h) Proposed layouts and sizes of operator interface graphic display panels and alarm annunciator panels.
 - i) Calculations for heating and cooling of panels, as applicable.
 - j) Subpanel layouts and mounting details for items located inside control panels.
- 2) Product information on panel components including:
- a) Manufacturer's product name and complete model number of devices being provided, including manufacturer's name and address.
 - b) Instrument tag number in accordance with the Contract Documents.
 - c) Data sheets and catalog literature. Submit data sheets as shown in ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets with format similar to ISA 20.
 - d) Description of construction features.
 - e) Performance and operation data.
 - f) Installation, mounting, and calibration details; instructions and recommendations.
 - g) Service requirements
- 3) Wiring and piping diagrams, including the following:
- a) Name of each panel, console, or cabinet.

- b) Wire sizes and types.
 - c) Pipe sizes and types.
 - d) Terminal strip and terminal numbers.
 - e) Wire color coding.
 - f) Functional name and manufacturer's designation for components to which wiring and piping are connected.
 - g) Lightning and surge protection grounding, refer to Electrical specification Section 26 05 26, Grounding and Bonding for Electrical Systems and drawings.
- 4) Electrical control schematics in accordance with NFPA 79. Drawings shall be in accordance with convention indicated in Annex D of the NFPA 79. Typical wiring diagrams that do not accurately reflect actual wiring to be furnished are unacceptable. Tables or charts for describing wire numbers are unacceptable.
 - 5) Stock list or bill of materials for each panel including tag number, functional name, manufacturer's name, model number and quantity for components mounted in or on the panel or enclosure.
 - 6) Detail showing anchorage plan of wire bundles between subpanels and front panel mounted devices.
- c. Field wiring and piping diagrams, include the following:
 - 1) Wire and pipe sizes and types.
 - 2) Terminal numbers at field devices and in panels.
 - 3) Fiber optic termination designations in the field and in panels.
 - 4) Color coding.
 - 5) Conduit numbers in which wiring will be located.
 - 6) Locations, functional names, and manufacturer's designations of items to which wiring or piping are connected.
- d. Submit proposed HMI & OIT graphics layouts for approval; all equipment screens shall be added as part of this project. Each graphic display and process report layout will be subject to modification from Contractor's submitted format within limits of software package used for

development. Implement such modifications in accordance with Owner/Engineer's comments.

e. Supervisory Control and Data Acquisition (SCADA) System Modifications:

1) Submit the following general information:

- a) Detailed block diagram showing system hardware configuration and identifying model numbers of system components.
- b) Software listings for operating system, applications, and HMI.
- c) Software language and organization.
- d) Format, protocol and procedures for data transmission and communications with input/output modules and peripheral devices, including local area network (LAN).
- e) HMI interfacing details, licensing structure, and included functions.
- f) Control and failure modes.
- g) Input/Output Information:
 - i. Input/output (I/O) point listing with I/O module cross-reference identification.
 - ii. I/O module cross-reference identification based on I/O address list developed by I&C Subcontractor .
- h) Database listing, including all I/O points.
- i) Format and configuration of log reports, alarm summaries, printer outputs, displays, and graphics shall match the existing. Examples can be provided if requested.

2) Hardware:

- a) Layout drawings showing front, rear, end and plan views to scale of equipment, I/O components, power supplies, and peripheral devices.
- b) Equipment ventilation requirements.

- c) Interconnection diagrams, including termination details, cable identification list, and cable length.
 - d) Drawings showing equipment layout.
 - e) Installation requirements, instructions, and recommendations.
- 3) Software:
- a) Licensing agreement with name of licensee, renewal requirements, release and versions, expiration dates (if any) and upcoming releases scheduled before Project completion. When upcoming releases are expected, provide descriptions, when available, of features that differ from the proposed release.
 - b) Standard technical and instructional documentation covering software for utility, system support, system documentation, display, communications, data logging and storage and diagnostic functions. Submit this information on electronic media.
 - c) Standard technical documentation covering all aspects of the computer system software functions and capabilities, including instruction set description and programming procedures related to monitoring, display, logging, reporting and alarming functions.
 - d) Detailed functional descriptions of application programs explaining control, display, logging and alarming features to be provided and functions to be performed.
- 4) Documentation describing memory type, size and structure and listing size of system memory, I/O and Data Table memory and size of memory available for control programs shall be provided upon updating the existing software.
- 5) New System I/O Loop Wiring Diagrams: Prepare Shop Drawings on module-by-module basis and include the following information:
- a) Rack numbers, module type and slot number, and module terminal point numbers. Include location and identification of intermediate panel and field terminal blocks and terminal numbers to which I/O wiring and power supply wiring is connected. Identify power supply circuits with designation numbers and ratings.

- b) Wiring types, wire numbers, and color coding.
 - c) Designation of conduits in which field I/O wiring will be installed.
 - d) Location, functional name, tag numbers and manufacturer's module numbers of panel and field devices and instruments to which I/O wiring will be connected.
 - e) Prepare loop wiring diagrams in accordance with ISA 5.4.
- f. Complete point-to-point interconnection wiring diagrams of field wiring associated with the system. Diagrams shall include the following:
- 1) Field wiring between each equipment item, panel, instruments, and other devices, and wiring to control stations, panelboards, VFD's, and motor starters. Some of this equipment may be specified in other Divisions, Contractor is responsible for providing complete point-to-point interconnection wiring diagrams for control and monitoring of that equipment.
 - 2) Numbered terminal block and terminal identification for each wire termination.
 - 3) Identification of assigned wire numbers for interconnections. Assign each wire a unique number.
 - 4) Schedule showing the wiring numbers and the conduit number in which the numbered wire is installed.
 - 5) Junction and pull boxes through which wiring will be routed.
 - 6) Identification of equipment in accordance with the Contract Documents.

2. Product Data:

- a. Product data for field instruments in accordance with requirements for Shop Drawings in this Section.
- b. Product data for panels, and cabinets in accordance with requirements for Shop Drawings in this Section.
- c. Product data for field wiring and piping provided for instrumentation and control service and not included under other Sections or contracts.
- d. Product data for SCADA system, including software and hardware. Requirements for software product data are included in requirements for Shop Drawings under this Section.

3. Samples:
 - a. Color charts for finish paint for panels. Provide full range of paint manufacturer's standard and custom colors. Color selection will be by Engineer.
 - b. Color charts for FRP panels. Provide full range of panel manufacturer's standard and custom colors. Color selection will be by Engineer.
 4. Factory Acceptance Test Procedure: Submit factory testing procedures that will be performed to fulfill requirements of the Contract Documents. Test procedure shall include the following:
 - a. Visual inspection of components and assembly.
 - b. Description of hardware operational testing.
 - c. Description of software demonstration.
 - d. Description of testing equipment to be used.
 - e. Sign-off sheets to be used at time of testing.
- B. Informational Submittals: Submit the following:
1. Documents to be submitted prior to pre-submittal conference, in accordance with Article 1.03 of this specification.
 2. System Software Documentation: Submit preliminary software documentation not later than four weeks prior to scheduled start of factory testing. Software documentation shall include the following:
 - a. Complete printed copies of all programming.
 - b. Complete listing of external and internal I/O address assignments, register assignments and preset constant values with function point descriptions. List unused/undefined I/O and data table registers available.
 - c. Copies of all configured HMI screens.
 3. Manufacturer's Instructions:
 - a. Shipping, handling, storage, installation, and start-up instructions.
 4. Source Quality Control Submittals:
 - a. Factory test reports and results.
 5. Special Procedure Submittals:

- a. Submit notification to Owner and Engineer at least 14 days before readiness to begin system checkout. Schedule system checkout on dates agreed to by Owner and Engineer.
 - b. Submit written procedure for system checkout to Engineer three months prior to starting system checkout. Three months prior to starting system checkout submit written procedure for start-up to Engineer.
- 6. Field Quality Control Submittals:
 - a. Submit the following prior to commencing system checkout and start-up.
 - 1) Completed calibration sheets for each installed instrument showing five-point calibration (0, 25, 50, 75, 100 percent of span), signed by factory-authorized serviceman.
 - b. Field calibration reports
 - c. Field testing reports.
- 7. Supplier's Reports:
 - a. Installation inspection and check-out report.
 - b. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
- 8. Qualifications Statements:
 - a. Supplier.
 - b. Manufacturer, when required by Engineer.
- C. Closeout Submittals: Submit the following:
 - 1. Operations and Maintenance Data:
 - a. Submit in accordance with Section 017823 - Operation and Maintenance Data.
 - b. Include complete up-to-date system HMI, PLC software documentation. Provide hardcopy and electronic copies.
 - c. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.
 - 2. Record Documentation:

- a. Prepare and submit record documents in accordance with 017839 - Project Record Documents.
- b. Revise all system Shop Drawing submittals to reflect as-built conditions in accordance with the following.
 - 1) Two copies of each revised Shop Drawings and documentation to replace out-dated drawings and documentation contained in operation and maintenance manuals. Submit half-size black line drawings for each drawing larger than 11 inches by 17 inches. Include specific instructions for out-dated drawing removal and replacement with record documents submittal.
 - 2) Half-size black line prints of wiring diagrams applicable to each control panel shall be placed in clear plastic envelopes and stored in a suitable print pocket or container inside each control panel.
 - 3) Submit CADD drawings of the point-to-point interconnection wiring diagrams updated to reflect final as-built equipment information and as-installed field installation information.

D. Maintenance Materials Submittals: Submit the following:

1. Spare Parts and Test Equipment

a. General

- 1) Furnish the spare parts and test equipment as indicated below, identical to and interchangeable with similar equipment provided under this Section.
- 2) Provide source quality control for spare parts as part of factory testing prior to shipment of instrumentation and control equipment.
- 3) For process sensors and other analog instruments, Supplier shall submit a separate quotation for recommended list of spare parts and test equipment. Separately list and price each item recommended. Spare parts quotation shall include a statement that prices quoted are valid for a period of one year from date of equipment installation and that Supplier understands that Owner reserves the right to purchase none, any, or all parts quoted. Upon request, Supplier shall submit documentation that stock of spare parts and test equipment is obtainable within 48 hours of receipt of Owner's order.

b. Furnish the following spare parts:

- 1) Five of each type of input/output relay for each quantity of forty or fraction thereof provided under the Contract.
- 2) Three of each type of PLC input/output module or card used.
- 3) Two replacement power supply for each type and size provided under the Contract.
- 4) One-year supply of all expendable or consumable materials.
- 5) One per quantity of five or fraction thereof of gauges, indicators, and switches provided, complete with diaphragm seals, filled and ready to use.
- 6) One per quantity of ten or fraction thereof provided, per range of field instruments including insertion type instruments. No spares are required for inline instruments such as magnetic flow meters and flumes or venturis that include flow tubes through which flow is conveyed.
- 7) Twelve of each type and size of fuse used in instruments.

2. Software:

- a. Detailed PLC programming; HMI screens shall be provided for Engineer's approval.
- b. Submit copies of programming and configuration files developed specifically for the Project in accordance with Section 017823 - Operation and Maintenance Data.

1.05 STORAGE AND HANDLING

- A. Prior to packaging, each manufacturer or Supplier shall securely attach tag number and instructions for proper field handling and installation to each instrument.
- B. Comply with Section 016100 - Materials and Equipment.

PART 2 – PRODUCTS

2.01 Equipment Suppliers/ I&C Subcontractor

- A. Subject to compliance with specified requirements, equipment suppliers shall be the following:
 1. McKim & Creed
 2. Commerce Controls

3. Revere Controls
 4. Carollo Engineers
 5. Jacobs
- B. References made in these Specifications to specific manufacturer's products are intended to serve as a guide to type, construction, and materials. Listing of a manufacturer does not imply acceptance by Engineer of a manufacturer's particular product, product line, or latest product revision if it does not meet Specifications.
- C. Equipment Supplier: Equipment specified under this section and shown on Drawings shall be designed as a system, fabricated or purchased, shipped to Site, and started up by one of the qualified and approved equipment suppliers listed under this Section. Intent is for unit responsibility.
1. Equipment supplier shall not assign any of its rights or delegate any of its obligations under these Sections without prior written acceptance by Engineer.
 2. Direct purchase of any items in these Sections by Contractor is not in compliance with this Specification and will not be permitted.
 3. When a Service Contract is included, it shall be performed by factory-trained personnel employed by equipment supplier. Equipment supplier shall assign a qualified Engineer employed by the supplier as Project Engineer/Project Manager.
 - a. Project Engineer/Project Manager's name shall be forwarded to Contractor and Engineer within 30 days after receipt of a purchase order by equipment supplier.
 - b. Project Engineer/Project Manager shall be focal point for design, fabrication, Contract communications, and shall be responsible for start-up and acceptance. Project Engineer/Project Manager shall be at factory test at Site for start-up and at the Site during entire acceptance procedure. Only qualified and approved equipment suppliers shall be accepted as meeting this Specification.

2.02 SYSTEM REQUIREMENTS

- A. Power Supplies:
1. Electrically powered equipment and devices shall be suitable for operation on 115-volt plus-or-minus 10 percent, single-phase, 60 Hertz plus-or-minus two Hertz, power supply. If different voltage or closer regulation is required, provide suitable regulator or transformer at no additional cost to Owner.

2. Provide appropriate power supplies for field instruments requiring power source less than 115 volts. Power supplies shall be mounted in control panels or enclosures installed near associated instrument or in field panels.
3. Power supplies shall be capable of minimum of 130 percent of maximum simultaneous current draw.
4. Provide power on-off switch or air circuit breaker for each item provided under this Section that requires electric power.

B. Signal Requirements:

1. Control system shall use 4- 20 mA DC analog signals, unless otherwise shown or indicated.
2. Provide signal converters and repeaters where required. Adequately size power supplies for signal converters and repeater loads.
3. Isolate signals from ground.
4. Signals transient DC voltage shall not exceed 300 volts over one millisecond and shall not have a DC component over 300 volts.
5. Discrete signals shall use 24 vdc unless indicated on drawings. Provide interposing relays where required.
6. Provide fused terminal (lighted when blown) terminal block for each digital and analog signal.

C. Surge Protection Requirements:

1. Provide surge protection to protect electronic instrumentation and control systems from surges propagating along signal and power supply cabling. Protection systems shall be such that the protection level shall not interfere with normal operation, but shall be lower than instrument surge withstand level, and be maintenance-free and self-restoring.
2. Provide instruments in suitable metallic cases, properly grounded. Ground wires for surge protectors shall be connected to good earth ground and, where practical, run each ground wire individually and insulated from other wires. Mount protectors within instrument enclosure or in separate junction box compatible with the area designation coupled to the enclosure.
3. Surge suppression shall be provided on all incoming voltages, field mounted for all analog inputs, panel mounted for all analog inputs, and panel and field mounted for all Power Over Ethernet (POE) connections.
4. All surge protection shall be DIN rail mounted surge protection plug, Phoenix Contact PT and PLT or equal.

D. Miscellaneous:

1. General:

- a. Instrumentation components shall be heavy-duty types, constructed for continuous service.
 - b. System shall consist of equipment models currently in production.
 - c. Materials and equipment, including cabling and interconnections, shall be in accordance with Division 26, Electrical, and manufacturer's recommendations, unless indicated otherwise in the Contract Documents.
 - d. Materials and equipment shall, where applicable, be in accordance with UL standards and be so marked and labeled.
2. Logic and control loops shall be fail-safe. Instrumentation components shall return automatically to accurate measurement within 15 seconds upon restoration of power after power failure and when transferred to standby power supply.
 3. Provide surge protection for instruments and other control system components that could be damaged by electrical surges. Provide lightning arresters on both ends of communication lines, except for fiber optic cabling, external to buildings or structures, including leased telephone lines and similar communication lines.
 4. Field-mounted instruments and system components shall be constructed for use in humid and corrosive service conditions. Field-mounted instrument enclosures, junction boxes and appurtenances shall have NEMA rating appropriate for hazardous rating requirements shown or indicated on Electrical/ Mechanical Drawings, instrument schedules, and elsewhere in the Contract Documents.
 5. Miscellaneous hardware such as fittings, fasteners, and screws, be Type 316 stainless steel or other appropriate material to prevent galvanic reactions and shall be suitable for service intended. Piping stands shall be provided for fastening instruments as required. Provide threaded pipe stands with flange bolted to slab. Use carbon steel piping and flanges painted in accordance with Section 09 90 00, High Performance Paints and Coatings.
 6. Data processing equipment and relays with interconnections to field devices shall be wired through field wiring terminal blocks in the panel. Terminals as part of relay base are unacceptable.
 7. Arrange panel-mounted instruments, switches, and other devices ergonomically for functional use and ease of maintenance. Similar types of panel-mounted devices shall be by one same manufacturer and of the same model line.

8. Equipment furnished shall be of modular construction and be capable of field expansion through installation of plug-in circuit cards and additional cabinets as necessary.
9. Field- and panel-mounted instruments shall be tagged with equipment number and nomenclature indicated in the Contract Documents; if not so indicated, tag in accordance with approved Shop Drawings.
10. Coordinate ranges and scales specified in the Contract Documents with manufacturer of the equipment actually furnished for operability over the intended range. Complete the coordination prior to submitting Shop Drawings to Engineer.
11. Treat field-mounted devices with anti-fungus spray.
12. Protect field-mounted devices from exposure to high and freezing temperatures to provide complete operability under the environmental conditions indicated in the Contract Documents.

E. Environmental Conditions:

1. Provide control system suitable for continuous operation under the following conditions:
 - a. Indoor Instruments:
 - 1) Ambient Temperature: Zero degrees F to 120 degrees F.
 - 2) Relative Humidity: 100 percent, maximum.
 - b. Outdoor Instruments
 - 1) Ambient Temperature: 32 degrees F to 160 degrees F.
 - 2) Relative Humidity: 100 percent, maximum.
2. Protect outdoor-mounted field instruments from direct sunlight by providing sunshade for instruments. Construct sunshade out of non-corrosive material. Sunshade shall withstand wind velocity of 160 miles per hour.

2.06 IDENTIFICATION

A. Instrument Tagging

1. Headings on the field instrument schedule in the Contract Documents have the following meaning:
 - a. "TAG" is an alphanumeric character string.
 - b. "INSTRUMENT DESCRIPTION" is an explanation of instrument function.

- c. "RANGE" is the limit for the specified units of the instrument
- d. "SET POINT" is the precise value within the instrument's range.
- f. "NOTES" contains specific notes relative to the instrument.

B. Input/Output List Identification

1. I/O point list contains information required to configure PLC I/O interface hardware, and to indicate range conversion or signal functions.
2. "Tag" is an alphanumeric character string. For example, for the point "FIR-806" the following apply:
 - a. The first character is the functional identifier and conforms with ANSI/ISA S5.1. In the example, "F" represents flow.
 - b. The second and third character (and sometimes fourth and fifth) alphabetical character (I) is the function identifier. In the example, the "I" represent indication input, "R" represents recorded data.
 - c. The next three-digit number (806) identifies the loop or field device.
 - d. Suffix, where required, is used for distinguishing between similar variables.
3. "DESCRIPTION" is an alphanumeric character string up to 40 characters in length. Points described as "SPARE" indicate pre-wired I/O.
4. "TYPE" is one of the following:
 - a. AI indicates analog input.
 - b. DI indicates discrete input.
 - c. PI indicates pulse input.
 - d. AO indicates analog output.
 - e. DO indicates momentary, maintained or latched discrete output.
5. "SIGNAL" is one of the following:
 - a. ETH indicates Ethernet/IP
 - b. HARDWIRE

C. ISA Identification

1. A = Analytical.

2. B = Burner, Combustion.
3. C = Cooling (Cooling Condenser).
4. D = Dissolved.
5. E = Voltage.
6. F = Flow.
7. G = Intrusion.
8. H = Hand.
9. I = Current.
10. J = Power.
11. K = Time.
12. L = Level.
13. M = Manual.
14. N = UNDEFINED.
15. O = Overload.
16. P = Pressure.
17. Q = Communication.
18. R = Reverse.
19. S = Speed, Frequency.
20. T = Temperature.
21. U = Universal (Common).
22. V = Vibration.
23. W = Torque (Weight or Force).
24. X = Critical (Emergency).
25. Y = Event, State or Presence.
26. Z = Position, Dimension.

D. Function Identifier:

1. A = Alarm
2. B = UNDEFINED.
3. C = Control.
4. D = Differential.
5. E = Element.
6. F = Failure.
7. G = UNDEFINED.
8. H = High.
9. I = Indication.
10. J = UNDEFINED.
11. K = Factor.
12. L = Low.
13. M = Mode.
14. N = Normal.
15. O = Oxygen.
16. P = UNDEFINED.
17. Q = Quantity.
18. R = Rotation.
19. S = Switch.
20. T = Timer
21. U = UNDEFINED.
22. V = Slow (output)
23. W = Slow (input)
24. X = Selector Switch (input)

2.07 Existing SCADA Software modifications:

A. Products and Manufacturers: Owner currently uses the following SCADA/ HMI software:

1. GE iFix

Integrator is expected to match the format of the plant existing graphical screens for conformance and standardization purposes.

B. The SCADA/ HMI Software system shall be modified to provide access to the proposed system elements that allow direct operations personnel interface to documentation, process management information, process control blocks, and system configuration elements.

C. The modifications to the existing software packages and subsystems shall allow operations personnel access to manipulate and monitor control blocks and operations environment. Tasks allocated to systems and process engineers and process operators shall be simplified for easy use.

D. Existing Software is comprised of the following:

1. System configuration utilities.
2. Database manager.
3. Environment configuration utilities.
4. Graphic screen painter.
5. Graphic screen viewer.
6. Historical data manager.
7. Reporting system.
8. Real-time data manager.
9. Communications subsystem.
10. Alarm handler.
11. Supervisory control system.

E. All modifications to add the proposed equipment to the existing System software shall work as virtually independent units or in concert with other internal software. Human interface software shall support operations such as:

1. Setting up I/O database.
2. Accessing I/O point settings.

3. Editing graphic displays and building new displays.
 4. Editing and creating objects within displays.
 5. Editing system configuration.
 6. Setting up and tracking process control trends.
 7. Checking system performance.
- F. Modifications performed to add all proposed equipment to the existing SCADA/ HMI software shall provide standard process control algorithms for use with control schemes as shown and specified in this Section, and to enable operations personnel to develop new supervisory and regulatory distributed digital, control schemes on-line. Provide algorithms consisting of modular, function block type of control elements which are familiar to control engineers. Algorithms shall include input blocks for acquiring, converting, and characterizing signals representing process variables; computational blocks for performing arithmetic, scaling, and compensating operations; control blocks for performing control functions; and special algorithm blocks for switching, fan-out, display, and user-specified operations, including interacting with supervisory programs. Tuning constants shall be easily set from operator consoles and workstation keyboards.
- G. Graphical user interface shall support distributed access through the alarm and historical modules as well as application development and transfer across a network with built-in network application development (NAD) functionality. NAD shall provide automatic notification of application changes and automatic distribution of updated applications to runtime (view) nodes.
- H. Graphical user interface shall be capable of exporting entire database of I/O points into CSV file format for import and subsequent editing to a Microsoft Excel spreadsheet.
- I. Electronic Documentation:
1. Documentation for control system shall be provided with the system in electronic format. Documentation shall be available and accessible from within the applications programs.
 2. Documentation shall be broken down by function. Information usually required for an authorized person to perform configuration shall be included in a guide; information required to configure the process I/O blocks shall be included in control blocks documents.
 - a. Online Help:
 - 1) Online help shall provide information and assistance to user as user uses an application program. Information available through online help shall relate to the current display, current program operation or selection, and changes as user proceeds through the program to provide user with appropriate information.

- 2) Help shall be requested by selecting "HELP" from the menu bar. Menu of topics relating to current display or selection shall appear on the screen. Help text shall be displayed in a partial screen overlay.
- 3) Screen control functions shall be displayed as menu selections.

J. Real- Time Displays:

1. Add new graphic screens using existing drawing package. Use of proprietary graphic file formats is unacceptable. The Integrator shall ensure to keep the format of the graphic screens similar to the existing graphic screens.
2. Proposed system graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, and links to other graphic screens.
3. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
4. Graphics editor shall allow layering of objects to activate specific objects based upon specific conditions in control system.
5. Graphics editor tool shall allow object placement via "snap-to-grid" feature with configurable grid spacing. The operator has the ability to configure the pixel interval on the "snap-to-grid" tool.
6. System shall support import of DXF files with the drawing elements imported as native objects. It shall be possible to animate such objects using a full set of object animation properties.
7. User shall be able to configure graphic screens while system is monitoring the process.

K. System Configuration:

1. At minimum, graphical user interface shall allow user to perform the following tasks with proper password access.
 - a. Create, delete, or edit control strategies.
 - b. Add and delete objects to the system.
 - c. Tune control loops through editing of control loop parameters.
 - d. Enable and disable control strategies.
 - e. Select points to be alarmed and define the alarm status.

- f. Select points to be trended over a period of time and initiate recording of values automatically.
- L. Integrator shall develop the new graphical screens of the proposed system and submit for Engineer/ Owner's review a draft and a final graphical screens of the proposed system that are required to be added to the existing SCADA/ HMI system.
- M. At a minimum two meetings shall be required for review of the proposed graphical screens with the Engineer/ Owner. Integrator shall accommodate/ allocate time to allow for graphical screen changes/ corrections. All changes/ corrections shall be recorded and submitted for Engineer/ Owner's approval upon which the Integrator shall coordinate for onsite deployment.
- N. Alarm Subsystem:
 - 1. Provide system with alarm window or console. Window shall notify user of alarm conditions and allow user to view details of alarm and acknowledge the alarm.
 - 2. When alarm console is not visible, separate alarm notification window will supersede other windows on the display and shall not be capable of being minimized by user. This window will notify user of new alarms and unacknowledged alarms. Alarm notification windows or banners that can be minimized by the user are unacceptable.
 - 3. User shall be able to select alarms displayed by object alarms by group and priority by using command buttons. Up to 98 priority levels shall be supported. User shall be able to view and acknowledge alarms from any node in the enterprise.
 - 4. Alarms shall be color-coded according to alarm status and priority, including an acknowledged alarm, unacknowledged alarm, and alarm that has returned to normal but is not yet acknowledged.
 - 5. System shall be configurable such that the user is notified of alarm no matter what display the user is currently viewing. Notification shall include the option of pop-up alarm display window, flashing symbol, alarm text message that is available on each display, or dedicated alarm display window on the screen.
 - 6. User shall be able to view alarms on individual or a group basis, with support for 16 groups each having up to 16 sub-groups. Alarm hierarchy shall be capable of being nested up to eight levels deep.
 - 7. Provide capability of performing alarm acknowledgment on all alarms, on alarms in a single group, and on alarms in collection of groups as defined in an alarm group hierarchy, or on a point-by-point basis.
 - 8. Provide system capable of storing alarms in structured query language (SQL) database for long term storage of alarm information.

9. Standard alarm display shall support display of the following alarm parameters which are user-selectable in the configuration mode:
 - a. Date
 - b. Time
 - c. Event
 - d. Alarm type
 - e. Operator
 - f. Priority
 - g. Comment
 - h. Tag name
 - i. Group name
 - j. Value of variable in alarm
 - k. Alarm limit
 - L. Alarm status

O. Process Report Generation:

1. Update existing reports to reflect processes integrated as part of this project.

2.08 SOURCE QUALITY CONTROL

A. General:

1. Factory Test:
 - a. Representatives of Owner and/or Engineer will witness factory test at testing facility during operational test of equipment, either for individual units or as an integrated system. Give minimum of 30 days notice to Engineer prior to the proposed testing date so that arrangements for test witnessing can be made. Presence of Owner and Engineer during testing does not relieve Contractor from complying with the Contract Documents and shall not imply acceptance of equipment. When factory tests have been successfully completed, a submit factory test report to Engineer.
2. Factory test results will be acceptable when all components within tested control panel or system being tested successfully operate and meet its intended function and are so certified by the testing entity.

3. Do not ship the equipment until obtaining Engineer's acceptance of factory test results.

B. Factory Inspection:

1. Inspect each panel, console, device, and cabinet before testing and before shipping. Inspection shall include, but not be limited to the following:
 - a. Verify all "Exceptions Noted" and "Make Corrections Noted" comments on Shop Drawings were implemented.
 - b. Verify presence of and accuracy of nameplates and tags.
 - c. Verify that wire sizes and color-coding comply with the Contract Documents.
 - d. Verify presence of terminal blocks, terminal block numbers, and required quantity of spares.
 - e. Verify annunciator window engravings and quantity of spare windows comply with the Contract Documents.
 - f. Verify proper wiring practices and grounding.
 - g. Verify enclosure flatness, finish, and color.
 - h. Verify anchoring of wire bundles between subpanels and front panel-mounted devices.
 - i. Verify presence of applicable items specified in this Section.
 - j. Check and verify software licenses for latest release and license types.

C. Panel Operational Testing:

1. Test all input/output components to verify that internal panel wiring is properly terminated at correct locations. Verify initial ranges and settings.
2. Test all system hardware and software to verify proper operation as stand-alone units. Test shall include, but not be limited to, the following:
 - a. Power distribution and breaker ratings to match approved Shop Drawings.
 - b. Power fail/restart tests.
 - c. Diagnostics checks.
 - d. Demonstrate that all specified equipment functional capabilities are working properly.

- e. Check and verify process displays are in accordance with approved Shop Drawings.
- 3. Test components and devices requiring data transmission to verify that communication between such components is working properly. Verify communication by using the same media required for the completed system at the Site as indicated in the Contract Documents.
- 4. Perform integrated system test with all system equipment and simulated inputs/outputs connected to verify that equipment is performing properly as an integrated system.
- 5. Simulation devices shall be of suitable quality to not mask control panel defects.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which the Work will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Environmental Requirements:
 - 1. Do not install instruments in areas where construction may cause instrument to be damaged, without providing adequate protection for said instrument.
- B. Installation of Instrumentation:
 - 1. Secure field-mounted instruments to stands or brackets in accordance with manufacturer's recommendations, approved or accepted (as applicable) submittals, and the Contract Documents.
 - 2. Locate sensors where shown on the Drawings. Confirm exact locations in the field with Engineer.
 - 3. Install all devices so that devices are readily accessible for service and do not cause potential hazards.
- D. Services and Operator Instructions:
 - 1. Provide repairs or replacement of defective materials, equipment or workmanship, including with respect to equipment, the services of factory-trained servicemen.
 - 2. In addition to the calibration required for check-out, provide two additional calibrations on all instruments. The first re-calibration shall be approximately six

months after acceptance of the system, and the second shall be approximately eleven months after acceptance. As part of each calibration, provide two copies of the calibration sheets, a detailed list of deficiencies (should any be found), and a statement that the entire system is in proper operation and condition (except for the deficiencies noted) and shall be turned over to the Owner.

3.03 FIELD QUALITY CONTROL

- A. Tests and Inspections: Field Testing shall be conducted per section 406350 Field Testing. Field-verify calibration and performance of each instrument prior to start-up of the associated equipment, and document on a separate sheet for each.
1. For each calibration certification sheet, include the following information:
 - a. Project name.
 - b. Tag number and description.
 - c. Manufacturer.
 - d. Model and serial number.
 - e. Date, time and person who performed calibration.
 - f. Calibration data to include.
 - 1) Input, output, and error at 0, 25, 75, and 100 percent of span for analog instruments.
 - 2) Switch setting, contact action and deadband, if applicable, for discrete elements.
 - g. Space for comments.
 - h. Signature and date.
 2. System Check-Out and Start-Up Responsibilities:
 - a. Contractor shall retain the services of the System Supplier to supervise and/or perform check-out and start-up of all system components. As part of these services, the System Supplier shall include for those equipment items not manufactured by him the services of an authorized manufacturer's representative to check the equipment installation and place the equipment in operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation and maintenance of the equipment.
 - b. Check and approve the installation of all instrumentation and control system components and all cable and wiring connections between the

various system components prior to placing the various processes and equipment into operation.

- c. Conduct a complete system checkout and adjustment, including calibration of all instruments, tuning of control loops, checking operation functions, and testing of final control actions. When there are future operational functions included in the Work, they should be included in the system checkout. All problems encountered shall be promptly corrected to prevent any delays in start-up of the various unit processes.
- d. Contractor shall provide all test equipment necessary to perform the testing during system checkout and start-up.
- e. Contractor and System Supplier shall be responsible for initial operation of monitoring and control system and shall make any required changes, adjustments or replacements for operation, monitoring and control of the various processes and equipment necessary to perform the functions intended at no additional cost to the Owner. These changes or adjustments shall be documented by the Contractor and submitted to the Engineer as part of the Installation Inspection Report described in Paragraph g. below.
- f. Contractor shall furnish to the Engineer certified calibration reports for field instruments and panel mounted devices specified in this Section as soon as calibration is completed.
- g. Contractor shall furnish Engineer an Installation Inspection Report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of both Contractor and the System Supplier.
- h. Instrumentation and Control System Field Test:
 - 1) Following the instrumentation and control system checkout and initial operation, Contractor, under the supervision of the System Supplier, shall perform a complete system test to verify that all equipment and programmed software is operating properly as a fully integrated system, and that the intended instrumentation and control functions are fully implemented and operational. Any defects or problems found during the test shall be corrected by Contractor and then retested to demonstrate proper operation.
 - 2) Following demonstration of all system functions, the instrumentation and control system, including field sensors/transducers and instruments, and telemetry system shall be running and fully operational for a continuous 48 hour period.

3.04 MANUFACTURER'S SERVICES

A. General:

1. Contractor shall retain the services of the System Supplier to provide operation and maintenance training for all instrumentation and control system equipment as specified herein.
2. For equipment items not manufactured by the System Supplier, he shall provide for on-Site training by an authorized representative of the equipment manufacturer as part of his services. The manufacturer's representative shall be fully knowledgeable in the operation and maintenance of the equipment.
3. Contractor shall be responsible for all costs associated with training and shall provide all required materials, texts and required supplies.
4. Training shall conform to the requirements of Section 017823, Operating and Maintenance Data.

B. On-Site Training:

1. General:

- a. Provide on-Site operation and maintenance training by System Supplier and the equipment manufacturer representatives prior to placing the equipment in continuous operation.
- b. Training courses shall include time for students to develop and demonstrate understanding of training concepts. Testing shall include hands on training with equipment.
- c. At the conclusion of each course students shall be tested on course material. Testing shall include exercises where students must demonstrate proper response to normal operational needs, emergencies and maintenance tasks. Every student shall be tested individually.
- d. Training shall be over a two (2) day period (i.e. Tuesday and Thursday afternoon) to include all of the operations and maintenance personnel.
- e. Training shall accomplish the following:
 - 1) Provide instruction covering use and operation of the equipment to perform the intended functions.
 - 2) Provide instruction covering procedures for routine, preventive and troubleshooting maintenance, including equipment calibration.

- 3) Explain procedures for placing the equipment in and out of operation and explain necessary actions and precautions to be taken regarding the overall plant monitoring and control system.
 - 4) Provide classes and field training as to how to change process control and alarm set points in all microprocessor based controllers and transmitters. Maintenance personnel shall be trained to enter passwords, programming or configuration data, etc.
2. Primary Sensors/Transducers and Field Instruments:
- a. The services of equipment manufacturer's representatives shall be provided for a minimum of 2 hours for each type of instrument.
 - b. Training shall include:
 - 1) Basic repair and maintenance capabilities of installed equipment.
 - 2) Procedures for placing the equipment in and out of operation.
 - 3) Use of any special repair equipment or software packages that are used for repair or maintenance.
 - 4) Procedures for testing any repair before placing equipment back in service.
3. PLC and SCADA Training
- a. Training shall include
 - 1) Hardware and software configuration of PLC and SCADA programs.
 - 2) Perform a walk through with students identifying system components. Instructor shall test each student's knowledge of system components during walk through.
 - 3) Identify key operating and alarm features of the project specific PLC and HMI programs.
 - 4) Test students knowledge of proper response to alarms, capabilities to replace hardware components, switch hardware and software between online and offline, add new components, know when to call for assistance, demonstrate understanding of hardware and safety requirements, understand impact of changes made to rest of the control system.

- 5) Provide instruction covering basic editing of PLC programs and SCADA screens. Instruction shall include testing students programming capabilities by having students make minor changes to programs and test changes online.

END OF SECTION

SECTION 406120

CONTROL PANELS

PART 1 - GENERAL

1.01 SUMMARY

- A. Custom built control panel requirements and materials.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Division 1, Shop Drawings covering the items included under this Section.
- B. Contract Closeout: Submit in accordance with Division 1.
- C. Fabricated and pre-engineered panels are subject to this specification and Appendix A Collier County Public Utilities Division SCADA Standards Section 1.7.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Codes, Ordinances, and Industrial Standards: Design, testing, assembly, and methods of installation for materials, electrical equipment, and accessories proposed under this Section shall conform to National Electric Code and to applicable State and local requirements.
 - 2. UL listing and labeling of custom-built panels (UL 508) shall be adhered to under this Contract.
 - 3. Panels to be located in non-hazardous (non-classified) environments shall comply with UL 50 and UL 508A.
 - 4. Panels to be located in hazardous (classified) environments shall comply with UL 698A, and bear a label stating such, and UL 2062. Panels that include intrinsically safe circuits shall comply with UL698A and shall include label stating such.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Control panels shall be manufactured in a UL listed panel shop.

2.02 CONTROL PANELS

A. Sheet Metal Construction:

1. Indoor panels located in dry and non-corrosive environments shall be NEMA 12. Outdoor panels and panels located in wet environments shall be NEMA 4X 316 stainless steel powder coated white.
2. Panel bodies shall be 12 gauge minimum for freestanding panels up to 42 inches in width, and 10 gauge minimum for panels exceeding 42 inches in width. Panel bodies shall be 14 gauge minimum for non-freestanding panels up to 42 inches in width, and 12 gauge minimum for panels exceeding 42 inches in width. Stiffening members shall be provided for strength and stiffness as required.
3. Panel subplate shall be mounted on collar studs for easy removal. Print pockets shall be provided on each panel. Brackets welded to inside of panel, complete with lights, shall be provided on panels where indicated by Drawings.
4. Wall mounted panels shall not exceed 18 inches in depth.

B. Access:

1. Wall- and/or floor-mounted control panels shall have continuous piano-hinged doors for ease of access. Door openings shall expose a minimum of 80 percent of panel interior. Door openings shall be sealed with a 0.125-inch thick minimum cellular neoprene gasket cemented with oil-resistant adhesive and held in place with a retaining strip. Print pockets shall be provided on each door. Two door enclosures shall have a removable center post. Panel doors less than 40 inches high shall be equipped with a 2-point latching mechanism. Panel doors 40 inches high or more shall be equipped with a 3-point latching mechanism.
2. Components and terminals shall be accessible without removing another component except covers. Swing out sections shall be used if mounting space is required that is not normally accessible.

C. Finish:

1. Panel face openings for mounting equipment shall be smoothly finished cut with counterboring and trim strips provided as required to give a neat finished appearance. Bezels shall be used on all front panel-mounted devices to cover panel cutouts. A chrome-plated or stainless steel bezel shall be used at parting line of panels that have shipping splits or at parting line of panels placed end to end.
2. Graphic plates, when used, shall be fastened to panel frame with fasteners not visible from front of graphic.

D. Control of Environment:

1. Provide 120 vac thermostatically controlled fan-driven heater units to maintain stable temperature within enclosure to protect equipment from harmful effects of condensation, corrosion, and low temperatures inside panels.
2. Provide automatically controlled closed-loop heat exchangers or closed-loop air conditioners to maintain temperature inside each enclosure at optimum operating temperature rating of components inside the enclosure.
3. Each heat exchanger or air conditioner shall have a dedicated, properly-sized and -rated circuit breaker.
4. Submit supporting calculations as part of panel Shop Drawing submittal if panel equipment to comply with specified environmental requirements is proposed to be deleted as unnecessary.

E. Electrical:

1. Provide in the panel, near where incoming power is terminated, nameplate with panel power supply source, type, voltage, and circuit number.
2. Protect incoming 120 vac power feeds to power the panel by providing lightning and surge arrestors, properly connected to grounds.
3. Provide panels with internal 120 vac power distribution system with properly-sized and -rated circuit breakers to distribute power. Power not more than six devices from a single breaker. When power supplies are included in the panel, not more than two power supplies shall be powered from a single breaker. Convenience receptacles and interior panel lights shall have their own breakers. When one or more field instruments require 120 vac power from the panel for instrument power, power not more than three instruments from a given breaker.
4. Provide space for a minimum of two spare breakers in each panel.
5. Internal panel wiring shall be:
 - a. AC power wiring size for current to be carried but not less than 18 AWG MTW.
 - b. Signal wiring use wiring size for current to be carried but not less than 18 AWG, 90°C MTW
 - c. Analog signal wiring use shield twisted pair 18 AWG minimum.
 - d. For wiring carrying more than 15 amps use sizes required by the NEC.
6. All panel wiring not run in wire ducts shall be bundled and tied. Each wire shall be identified at both ends with same exclusive number. Number shall be same number shown on control schematic. Number shall not be used again for any

other purpose. Wires marked differently on each end will not be accepted. Wire markers shall be provided on end of each wire at termination point.

7. Control wire coloring:
 - a. Black – 120 VAC
 - b. Red – 120 VAC Controlled
 - c. Yellow – 120 VAC Power from external devices
 - d. White – 120 VAC Neutral
 - e. Blue – 24 VDC Positive and 24 VDC Controlled
 - f. Blue w/ White Stripe – 24 VDC Ground
 - g. Green – Signal Ground
 - h. Yellow on Green – Panel Ground
 - i. Red – 4-20mA Positive Signal Wiring
 - j. Black – 4-20mA Ground
8. Provide an instrument common bus 0.1 by 0.5 by 6-inch minimum in enclosure and isolated from enclosure. A separate instrument common wire shall be run from each common terminal on an instrument to instrument common bus. Instrument common wires looped from one terminal to another and then to instrument common bus will not be accepted.
9. Instrument common bus shall be connected to power supply common with a wire or wire braid strap as short as practical and of sufficient capacity to prevent troublesome voltage drop. Common terminals and common bus for instrument common shall be tagged "Instrument Common." Instrument signal wires of 4-20 mA or 1-5V shall be shielded wire. Telephone wires and telemetry equipment interconnection wires shall be shielded wires.
10. Provide a copper ground bus 0.1 by 0.5 by 6-inch minimum in enclosure to which all instrument grounds and panel enclosures are tied. Separate ground wire shall be run from instrument enclosure ground terminal directly to ground bus. Instrument ground wires looped from one instrument to another will not be accepted. Under no circumstances shall neutral side of power source or any other terminals used for grounding power circuits be used as an instrument common.
11. Wires to internal components shall be connected to inside of terminal strip. Wires to external components shall be connected to outside of terminal strip. No more than 2 wires shall be connected to one terminal point.

12. Panel wire duct shall be provided between each row of components and adjacent to each terminal strip. Wire ducts shall be a minimum of 1-inch wide and 3 inches deep with removable snap-on covers and perforated walls for easy wire entrance. Wire ducts shall be constructed of nonmetallic materials with voltage insulation in excess of maximum voltage carried therein.
13. Vendor provided control panels and consoles with motor controllers, such as motor starters and/or VFDs, shall be equipped with a flange mounted 600V rated main non-automatic trip circuit breaker or disconnect switch. Single phase, 60 hertz power at voltage shown on Drawings shall be supplied to main disconnect. Panel fabricator shall provide any additional voltages and power requirements at control panel to meet requirements of equipment contained therein.
14. Disconnect shall have enclosed protected terminations to prevent accidental shock.
15. Relays, timers, etc., installed on panel subplate shall be provided with a minimum spacing between component and wire duct of 1.5 inches above and 1 inch below. Minimum spacing between adjacent components shall be 0.25 inch. Relays, timers, etc., shown in schematics are intended to show function. Additional relays may be required in conjunction with items shown to provide total number of contacts required. Where limit, pressure, float switches, etc., are used and more than SPDT contacts are indicated by schematics, provide additional contacts required by using auxiliary relays. However, if a DPDT switch is called for, using a SPDT with a relay will not be accepted. All control and pilot devices such as relays, timers, etc., shall be 120V, 3 amp rated except where noted with 24VDC coil voltage. One N.O. spare contact shall be provided on each relay.
16. Inside of panels, route dc signal wiring separately from power wiring with minimum separation distance of six inches.
17. Use covered wireways to route internal panel cables and wiring. Wireways in each section of panel shall be appropriately sized to accommodate the quantity of wires to be routed with a spare capacity of 40 percent.
18. Install wire troughs inside panels along horizontal or vertical routes to present a neat appearance. Angled runs are unacceptable.
19. Wiring that is routed without wireways shall be adequately supported and restrained to prevent sagging or other movement. Use of adhesive anchors to support or restrain wiring is unacceptable.
20. Terminate internal panel wiring using forked, insulated, crimp-on connectors; soldered connectors are unacceptable. Provide panels with 600-volt rated barrier type terminal strips mounted on Din rails. Identify terminal strips as indicated in this Section. Identification devices shall be self-stick, plastic tape strips with permanent, machine-printed numbers.

21. Wiring in panels shall be installed such that, if wires are removed from any one device, power will not be disrupted to other devices.
22. Provide spare terminals equal in number to 20 percent of terminals used for each type of wiring (e.g., dc signal and ac power).
23. Provide ground terminals to terminate the shield wire of shielded cables. Termination of more than two shielded wires on a single ground terminal is unacceptable.
24. Provide a single copper bus bar with 5/16 inch diameter copper grounding stud to connect the panel to external ground. Panel's internal grounds shall be terminated to the bus bar.
25. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.
26. When dc power is required, furnish and install in the panel required power supplies.

F. Panel/Subplate Layout:

1. Panel face-mounted equipment shall consist of pilot lights, push-buttons, selector switches, meters, indicating timer, etc. Spacing between horizontal rows of components shall be 1.5 inches minimum; spacing between vertical columns of components shall be 1.875 inches minimum. Components shall be grouped and/or located as indicated on Drawings. Distance from bottom row of components to floor shall be not less than 36 inches. Top row of recording and indicating instruments shall be centered approximately 60 inches above floor. Maximum height for annunciator windows shall be 85 inches above floor. In general, indicating lights, push-buttons, etc., shall be mounted in accordance with sequence of operation from left to right and top to bottom.
2. A minimum of 2 inches shall be provided between terminal strips and wire ducts or terminal strips and terminal strips. In general, terminal strips shall be mounted on vertical edges of subplate. Where terminal strips are mounted side-by-side, terminals shall be elevated 1.5 inches above subplate to allow wires to pass underneath.
3. Subplates shall have a minimum of 15 percent spare mounting space, and terminal strips shall have a minimum of 20 percent spare terminal blocks.

G. Control Panel Accessories:

1. One 120 vac, 15-amp duplex, GFCI duplex receptacle.
2. One 120 vac LED service light fixture with protective plastic shield for every 4 feet of panel width.

3. One 120 vac snap switch, to turn on service light, mounted in outlet box with cover and located so that switch is easily accessible from access door.
4. Service light with switch and duplex receptacle shall have a dedicated circuit breaker.
5. Provide complete wiring diagram of "as-built" circuitry enclosed in transparent plastic.
6. One folding laptop shelf on inside of door, shelf shall be welded to door to avoid any rating changes to enclosure.

H. Identification:

1. Identification plates shall be laminated phenolic with black letters engraved on a white background and mounted with screws or double-back adhesive foam tape.
2. All components inside panel shall have identification plates. This includes instruments, relays, switches, circuit boards in plug-in racks, etc. Identification plates shall include engineering symbols (FBQ-1, SW-3, FIC-4, CR-1, etc.). Switches and circuit breakers inside panel shall have names (Horn, Audio Tone, Panel Power, etc.) on identification plates as well as engineering symbol.
3. Identification plates shall be located on or adjacent to device they are identifying and shall be readable without looking around, under, or on top of device to find identification plate.

2.03 SWITCH, PUSH BUTTONS, LIGHTS

- A. Selector switches shall be 120 VAC rated, oil-tight construction with standard operator knob.
- B. Start push buttons shall be 120 VAC rated, oil-tight construction with extended guard and black color insert.
- C. Stop push-buttons shall have a half-guard with black color insert. Contacts shall be rated NEMA B-150 and P-150.
- D. Pilot lights shall be push-to-test oil-tight construction, LED with cap colors and voltages as required. Nameplates for each switch and light shall conform to manufacturer's series and type with engraving as called for on Drawings.

2.04 RELAYS

- A. Control Relays: Switching and output relays shall be plug-in type with contacts rated 120 VAC, 3 amp with 24 VDC coil, indicating light, manual operator, and plastic transparent cover. Relays shall have a retainer mechanism to prevent loosening from vibration. Relays shall not be used for switching 1-5 VDC or 4-20 mA signals associated with instruments.

SECTION 406123

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section project specific PLC and I/O model numbers.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 013323 and 406113, Submittal Procedures covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

- 1. All Intergrator provided PLC's:

- a. Allen-Bradley ControlLogix 1769-L33ER.

- b. For specific CPU and I/O module part numbers refer to Appendix A – Collier County Public Utilities Division SCADA Standard Section 1.5 PLC – Allen Bradley.

2.02 PLC PROGRAM

- A. Provide all PLC programs with notes to Client on USB storage device once project as reached final completion.

PART 3 - EXECUTION

None

END OF SECTION

SECTION 406166

SOFTWARE SERVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, equipment, and services necessary for furnishing fabrication, production, and installation of items specified in this Section or as shown on Drawings.
- B. Work includes programming, testing, and installation of software required for a complete and fully operational control system. Principal segments of Work include, but are not limited to, programmable logic controller ladder logic, data collection, operator process control interfaces.
- C. The SYSTEM SUPPLIER shall integrate the new PLC's located on the drawings into the new SCADA system.
- D. The SYSTEM SUPPLIER shall provide ALL graphic screen and report development associated with all plant treatment processes.
- E. The SYSTEM SUPPLIER may duplicate software logic code and database and graphics applications, as required, while still meeting the functional specifications. The Engineer may require modifications to the submitted graphics, reports and control logic without change to the contract price. All engineering development required by the SYSTEM SUPPLIER will be in accordance with the Conditions of this Contract.

1.02 SYSTEM DESCRIPTION

- A. Performance Requirements: Programmable logic controllers (PLCs) shall complete execution of all rungs with a cycle time not to exceed 250 mS. HMI functions shall have a 2-second response time or better. Adjust timing and operating system parameters of PLCs and computers as necessary.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 013323 and 406113, Submittal Procedures and product data for products provided under this Section.
- B. An application programming design package that contains a written description of each control strategy. These descriptions shall lead the user through the major subsections of the programs. They shall generally describe the programming methods and techniques that will be used to implement the functional requirements of this Specification.
- C. A graphic screen development package that includes:

1. A list of all proposed screens.
 2. Proposed color standards that would subsequently be used to develop the screens.
- D. A final documentation package that includes:
1. Licenses in the Owner's name for all software supplied.
 2. Final copies of all programming files on USB drive, including:
 - a. PLC programs.
 - b. Radio configuration files.
 3. A complete printout of all PLC program logic with notes.

1.04 QUALITY ASSURANCE

- A. Project progress meetings shall be held at Site at an interval not to exceed once per month during the software development cycle. Meetings shall be once per week during software installation and field checking phases. Representatives of Owner and Engineer will attend these meetings.

PART 2 - PRODUCTS

2.01 SERVICE SUPPLIER

- A. Software services shall be fulfilled by the organization selected as "Equipment Supplier" under Section 406113.

2.02 SOFTWARE SERVICES

- A. Software services include program development, testing, documentation, and Work necessary to implement a complete and fully operating system as shown on Drawings and/or as specified. Provide programming to implement required functions and features.
- B. Work requires coordination with concurrent program development for PLCs, Operator Interfaces. Include PLC error detection logic for communications failures, data highway faults, internal faults, and time outs. Communicate PLC error conditions to Operator Interface for logging and reporting.
- C. Communication between PLCs and Operator Interface shall be on an exception basis. When reportable changes in process state occur, such as alarm assertion, return to normal, or analog value out of dead band, report event to PLC that communicates with Operator Interface. This PLC shall maintain data tables current with all process inputs and outputs. Organize data to be transferred into contiguous blocks of information using bit-mapped and integer tables. Employ a "watchdog" timer for each remote PLC

and poll that PLC if no message has been received in a reasonable amount of time. Accept Operator Interface directives for setpoint changes and hand switches.

- D. PLC Software. The latest revision of the programming software shall be installed as of substantial completion. This shall include software for programming the PLCs as well as Windows based software for configuring the local operator interface applications. Provide a full copy of both packages on the HMI subsystem as well as on the programming laptop specified elsewhere herein.
 - 1. PLC programming software: Rockwell Automation RSLogix 5000 or Studio 5000.
 - 2. HMI programming software: FactoryTalk View Studio Machine Edition
 - 3. SCADA programming software: Rockwell PlantPAX

2.03 PROGRAMMABLE CONTROLLER LOGIC

- A. Develop programs for execution on PLC using development software supplied under that Section. Logic shall perform functions required to control processes and equipment as shown on Drawings and/or as specified. Develop complete cross-references for ladder logic and complete input/output listings.

2.04 HUMAN MACHINE INTERFACE (HMI)

- A. Operator Interface programs for HMI's provide graphic representation of local processes and control over machinery.
- B. Screens shall include indicating lamps and hand switches shown. Include analog instruments such as indicators, manual loading stations, controllers, etc., as shown. Programming shall be done using panel viewing software as manufactured by the PLC vendor.
- C. Operator Displays: Develop programs to provide following elements and as required for a complete fully functional Operator Interface and data collection system:
 - 1. Video displays shall be color at highest resolution supported by hardware. Install operating system drivers as necessary. They shall be fully windowed. Use colors, function keys, and navigational controls consistently.
 - 2. Alarm Management: For each process or system event classified as an alarm provide facilities for displaying and logging on system alarm printer, acknowledgment, and purging of stale messages. Alarm events are derived from discrete inputs, analog trip values, logic combinations and computations as needed. Print and display each alarm events and returns to normal. Provide date/time stamps for events, descriptive message, and event type code. Use color combinations to distinguish following alarm states: Alarm-Unacknowledged, Alarm-Acknowledged, Normal-Unacknowledged, and Normal-Acknowledged.

3. Graphic Displays: Provide process-oriented displays showing current process status and accepting operator input for setpoint and status changes. Submit for approval color schema and screen-to-screen navigation strategies. For each display, show process elements such as pumps, valves, tanks, pipelines, etc., with their current operational status. Provide analog displays for board instruments shown including indicators, controllers, manual loading stations, etc. Indicators shall use an appropriate number of significant digits and dead band to produce steady values and color to show operational status.
 4. Trending: Provide on-screen trending displays that are user definable that operate from either previously collected historical trend groups (named file) or from a group of real-time variables. Provide facilities for user selection of colors, time (horizontal), and measurement (vertical) scales. Accommodate real-time sampling intervals as short as 1 second. Real-time trends shall show alarm setpoints. Historical trend displays shall have timescale panning controls.
 5. Security: Using operator interface and operating system software, implement a security system to restrict access to parts of system. Provide following as a minimum:
 - a. Programmer- Access to all facilities including changing displays and logic.
 - b. Supervisor- Access to all displays, change master set points and purge stale alarm messages.
 - c. Operator- Access to all displays, change normal operational sequences and acknowledge alarms.
 - d. Observer- Access to displays only.
- D. Provide following data management functions:
1. Collection files are closed at 00:05 of first day of each calendar month and a new file started. Establish a file naming convention based on file type (analog, historical, or motor), month, and year. Provide operator screens for managing file space:
 - a. Backing up to archive medium.
 - b. Restoration from archive.
 - c. Deleting archive files.
 - d. Display/print of archive catalog.
 - e. Forcing early closure of collection file.
 - f. Create export file.

2. Analog Points: Scan each analog point every minute. Every hour, store minimum, maximum, and average values in a journal file. Do not store values that are out of range, out of service, or not valid for any other reason.
3. Historical Trend Data Collection: Establish data collection tables for up to 20 groups of up to 6 process points each with a collection interval of 1 minute. Provide facilities for defining and changing trend groups. Removal and archiving of closed trend files shall be accomplished using operating system's standard backup/restore programs. Do not store values that are out of range, out of service, or not valid for any other reason.
4. Motor Run Times: For each monitored motor, store daily values for running time. Run times may be developed either by scanning points every minute or by providing PLC timer logic. Daily accumulated run times are to be stored at 00:01 of each day and then reset. Close running time data collection file at 00:05 on first day of each month.
5. Data Export: Provide collected data file export facilities for use by management reporting programs and third-party data analysis programs such as dBase IV and spreadsheets. Export files shall be ASCII encoded, fixed record (and field) length with carriage control. Export files shall be made from closed collection files on user demand.

2.05 OPERATOR INTERFACE AND DATA COLLECTION (SCADA)

- A. This section defines requirements for modifications to the Owner's existing SCADA system operator interface (located at City of Rockledge WRF) and the new operator interface units located at the new Flow Equalization Basin & Sludge Thickening and Digesters Rehabilitation control panels, to incorporate the Flow Equalization System and Sludge Thickening and Digesters Rehabilitation Processes. Existing displays may be copied and modified as necessary.
- B. The standards to be used for new graphic screens and specific details of report formats and contents shall be defined by Owner and Engineer at the first project meeting.
- C. Provide a new graphic screen that provides an overview of the plant process similar to the process diagram contained in the Contract Drawings and including, as a minimum, the following
 1. Instantaneous and accumulated daily totals for influent and effluent flows.
 2. Depth and volume of fluid in the equalization basins and digesters.
 3. For individual pumps:
 - a. Status: Running/stopped, in alarm, remotely controllable, in automatic (software switch).
 - b. Speed.

- c. Link to detailed equipment control screen.
 - 4. For individual control valves:
 - a. Status: Open/closed/position, in alarm, remotely controllable, in automatic (software switch).
 - b. Link to detailed equipment control screen.
- D. Provide additional new graphic screens for the following:
 - 1. Equipment Screens - These should be individual equipment screens that provide complete details of each control valve, electric pump, and diesel pump.
 - 2. Diagnostic Display - This should identify communication link throughput and Bit Error Rates, PLC low battery, PLC running, PLC module faults, etc. The display should “look” like the actual equipment by showing individual modules in the correct location within the rack. Colors will then designate the specific module that is failed.

2.06 CONTROL STRATEGIES – COMMON REQUIREMENTS

- A. General Requirements applicable to Section 406196 Process Control Narrative are:
 - 1. All software fault conditions that are set can only be cleared by operator acknowledgement.
 - 2. When commands are issued from the HMI/SCADA, latch the commands in the PLC such that if communications are lost between the HMI/SCADA the command value is retained in the PLC.
 - 3. All control strategies shall run within the PLC. Data manipulation (calculated analog values, elapsed time functions, event determination) shall be performed by the PLC for the associated equipment it is monitoring. Any resulting values from these manipulations shall be reported as individual registers. The intent is to avoid utilizing the HMI software for this purpose.
 - 4. The control functions described herein and in Section 406196 Process Control Narrative are not intended to be complete comprehensive programming logic descriptions. They depict only the general intended control operation required. Provide complete program logic to completely fulfill the functional requirements indicated.
 - 5. Provide all programming necessary to support the functional requirements of the operator graphic screens.
 - 6. Provide complete debugging services to address issues identified by the Owner or Engineer during and after startup until final acceptance.

- B. Except where specifically defined elsewhere in Section 406196 Process Control Narrative provide the following for analog inputs (pseudo and real):
1. For all analog inputs:
 - a. Provide out of range alarms if the input signal goes outside the instrument's range.
 - b. Provide individually adjustable emergency high and low alarms when the value goes outside the allowable process range.
 - c. Provide individually adjustable high and low alarms when the value goes outside the normal process operating range.
 - d. Provide individually adjustable alarms to indicate when a process variable changes value at an abnormal rate.
 - e. Provide a dead band on all alarm settings.
 - f. Issue Return-to Normal alarms whenever the signal returns to within limits.
 2. For all flow related analog inputs:
 - a. Monitor for and record minimum and maximum daily values. Record the date and time of occurrence for each.
 - b. Accumulate a running daily total flow. At midnight, transfer the total to yesterday's total and restart from zero.
 - c. Calculate a running daily average flow. At midnight, transfer the value to yesterday's average and restart the averaging.
 3. For all level and pressure related analog inputs:
 - a. Monitor for and record minimum and maximum daily values. Record the date and time of occurrence for each.
- C. Except where specifically defined elsewhere in Section 13470 Process Control Narrative provide the following for discrete inputs (pseudo and real):
1. For all discrete inputs:
 - a. Indicate but do not alarm when a discrete signal changes, as expected, as a result of a control command.
 - b. Alarm when a discrete signal fails to change within a preset time, adjustable on an individual point basis, after a control command. Set a software fault for the controlled device that can only be reset by operator action.

2. For all local control switch position feedback discrete inputs:
 - a. Issue an advisory alarm to the operator whenever a position change is detected
 - b. Exclude from any control strategy any equipment whose local switch position precludes control. If an operator attempts to control the device through the system, issue a message indicating that the control cannot be accomplished together with the reason.
3. For all motorized equipment:
 - a. Accumulate equipment run times based on the running status feedback discrete input.
 - b. Reset the run time value to zero only on operator command
4. For all device failure discrete inputs:
 - a. Issue an alarm when the input indicates a device fault
 - b. Set a software fault for the controlled device that can only be reset by operator action after the fail signal has been removed.
5. Provide Derivative, Integral, Proportional adjustable parameters for all PID loops.

PART 3 - EXECUTION

3.01 SOURCE QUALITY CONTROL

- A. Conduct preliminary testing prior to factory checkout by executing programs supplied for this Project. Use simulated input and output devices as necessary to verify correct interpretation. Exercise inputs to test logic for correct function and proper response of outputs. Verify correct interface of PLC logic with programs used for Operator Interface and Data Collection Activities.
- B. Following successful completion of the factory demonstration test, and each time any change is made thereafter, make a complete copy of all application programs and screens on USB drive. Keep these discs until final acceptance.
- C. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410 Basic Instrumentation Requirements.

3.02 OWNER TRAINING

- A. Operations: Provide a minimum of two days of initial training at the jobsite for up to six of the Owner's personnel in the operation of the system. Provide a third day for follow up training. The training shall cover at least the following subjects:

1. System overview covering basic system design, configuration and purpose.
2. Use of the new graphic screens.
3. Explanation of the control strategies running in the PLC. The intent shall be to make the student fully knowledgeable in all aspects of the system provided, along with methods for making additions, modifications, and deletions to the system.

END OF SECTION

SECTION 406196

PROCESS CONTROL DESCRIPTIONS

PART 1 - GENERAL

1.01 PURPOSE

- A. This document describes the process automation for the master pump station at the Collier County Central County Water Reclamation Facility (WRF). This document along with the P&ID's and I/O list will give the PLC, operator interface unit (OIU), human machine interface (HMI) programmer an understanding of the control systems pertinent to the project.
- B. The specifications including this document, the Drawings, and the I/O list are complementary; what is required by one is as binding as if required by all.

1.02 GENERAL OVERVIEW OF PROCESS

- A. Master Pump Station:
 - 1. Pumps: There are two (2) effluent pumps. The pumps shall speed up or down in order to maintain an operator selected suction pressure in the force main. The pumps will operate in a LEAD-LAG configuration and rotate designation in order to maintain similar run times. There shall be one pressure sensor (PIT-100) on the suction pipe.
 - 2. Motor Actuated Plug Valves: There are two (2) motor actuated plug valves to control the flow in and out of the master pump station. Operator shall manually open or close the valves via SCADA.

1.03 EFFLUENT PUMPS

- A. The PLC will monitor the suction pressure (PIT-100). The PLC will compare the level to a start pressure setpoint determined by the operator and start the lead pump if the pressure is above the setpoint.
- B. The lead pump will increase speed until it reaches 100%. If the pressure in the suction pipe is still above an operator determined level setpoint then the next pump in the LEAD-LAG configuration will be called to run. This process will continue until all pumps are running at 100% speed.

1.04 EQUIPMENT AND DEVICES

- 1. PIT-100 – Suction Pressure
- 2. P-2 – Transfer Reject Pump No. 2

3. P-3 – Transfer Reject Pump No. 3

1.05 EQUIPMENT AND DEVICES

A. LOCAL:

1. When the Field LOR switch (mounted at VFD) is in LOCAL, the associated pump can be controlled.
2. When the Field LOR switch is in OFF, the associated pump will stop, and all REMOTE control will be disabled.
3. When the Field LOR switch is in REMOTE, the associated pump will be controlled by the PLC and HMI as described below.

B. REMOTE HAND:

1. Hand is Selected from the HMI; the pump will run.

C. REMOTE AUTO:

1. Auto is selected from the HMI, the associated pump(s) will operate via PLC control below:
2. Pumps will be controlled per Section 1.03.
3. If the level reaches the low-low level (LSLL-1300) the PLC shall stop the pump.

1.06 PARAMETER AND DISPLAY ON PLC

| Parameters on PLC | | | | |
|-------------------------|------------|-------|-------|----------|
| Description | Parameter | Units | Scale | Setpoint |
| Start Pressure Setpoint | Adjustable | PSI | 0-XX | XX |
| Pressure Setpoint | Adjustable | PSI | 0-XX | XX |
| | | | | |

| Display on PLC | | | |
|-------------------------|--------------------------|-------|-------|
| Description | Parameter | Units | Scale |
| Pump Mode Indication | Local/Remote* | | |
| Pump Mode Indication | Remote Hand/Remote Auto* | | |
| Pump Status | Running / Stopped* | | |
| VFD Info from Network* | | | |
| Pressure | | PSI | 0-XX |
| * Typical for each pump | | | |

1.07 INTERLOCK

- A. Pump will shut down if temperature switch on each associated pump trips, VFD must be reset before restarting pump.
- B. Pump will shut down if check valve position switch on each associated pump is in the closed position, VFD must be reset before restarting pump.

1.08 ALARMS

| Alarms | | | |
|---------|--|---------|----------|
| Tag | Function | Action | Priority |
| | | | |
| | | | |
| EA-102 | Transfer Reject Pump No.1 Not in Remote* | Warning | |
| TSH-102 | Transfer Reject Pump No.1 High Temp* | Alarm | |

END OF SECTION

SECTION 406350

FIELD TESTING

PART 1 - GENERAL

1.01 SUMMARY

- A. This section describes the requirements for field-testing equipment supplied under Sections 406113 Basic Instrumentation Requirements, 406196 Process Control Narrative, 406166 Software Services, and 406123 Programmable Logic Controllers and demonstrating the complete integration of the work.
- B. Furnish test equipment required to perform the testing specified herein. This test equipment may either be owned or leased and is not a part of the equipment furnished to the Owner under this Contract.
- C. Pretest equipment and wiring before beginning any formal field tests. Document pretest results.

1.02 SUBMITTALS

- A. Include test procedures, coordination/scheduling issues, and sign-off forms for each of the following tests:
 - 1. Loop Tests.
 - 2. Control Loop Tuning.
 - 3. Function Tests.
 - 4. Control Strategy Tests.
 - 5. Integrated System Tests.
- B. With initial test procedure submittal, include a proposed schedule outline which indicates how tests will be scheduled within specific subsystems or type, how coordination issues for each subsystem or type of test affect the proposed schedule, duration of tests, and any constraints between tasks or tests. Include time for mobilization of test personnel, set-up for each type of test or subsystem as applicable, and coordination meetings with construction manager. Include a written description or list of all field wiring required to be terminated and labeled for each subsystem or type of tests including whether panel end, equipment end, or both is required to be terminated and labeled before test.
- C. After testing, submit the completed test sign-off forms within ten days.

- D. Document loop checks on the loop drawings and submit to the Engineer. Include the following:
1. Type of test(s) performed.
 2. Date tested.
 3. Problem description, if any.
 4. Signature of tester and date.
 5. Signature of Engineer and date.
 6. Attach additional sheets to the loop drawings as needed to document resolution of issues raised during the test.
- E. Submit loop tuning documentation to the Engineer which includes:
1. Loop number and description.
 2. Problem description, if any.
 3. Signature of tester and date.
 4. Signature of Engineer and date.
- F. Document strategy tests and submit to the Engineer. Include the following:
1. Strategy identification.
 2. Tests performed.
 3. Logic which could not be tested.
 4. Copies of messages, displays, and trends which verify operation.
 5. Problem description, if any.
 6. Signature of tester and date.
 7. Signature of Engineer and date.
- G. Document function tests and submit to the Engineer. Include the following:
1. Description of function.
 2. Tests performed.
 3. Copies of messages, displays, reports, and trends which verify operation.

4. Problem description, if any.
 5. Signature of tester and date.
 6. Signature of Engineer and date.
- H. Submit separately test results which indicate failure and need to be retested. Indicate reason for failure, proposed date for retesting, and overall schedule impacts if any.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

- A. Pretest loops and wiring prior to formal field testing. Provide complete documentation describing results of pre-testing. Clearly indicate that loops have been pre-tested, along with descriptions of any problems encountered. Perform no formal field testing until pre-tests have been completed.
- B. Conduct field tests in the presence of the Owner or Engineer, except when advised by the Engineer that test witness presence will not be necessary.
- C. If a test, or a portion of a test, fails to the point where it needs to be rescheduled for a later date, re-testing shall be required at no additional cost to the Owner and no extension of the Contract completion date.
- D. Perform field testing to verify the operation of the control system. Perform field testing sequentially and organize by plant area and by unit process within each area. Field tests are as follows:
 1. Loop tests.
 2. Loop tuning.
 3. Control strategy tests.
 4. Function tests.
 5. Integrated system test.
- E. Test each major subsystem. A subsystem is an integrated, fully operational subset of the control system and includes the following:
 1. Programmable Logic Controller (PLC) and associated I/O.
 2. Network communications equipment required for operation of the subsystem.

3. Field instruments, panels, termination cabinets, control devices and related interconnections provided for the plant area.
 4. Operator interface and graphics added and integrated into the existing Plant Control System.
- F. Meet the following conditions prior to the start of any testing:
1. Correct deficiencies noted during unwitnessed in-factory testing.
 2. Have documentation on-site pertinent to the part of the system being tested.
 3. Have on-site, labeled, and properly stored, spare parts, expendables and test equipment pertinent to the part of the system being tested.
 4. Have Engineer approved test schedules and test procedures.
- G. Schedule field testing through the Construction Manager and the Owner on a daily basis.
1. The Owner may redirect testing from one-unit process to another. Make no claim for delay or additional costs for testing if the testing effort is redirected to a different unit process provided the following conditions are met:
 - a. The redirection does not cause more than one-hour interruption to the testing to move test equipment and test personnel to the new unit process.
 - b. There is no change in the amount of test equipment or personnel requirements.
 - c. The redirection is not arbitrary. Process operational constraints, personnel availability, and other's work are valid reasons for redirection.
 - d. The redirection does not occur more than once in any workday subsequent to the daily scheduling meeting.
 2. Perform no testing that may affect plant operation without Owner concurrence.
 3. Perform testing on a per site basis. Test no more than one site at any given time.
- H. Perform tests by following the operation and maintenance manuals word-for-word unless approved otherwise by the Engineer. Lack of complete, detailed manuals will be cause for declaring the test to have failed regardless of the actual test results.

- I. Begin testing by performing the following steps:
 - 1. Check equipment against shop drawing lists.
 - 2. Verify that the equipment has been installed in accordance with Contract documents and manufacturer's directions.
 - 3. Power up the equipment and run diagnostics to verify error-free operation.
 - 4. Load software.
- J. Make available for Owner's use loops and control strategies that have been verified to operate properly immediately subsequent to conclusion of the respective test.
- K. The Owner and/or Engineer may participate in testing activities at the Owner's discretion.
 - 1. This participation will serve as a learning experience for plant operations and maintenance personnel but does not take the place of specified training.
 - 2. This participation does not relieve the Contractor from the specified requirements for testing.
 - 3. Recognize and adjust for Owner involvement in developing test procedures and schedules.
 - 4. Owner participation and use will be such that it does not adversely affect specified testing requirements. Make no claim for delay unless the following conditions are met:
 - a. The Owner and the Engineer are notified verbally that Owner actions could cause delay if continued.
 - b. The Owner persists in the delay action.
 - c. Submit written documentation within 24-hours which describes the Owner action and the impact.

3.02 LOOP TESTS

- A. Verify field wiring continuity from field device to PLC Panel termination.
- B. Check each loop from the end element to the respective Operator Workstation control display. Include instruments, field wiring, control devices, panels, termination cabinets, input/output cards and other devices in the loop to ensure proper operation and linkage to control station displays.
- C. Test operation of the final control element through panels and through control stations. If a final control element is out of service or not released by the Owner for testing, simulate operation at the final control element location.

- D. For loops found to contain defective or inoperable equipment perform the following:
 - 1. Correct and recheck these loops when equipment is operable.
 - 2. The Engineer will assist in coordinating the correction of defective work by others.
 - 3. Do not perform additional checkout work unless directed by the Engineer.
- E. Verify scaling of all devices from minimum to maximum output/range.
- F. Document all debugging issues, fix until the operation is satisfactory, verify and obtain approval of the Engineer/ OWNER.

3.03 CONTROL LOOP TUNING TESTS

- A. Complete loop checkout and problem correction prior to loop testing.
- B. Tune regulatory control loops to produce stable control. Use a loop tuning software program to document loop performance.
 - 1. For conventional control loops for PI and PID control, use minimum ITAE (Integral of Time and Absolute Error) criteria with overshoot constrained to 10 percent unless otherwise directed by the Engineer.
 - 2. Provide reduced gains or filtering to minimize unnecessary output activity to electric actuators as directed by the Engineer.
 - 3. Adjust input scan time or time intervals between controller calculations as necessary to produce stable control.
 - 4. Tune cascaded controllers similar to the above with the inner loop tuned first while the outer loop is off or inactive.
- C. Derive initial tuning parameters from open loop tests. Make final tuning parameter adjustments based on closed loop tests.
- D. Operate tuned loops for a minimum of 24 hours prior to control strategy testing.

3.04 CONTROL STRATEGY TESTS

- A. Submit Control Strategy Test Plan for approval and use during test. Documentation shall include a sequence of all tests for each equipment individually and an overall startup and shut down operation. Upon approval of the test plan, schedule with Engineer and Owner for conducting the Control Strategy Test at site.
- B. Fully test control strategies to ensure specified operation. Include the following:
 - 1. Sequences.
 - 2. Alternate control modes.

3. Dynamic gain adjustments.
 4. Contingency responses to device failures, where possible.
 5. Display and keyboard interaction.
 6. Messages.
- C. Prior to use on the process equipment, compare strategies with approved submittals to verify that as-built linkages and logic agree with the documentation. Note and correct discrepancies.
- D. Test as much of the logic as possible for process equipment. It may not be possible to test all logic due to operational constraints.
- E. Annotate changes made during testing on the documentation to reflect final as-built conditions.

3.05 FUNCTION TESTS

- A. Test functions of subsystems to verify that the subsystem has been installed and is operational. Test functions that apply to the subsystem being tested.
- B. Fully test operator station functions. Include the following:
1. Process control displays and linkages.
 2. User entry functions.
 3. Alarm and event handling. Generate or simulate alarm conditions to test.
 4. Other specified functions for the stations.
- C. Test data handling and access functions. Use live data and include the following:
1. Plant-wide database.
 2. Historical data collection and storage, retrieval, and correction at both SCADA Servers.
 3. Historical trending.
 4. Report generation and printing.
 5. Other specified data handling functions.
- D. Demonstrate the following support and maintenance functions:
1. System status displays and use.

2. Diagnostics.
 3. Power fail/restart.
 4. Other specified functions.
- E. Data acquisition tests shall include the following:
1. Plant Control System data acquisition via the in-plant PLC fiber optic Ethernet data highway.
 2. Alarm/event handling.

3.06 INTEGRATED SYSTEM TEST

- A. The integrated system tests may only begin after other testing specified in this section has been completed and test results submitted.
- B. Perform integrated system testing to verify the operation and performance of the complete, integrated control system.
1. Begin integrated system testing after other field tests have been completed.
 2. Conduct the test for two calendar weeks, 24 hours per day.
 3. Provide full-time, on-site assistance during business days and within four hours after call-in for the test duration.
 4. The Engineer will monitor and participate in the test.
- C. Include the following:
1. Data communication, both normal and failure modes.
 2. Fully loaded system response times.
 3. Other system operations the Engineer may elect to perform.
- D. Correct deficiencies within 24 hours of notice. If deficiencies remain uncorrected at the end of the test period, the test period will be extended on a day-to-day basis until specified operation can be demonstrated.

END OF SECTION

GOLDEN GATE MPS I/O TABLE

| NO | SHEET # | DESCRIPTION | TAG | TYPE | SIGNAL | RANGE / OFF STATUS | UNITS / ON STATUS | FIELD WIRING DATA | | NOTES |
|----|---------|---|---------|------|----------|--------------------|-------------------|---------------------------------------|---------------|-----------------------|
| | | | | | | | | FIELD ISA SIGNAL SOURCE / DESIGNATION | CONTROL PANEL | |
| 1 | | | | | | | | | | |
| | | INFLUENT FLOW | FIR-100 | AI | ETHERNET | 0-2500 | GPM | FE/FIT-100 | MPS-CP-1 | |
| | | MOV NO.1 NOT IN REMOTE | EA-100 | DI | HARDWIRE | ALARM | IN REMOTE | MOV NO.1 | MPS-CP-1 | |
| | | MOV NO.1 OPEN COMMAND | ZCO-100 | DO | HARDWIRE | - | OPEN | MOV NO.1 | MPS-CP-1 | |
| | | MOV NO.1 CLOSE COMMAND | ZCC-100 | DO | HARDWIRE | - | CLOSE | MOV NO.1 | MPS-CP-1 | |
| | | MOV NO.1 OPEN FEEDBACK | ZIO-100 | DI | HARDWIRE | - | OPENED | MOV NO.1 | MPS-CP-1 | |
| | | MOV NO.1 CLOSE FEEDBACK | ZIC-100 | DI | HARDWIRE | - | CLOSED | MOV NO.1 | MPS-CP-1 | |
| | | MOV NO.1 FAULT | YA-100 | DI | HARDWIRE | NORMAL | ALARM | MOV NO.1 | MPS-CP-1 | |
| | | MOV NO.2 NOT IN REMOTE | EA-110 | DI | HARDWIRE | ALARM | IN REMOTE | MOV NO.2 | MPS-CP-1 | |
| | | MOV NO.2 FAULT | YA-110 | DI | HARDWIRE | NORMAL | ALARM | MOV NO.2 | MPS-CP-1 | |
| | | MOV NO.2 POSITION COMMAND | ZIC-110 | AO | HARDWIRE | 0-100 | % | MOV NO.2 | MPS-CP-1 | |
| | | MOV NO.2 POSITION FEEDBACK | ZIR-110 | AO | HARDWIRE | 0-100 | % | MOV NO.2 | MPS-CP-1 | |
| | | INFLUENT PRESSURE | PIC-100 | AI | HARDWIRE | -14.7 TO 150 | PSI | PIT-100 | MPS-CP-1 | |
| | | INFLUENT PRESSURE | PIC-100 | AI | HARDWIRE | -14.7 TO 150 | PSI | PIT-101 | DIESEL PUMP | |
| | | PUMP NO.1 NOT IN AUTO | EA-101 | DI | HARDWIRE | ALARM | IN REMOTE | DIESEL PUMP | MPS-CP-1 | |
| | | PUMP NO.1 RUNNING | YIR-101 | DI | HARDWIRE | RUNNING | - | DIESEL PUMP | MPS-CP-1 | |
| | | PUMP NO.1 FAULT | YA-101 | DI | HARDWIRE | FAULT | - | DIESEL PUMP | MPS-CP-1 | |
| | | PUMP NO.1 FUEL LOW | LLA-101 | DI | HARDWIRE | NORMAL | ALARM | DIESEL PUMP | MPS-CP-1 | |
| | | PUMP NO.1 FUEL LEAK | LSA-101 | DI | HARDWIRE | NORMAL | ALARM | DIESEL PUMP | MPS-CP-1 | |
| | | PUMP NO.1 FUEL LEVEL | LIR-101 | AI | HARDWIRE | 0-100 | % | DIESEL PUMP | MPS-CP-1 | |
| | | PUMP NO.2 NOT IN REMOTE | EA-102 | DI | ETHERNET | ALARM | IN REMOTE | PUMP NO.2 VFD | MPS-CP-1 | |
| | | PUMP NO.2 START/STOP COMMAND | YC-102 | DO | ETHERNET | START | STOP | PUMP NO.2 VFD | MPS-CP-1 | |
| | | PUMP NO.2 REMOTE RESET | HS-102 | DO | HARDWIRE | - | RESET | PUMP NO.2 VFD | MPS-CP-1 | |
| | | PUMP NO.2 RUNNING | YIR-102 | DI | ETHERNET | RUNNING | - | PUMP NO.2 VFD | MPS-CP-1 | |
| | | PUMP NO.2 SPEED COMMAND | SCR-102 | AO | ETHERNET | 0-60 | HZ | PUMP NO.2 VFD | MPS-CP-1 | |
| | | PUMP NO.2 SPEED FEEDBACK | SIR-102 | AI | ETHERNET | 0-60 | HZ | PUMP NO.2 VFD | MPS-CP-1 | |
| | | PUMP NO.2 FAULT | YA-102 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.2 VFD | MPS-CP-1 | |
| | | PUMP NO.2 MOTOR HIGH TEMP | THA-102 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.2 VFD | MPS-CP-1 | |
| | | PUMP NO.2 NO FLOW | FLA-102 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.2 VFD | MPS-CP-1 | |
| | | PUMP NO.2 OVERLOADED | JHA-102 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.2 VFD | MPS-CP-1 | |
| | | PUMP NO.2 UNDERLOADED | JLA-102 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.2 VFD | MPS-CP-1 | |
| | | PUMP NO.2 HIGH MOTOR TEMPERATURE SWITCH | | DI | HARDWIRE | - | - | TSH-102 | PUMP NO.2 VFD | FIELD I/O TO PUMP VFD |
| | | PUMP NO.2 DISCONNECT OPEN | | DI | HARDWIRE | - | - | PUMP NO.2 DISCONNECT | PUMP NO.2 VFD | FIELD I/O TO PUMP VFD |
| | | PUMP NO.2 CHECK VALVE LIMIT SWITCH | | DI | HARDWIRE | - | - | ZS-102 | PUMP NO.2 VFD | FIELD I/O TO PUMP VFD |
| | | PUMP NO.3 NOT IN REMOTE | EA-103 | DI | ETHERNET | ALARM | IN REMOTE | PUMP NO.3 VFD | MPS-CP-1 | |
| | | PUMP NO.3 START/STOP COMMAND | YC-103 | DO | ETHERNET | START | STOP | PUMP NO.3 VFD | MPS-CP-1 | |
| | | PUMP NO.3 REMOTE RESET | HS-103 | DO | HARDWIRE | - | RESET | PUMP NO.3 VFD | MPS-CP-1 | |
| | | PUMP NO.3 RUNNING | YIR-103 | DI | ETHERNET | RUNNING | - | PUMP NO.3 VFD | MPS-CP-1 | |
| | | PUMP NO.3 SPEED COMMAND | SCR-103 | AO | ETHERNET | 0-60 | HZ | PUMP NO.3 VFD | MPS-CP-1 | |
| | | PUMP NO.3 SPEED FEEDBACK | SIR-103 | AI | ETHERNET | 0-60 | HZ | PUMP NO.3 VFD | MPS-CP-1 | |
| | | PUMP NO.3 FAULT | YA-103 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.3 VFD | MPS-CP-1 | |
| | | PUMP NO.3 MOTOR HIGH TEMP | THA-103 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.3 VFD | MPS-CP-1 | |
| | | PUMP NO.3 NO FLOW | FLA-103 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.3 VFD | MPS-CP-1 | |
| | | PUMP NO.3 OVERLOADED | JHA-103 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.3 VFD | MPS-CP-1 | |
| | | PUMP NO.3 UNDERLOADED | JLA-103 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.3 VFD | MPS-CP-1 | |
| | | PUMP NO.3 HIGH MOTOR TEMPERATURE SWITCH | | DI | HARDWIRE | - | - | TSH-103 | PUMP NO.2 VFD | FIELD I/O TO PUMP VFD |
| | | PUMP NO.3 DISCONNECT OPEN | | DI | HARDWIRE | - | - | PUMP NO.3 DISCONNECT | PUMP NO.2 VFD | FIELD I/O TO PUMP VFD |
| | | PUMP NO.3 CHECK VALVE LIMIT SWITCH | | DI | HARDWIRE | - | - | ZS-103 | PUMP NO.2 VFD | FIELD I/O TO PUMP VFD |
| | | PUMP NO.4 NOT IN REMOTE | EA-104 | DI | ETHERNET | ALARM | IN REMOTE | PUMP NO.4 VFD | MPS-CP-1 | |
| | | PUMP NO.4 START/STOP COMMAND | YC-104 | DO | ETHERNET | START | STOP | PUMP NO.4 VFD | MPS-CP-1 | |
| | | PUMP NO.4 REMOTE RESET | HS-104 | DO | HARDWIRE | - | RESET | PUMP NO.4 VFD | MPS-CP-1 | |
| | | PUMP NO.4 RUNNING | YIR-104 | DI | ETHERNET | RUNNING | - | PUMP NO.4 VFD | MPS-CP-1 | |
| | | PUMP NO.4 SPEED COMMAND | SCR-104 | AO | ETHERNET | 0-60 | HZ | PUMP NO.4 VFD | MPS-CP-1 | |
| | | PUMP NO.4 SPEED FEEDBACK | SIR-104 | AI | ETHERNET | 0-60 | HZ | PUMP NO.4 VFD | MPS-CP-1 | |

| NO | SHEET # | DESCRIPTION | TAG | TYPE | SIGNAL | RANGE / OFF STATUS | UNITS / ON STATUS | FIELD WIRING DATA | | NOTES |
|----|---------|--|---------|------|----------|--------------------|-------------------|---------------------------------------|---------------|----------------------------------|
| | | | | | | | | FIELD ISA SIGNAL SOURCE / DESIGNATION | CONTROL PANEL | |
| | | PUMP NO.4 FAULT | YA-104 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.4 VFD | MPS-CP-1 | |
| | | PUMP NO.4 MOTOR HIGH TEMP | THA-104 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.4 VFD | MPS-CP-1 | |
| | | PUMP NO.4 NO FLOW | FLA-104 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.4 VFD | MPS-CP-1 | |
| | | PUMP NO.4 OVERLOADED | JHA-104 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.4 VFD | MPS-CP-1 | |
| | | PUMP NO.4 UNDERLOADED | JLA-104 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.4 VFD | MPS-CP-1 | |
| | | PUMP NO.4 HIGH MOTOR TEMPERATURE SWITCH | | DI | HARDWIRE | - | - | TSH-104 | PUMP NO.4 VFD | FIELD I/O TO PUMP VFD |
| | | PUMP NO.4 DISCONNECT OPEN | | DI | HARDWIRE | - | - | PUMP NO.4 DISCONNECT | PUMP NO.4 VFD | FIELD I/O TO PUMP VFD |
| | | PUMP NO.4 CHECK VALVE LIMIT SWITCH | | DI | HARDWIRE | - | - | ZS-104 | PUMP NO.4 VFD | FIELD I/O TO PUMP VFD |
| | | PUMP NO.5 NOT IN REMOTE | EA-105 | DI | ETHERNET | ALARM | IN REMOTE | PUMP NO.5 VFD | MPS-CP-1 | |
| | | PUMP NO.5 START/STOP COMMAND | YC-105 | DO | ETHERNET | START | STOP | PUMP NO.5 VFD | MPS-CP-1 | |
| | | PUMP NO.5 REMOTE RESET | HS-105 | DO | HARDWIRE | - | RESET | PUMP NO.5 VFD | MPS-CP-1 | |
| | | PUMP NO.5 RUNNING | YIR-105 | DI | ETHERNET | RUNNING | - | PUMP NO.5 VFD | MPS-CP-1 | |
| | | PUMP NO.5 SPEED COMMAND | SCR-105 | AO | ETHERNET | 0-60 | HZ | PUMP NO.5 VFD | MPS-CP-1 | |
| | | PUMP NO.5 SPEED FEEDBACK | SIR-105 | AI | ETHERNET | 0-60 | HZ | PUMP NO.5 VFD | MPS-CP-1 | |
| | | PUMP NO.5 FAULT | YA-105 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.5 VFD | MPS-CP-1 | |
| | | PUMP NO.5 MOTOR HIGH TEMP | THA-105 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.5 VFD | MPS-CP-1 | |
| | | PUMP NO.5 NO FLOW | FLA-105 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.5 VFD | MPS-CP-1 | |
| | | PUMP NO.5 OVERLOADED | JHA-105 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.5 VFD | MPS-CP-1 | |
| | | PUMP NO.5 UNDERLOADED | JLA-105 | DI | ETHERNET | NORMAL | ALARM | PUMP NO.5 VFD | MPS-CP-1 | |
| | | PUMP NO.5 HIGH MOTOR TEMPERATURE SWITCH | | DI | HARDWIRE | - | - | TSH-105 | PUMP NO.5 VFD | FIELD I/O TO PUMP VFD |
| | | PUMP NO.5 DISCONNECT OPEN | | DI | HARDWIRE | - | - | PUMP NO.5 DISCONNECT | PUMP NO.5 VFD | FIELD I/O TO PUMP VFD |
| | | PUMP NO.5 CHECK VALVE LIMIT SWITCH | | DI | HARDWIRE | - | - | ZS-105 | PUMP NO.5 VFD | FIELD I/O TO PUMP VFD |
| | | *** CONTROL PANEL UPS, TYP OF ALL VENDOR AND INTEGRATOR SUPPLIED PANELS*** | | | | | | | | |
| | | CONTROL PANEL HIGH TEMP | | DI | HARDWIRE | NORMAL | ALARM | TSH-901 | MPS-CP-1 | |
| | | CONTROL PANEL SURGE FAIL | | | HARDWIRE | NORMAL | ALARM | SURGE | MPS-CP-1 | |
| | | UPS MAIN OPERATION | | DI | ETHERNET | ACTIVE | INACTIVE | UPS | MPS-CP-1 | |
| | | UPS BATTERY MODE | | DI | ETHERNET | ACTIVE | INACTIVE | UPS | MPS-CP-1 | |
| | | UPS DC OK | | DI | ETHERNET | ACTIVE | INACTIVE | UPS | MPS-CP-1 | |
| | | UPS BOOST | | DI | ETHERNET | ACTIVE | INACTIVE | UPS | MPS-CP-1 | |
| | | UPS INPUT VOLTAGE | | DI | ETHERNET | 0-30 | VDC | UPS | MPS-CP-1 | |
| | | UPS INPUT CURRENT | | DI | ETHERNET | 0-10 | AMP | UPS | MPS-CP-1 | CONFIRM RANGE WITH INSTALLED UPS |
| | | UPS OUTPUT VOLTAGE | | DI | ETHERNET | 0-30 | VDC | UPS | MPS-CP-1 | |
| | | UPS OUTPUT CURRENT | | DI | ETHERNET | 0-10 | AMP | UPS | MPS-CP-1 | |
| | | UPS WARNING | | DI | ETHERNET | NORMAL | WARNING | UPS | MPS-CP-1 | |
| | | UPS ALARM | | DI | ETHERNET | NORMAL | ALARM | UPS | MPS-CP-1 | |
| | | OTHER AVAILABLE DATA REQUIRED BY CLIENT | | | | | | UPS | MPS-CP-1 | |

END

FIELD INSTRUMENT SCHEDULE

| Instrument Description | Tag | Type | Units | Range | Setpoint | Size | Manufacturer | Model Number | Transmitter # | Power Supply | Output | Sheet # | Notes |
|---|------------|--------------|-------|-----------|----------|----------|--------------|--------------|-------------------|--------------|-------------|---------|---|
| INFLUENT FLOW | FE/FIT-100 | MAGNETIC | GPM | 0-2500 | - | 12-INCH | E+H | PROMAG W400 | REMOTE W/ DISPLAY | 120 VAC | ETHERNET/IP | I-201 | 316L BULLET ELECTRODE, POLY LINER, 150# STEEL FLG, SS GROUND RINGS, AL COATED TRANSMITTER, 0.5% CAL |
| INFLUENT PRESSURE | PIT-100 | TRANSDUCER | PSI | -14.7-150 | - | 1/2-INCH | ROSEMOUNT | 3051 | | LOOP | 4-20 mADC | I-201 | 316SS WETTED PARTS, GAUGE PRESSURE, PROVIDE 316SS ANNULAR FLOW THRU SEAL |
| INFLUENT PRESSURE | PIT-101 | TRANSDUCER | PSI | -14.7-150 | - | 1/2-INCH | ROSEMOUNT | 3051 | | LOOP | 4-20 mADC | I-201 | 316SS WETTED PARTS, GAUGE PRESSURE, PROVIDE 316SS ANNULAR FLOW THRU SEAL |
| PUMP NO. 1 SUCTION PRESSURE GAUGE | PI-101A | BOURDON TUBE | PSI | 30 | - | 1/2-INCH | ASHCROFT | 1009 | - | - | 4.5" FACE | I-201 | 316SS TUBE AND SOCKET, SILICONE FILLED, PROVIDE 316SS ANNULAR FLOW THRU SEAL |
| PUMP NO. 1 DISCHARGE PRESSURE GAUGE | PI-101B | BOURDON TUBE | PSI | 60 | - | 1/2-INCH | ASHCROFT | 1009 | - | - | 4.5" FACE | I-201 | 316SS TUBE AND SOCKET, SILICONE FILLED, PROVIDE 316SS ANNULAR FLOW THRU SEAL |
| PUMP NO. 2 SUCTION PRESSURE GAUGE | PI-102A | BOURDON TUBE | PSI | 30 | - | 1/2-INCH | ASHCROFT | 1009 | - | - | 4.5" FACE | I-201 | 316SS TUBE AND SOCKET, SILICONE FILLED, PROVIDE 316SS ANNULAR FLOW THRU SEAL |
| PUMP NO. 2 DISCHARGE PRESSURE GAUGE | PI-102B | BOURDON TUBE | PSI | 60 | - | 1/2-INCH | ASHCROFT | 1009 | - | - | 4.5" FACE | I-201 | 316SS TUBE AND SOCKET, SILICONE FILLED, PROVIDE 316SS ANNULAR FLOW THRU SEAL |
| PUMP NO. 2 SUCTION PRESSURE GAUGE | PI-102A | BOURDON TUBE | PSI | 30 | - | 1/2-INCH | ASHCROFT | 1009 | - | - | 4.5" FACE | I-201 | 316SS TUBE AND SOCKET, SILICONE FILLED, PROVIDE 316SS ANNULAR FLOW THRU SEAL |
| PUMP NO. 2 DISCHARGE PRESSURE GAUGE | PI-102B | BOURDON TUBE | PSI | 60 | - | 1/2-INCH | ASHCROFT | 1009 | - | - | 4.5" FACE | I-201 | 316SS TUBE AND SOCKET, SILICONE FILLED, PROVIDE 316SS ANNULAR FLOW THRU SEAL |
| General Notes | | | | | | | | | | | | | |
| PROCESS FLUID: WASTEWATER TREATMENT PLANT, TEMP - 30 -100 DEG F | | | | | | | | | | | | | |
| 1. ALL WETTED PARTS SHALL BE COMPATIBLE WITH THE PROCESS FLUID. | | | | | | | | | | | | | |
| 2. INSTALL ALL INSTRUMENT PER MANUFACTURES RECOMMENDATIONS AND INSTALLATION DETAILS PER CONTRACT DRAWINGS. | | | | | | | | | | | | | |
| 3. FACTORY CALIBRATE ALL INSTRUMENTS PRIOR TO SHIPPING TO PROJECT SITE. IN ADDITION TO FACTORY CALIBRATION ALL PROCESS PROBES REQUIRE CORRELATION/MATRIX CORRECTION TO ACTUAL FIELD CONDITIONS. | | | | | | | | | | | | | |
| 4. PROVIDE REMOTE TRANSMITTERS / DISPLAYS FOR ALL INSTRUMENTS LOCATED HIGHER THAN 5 FEET FROM FINISHED FLOOR OR GRADE. | | | | | | | | | | | | | |
| 5. INSTRUMENT SPECIFIC NOTES APPLICABLE TO ALL SIMILAR INSTRUMENTS. | | | | | | | | | | | | | |

SCOPE OF WORK

All services provided to Collier County through this bid shall be performed solely by the County's contractor; no subcontractor or substitute performance will be accepted without prior approval by Collier County. Fiber optic terminations are "furnish and install" items and therefore shall be inclusive of all labor and equipment costs. The contractor shall notify the contracting agency in writing prior to commencement of work if substitute performance shall be used, and provide the company name of the subcontractor and the name and telephone number of an appropriate contact person for the subcontractor. The subcontractor shall be licensed to perform work on Collier County and State of Florida rights-of-way. The contractor shall invoice Collier County for the subcontractor's work according to the prices provided on this bid.

Service Type 1: Major Fiber Optic Installation

For the purpose of this bid, a major fiber optic installation shall be defined as any installation project for which a one mile (5280 linear feet) or more quantity of total fiber optic cable is required, without regard to the number of locations specified, inclusive of amounts coiled in pull boxes or other storage areas. Contractors may be requested to perform fiber optic splices and/or fiber optic terminations in specified locations for this type of work. A major fiber optic installation also may or may not require the contractor to install communications pull boxes or underground conduit, either by trenching or directional bore.

The Collier County agency requiring a major fiber optic installation shall notify the contractor no fewer than thirty (30) calendar days prior to expectation of commencement of work to coordinate project planning, installation schedules, and completion deadline. Notice to proceed shall be in the form of a Purchase Order, and no work shall commence until one has been issued to the contractor. The contractor shall schedule and complete daily work on weekdays between normal business hours (8:00 am to 5:00 pm). If, however, the contractor performs work outside of this schedule for the purpose of completing work of this service type, bid items shall be invoiced at the normal rate; no overtime or premium prices shall apply for major fiber optic installations.

Service Type 2: Minor Fiber Optic Installation

A minor fiber optic installation shall be defined as any installation project for which less than one mile of total fiber optic cable is required, without regard to the number of locations specified, inclusive of amounts coiled in pull boxes or other storage areas. Contractors may be requested to perform fiber optic splices and/or fiber optic terminations in specified locations for this type of work. A minor fiber optic installation also may or may not require the contractor to install communications pull boxes or underground conduit, either by trenching or directional bore.

The Collier County agency requiring a minor fiber optic installation shall notify the contractor no fewer than 14 calendar days prior to expectation of commencement of work to coordinate project planning and installation schedules, and completion deadline. Notice to proceed shall be in the form of a Purchase Order, and no work shall commence until one has been issued to the contractor. The contractor shall endeavor to schedule and complete daily work on weekdays between normal business hours (8:00 am to 5:00 pm). If, however, the contractor performs work outside of this schedule for the purpose of completing work of this service type, bid items shall be invoiced at the normal rate; no overtime or premium prices shall apply for minor fiber optic installations.

Service Type 3: Routine Maintenance

Routine maintenance shall be defined as any maintenance or repair of fiber optic cables or facilities which are anticipated and scheduled in advance of need, or can be planned to take place during normal business hours within three business days of need. Routine maintenance may include splicing fiber optic cable, modifying fiber optic terminations, troubleshooting communications interruptions by OTDR test.

The Collier County agency requiring routine maintenance or repair shall notify the contractor no fewer than three business days prior to expectation of commencement of work to coordinate project planning and installation schedules, and completion deadline. Notice to proceed shall be in the form of a Purchase Order, and no work shall commence until one has been issued to the contractor. The contractor shall endeavor to schedule and complete routine maintenance or repairs on weekdays between normal business hours (8:00 am to 5:00 pm). If, however, the contractor performs work outside of this schedule for the purpose of completing work of this service type, bid items shall be invoiced at the normal rate; no overtime or premium prices shall apply for

routine maintenance.

Service Type 4: Urgent Repair

Urgent repair shall be defined as any maintenance or repair to a critical facility which requires a contractor's response and be onsite within two (2) hours from notification, and may require that services be performed during or after regular business hours. The Collier County agency requiring an urgent fiber optic repair shall notify the contractor of the need for immediate repair and issue a Purchase Order to the contractor. If the contractor is unable to mobilize to the repair location within two hours of first contact, the contractor shall notify the relevant County project manager immediately, so an alternate contractor can be contacted for the repair. The alternate contractor will also be responsible to respond and be onsite within two (2) hours from notification, and repairs undertaken and completed in a timely fashion, as requested by the County's representative.

The need for urgent fiber optic repairs is unpredictable by nature. Since it is often critical to restore fiber optic communication quickly an urgent flat rate fee may be assessed with this service. Note that only an urgent repair request may be invoiced at a flat rate fee above standard bid prices; all other bid prices shall remain in effect regardless of the type of work order issued.

Specifications

Contractors are advised that work shall be completed to (1) engineering plan requirements, (2) Collier County specification, or (3) FDOT specification, whichever is deemed sufficiently stringent by the contracting agency. At no time shall a contractor proceed with the lesser of any standard or specification unless that determination has been approved by Collier County.

All work is subject to inspection by an authorized Collier County construction inspector. Collier County retains the right to hold back payment on any contractor invoice for work that does not meet acceptance criteria and is not corrected by the contractor to the County's specifications. The Collier County construction inspector shall have the authority to make final determination on whether workmanship, material, and/or the final work product satisfy the specifications.

Pre- and Post-Activity Requirements

Contractor/Sub-Contractor Requirements:

- Any subcontractor hired by the Awardee for services under this contract will be provided on a strictly cost plus 15% arrangement only. Documentation of awardees' subcontractor costs must be provided with actual invoices from the subcontractor.
- Respondents shall be firms, corporations, individuals or partnerships normally engaged in the deployment, maintenance and repairs of fiber optics at the municipal, county or state level.
- Respondents shall have one or more of the following certifications
 - Registered Communications Distribution Designer (RCDD)
 - IMSA Fiber Optics for Traffic Stem Technician 2
 - IMSA Traffic Signal Technician Level 2
 - IMSA Traffic Signal Technician Level 3

TRAFFIC CONTROL: When work is required alongside City streets, the Respondent and any subcontractor or independent contractor retained by the Respondent shall take adequate precautions to warn motorists of the work and to place flagmen and/or other controls to ensure the continued safe and orderly flow of traffic through the work site. Traffic control patterns and devices shall be erected in accordance with the most recent edition of the Manual on Uniform Traffic Control Devices (MUTCD).

RESTORATION OF PUBLIC AND PRIVATE PROPERTY: All public and private property affected by the work shall be restored to its original condition after the Work is substantially complete. Restoration shall include, but not be limited to, the following: removal of spoils and debris, repair of ruts, and replanting of grass or landscaping. The Contractor and any subcontractor or independent contractor retained by the Contractor shall make a reasonable effort to preserve and replant landscaping removed from within the limits of the City's easements. However, even if after taking prudent care the landscaping cannot be salvaged, the Contractor shall not be obligated to replace same.

A right-of-way permit is required for all new installations within State- or County-owned right of way, whether the activity is an

installation of fiber optic cable in an existing conduit, an installation of conduit and pull boxes alone, or an installation of fiber optic cable, conduit and pull boxes. The right-of-way permit shall be obtained prior to commencing any work. The contractor shall bear all costs associated with obtaining required right-of-way permits; the permit fee shall be invoiced to the requesting County agency. Routine maintenance and repair activities do not require a right-of-way permit; however, contractors are encouraged to notify the County Right-of-Way Permitting office (239-252-5767) prior to commencing any scheduled routine maintenance that may result in lane closures and/or sidewalk closures for any duration of time, or for any work which will require vehicles or equipment to be in the public right-of-way for four hours or more. At no time shall the contractor assume that their activities are covered under a "Countywide right-of-way permit."

When performing work under a Collier County or FDOT right-of-way permit, the contractor may not simultaneously perform work in the same service area for the benefit of any non-Collier-County BCC public agency or any private entity without a possessing a separate, current permit to do so.

The contractor shall contact Sunshine One Call (811) to obtain utility locates two full business days prior to beginning any scheduled underground work. For urgent work the contractor is also expected to contact Sunshine One Call as soon as possible. The contractor shall be responsible for any underground facility damaged by the contractor's or subcontractor's activities that was properly marked by its owner. The contractor shall comply with Chapter 556, Florida Statutes, "Underground Facility Damage Prevention and Safety."

It is anticipated that local road and utility construction projects will be in progress during the life of this contract. The contractor shall be required to coordinate his construction operations with those of other contractors doing work for the State of Florida, Collier County and City of Naples governments. This coordination includes on-site cooperation and scheduling of work to minimize or eliminate any rework or duplication of effort.

The contractor shall be present at all pre-activity and post-completion walkthroughs if required by the contracting agency. If required to do so by the contracting agency, the contractor shall notify the contracting agency 72 hours prior to expected completion of Work Order activities to schedule a pre-acceptance inspection.

[a] Fiber Optic Cable: Installation and Removal

All fiber optic cable shall be single mode. Fiber optic cable shall be shipped on reels of marked, continuous length, and shall be provided from the same manufacturer. The contractor shall test all fiber optic cable prior to installation. If the cable fails to meet specification requirements, the contractor shall replace the entire reel at no additional cost. The contractor may omit the pre-installation test if the manufacturer has tested the fiber optic cable on the reel prior to shipment and provides for inspection an OTDR trace and table of attenuations for all strands.

Collier County agencies and other local utility-owning entities have adopted a system to visually identify the owner of a given run of fiber optic cable by color-coding the external jacket of the fiber optic cable. All fiber optic cabling requested by the Collier County Information Technology Department shall have a stripe, yellow in color, along the entire length of the cable, and shall be marked "Collier County BCC IT" at three-foot intervals. All fiber optic cabling requested by the Collier County Traffic Operations Department shall have a stripe, green in color, along the entire length of cable, and shall be marked "Collier County BCC Traffic" at three-foot intervals. Any fiber optic cable installed by the contractor which does not conform to this color-coding and identification scheme shall be rejected by the agency, and shall require the contractor to remove all non-conforming cable at his own expense and replace it with fiber optic cable as specified in this bid.

Fiber optic cable shall be pulled in place by hand or by an approved pulling machine equipped with a monitored or recording tension-meter. The contractor shall not exceed the manufacturer's recommended pulling tension for the cable.

All fiber optic cable runs shall be installed in conduit with a 12-gauge copper locate wire with blue shielding if one is not already present in the conduit.

A minimum of one-hundred (100) feet of spare fiber optic cable shall be coiled in every communications pull box to provide slack in the run and to allow for future maintenance. Where a splice enclosure is present, the spare fiber shall be one-hundred (100) feet on either side of the splice, for a total of 200 feet of slack at each splice box. No fiber optic cable shall be bent at a radius less than

its manufacturer-recommended bending radius.

All fiber optic cable shall be clearly labeled at all storage points utilizing a durable, weatherproof tag or marker affixed to the cable. The label shall describe the cardinal direction (N, E, S, or W) that the fiber run exits to, as well as any other useful information (such as roadway name, termination point) that will assist in visually identifying fiber optic cable runs in the future.

The strand count for fiber optic cable(s) will be specified by Collier County at the time of issuing Notice to Proceed.

All fiber installed shall be tested by OTDR following installation at 1310 and 1550 nanometer wavelengths. The contractor shall use a bare fiber adapter to test any fibers that are not terminated at the time of installation. The contractor shall investigate any discontinuities greater than 0.2 dB per 300 feet, and repair or replace cable sections exceeding allowable attenuation at no cost to the contracting agency.

When removing fiber optic cable, the contractor shall record the measurement markings nearest to each end of the cable. Removal can be either by hand or by machine. Care shall be taken at the time of cable removal not to disturb or damage any fiber optic cables that may be remaining in the conduit and pull boxes. The contracting agency may request fiber optic cable removal as part of a relocation service, or because the fiber optic run is being put into disuse. The contractor shall exercise due care to preserve the condition of the cable if it is intended to be relocated. The contractor shall be responsible for damage to any cable designated to be left in place that was harmed during a removal operation.

[b] Fiber Optic Splicing

All splices shall be performed by the fusion method, by a machine equipped with a method for estimating the achieved splice loss. "Local Injection Detection" and "Core Alignment Loss Estimation" are the acceptable loss estimation methods. Only the buffer tube to be opened shall be accessed and only strands that will be spliced and put into use shall be cut. Splice loss shall not exceed a bi-directional average of 0.10 dB per splice for a complete fiber run or a maximum of 0.15 dB bi-directional average for any single splice at 1310 and 1550 nanometers. Splices which exceed allowable attenuation shall be replaced at no cost to the contracting agency.

All splices shall match fiber and buffer tube colors unless shown otherwise in plans or specified by the contracting agency. All drop cables spliced into a fiber optic cable run shall be of the same strand count as the underground cable, without regard to the number of splices or terminations requested. Drop cables shall be spliced to underground branch cables via mid span splice at the nearest pull box.

All splices shall be stored neatly in a splice tray and labeled for ease of future identification.

All splicing activity which results in planned or unplanned disruption of service on a network shall be completed, with service restored, within the same business day.

[c] Fiber Optic Termination: Installation and Modification

New terminations shall be performed such that all fiber optic cables, buffer tubes or strands are neatly routed, secured and terminated in a patch panel. Cable termination points shall include documentation regarding the identification, route and function of each fiber installed at a location.

Modification to existing terminations shall be performed such that sufficient slack is maintained for fiber strands receiving a modified connector. The contractor shall ensure that the condition of the patch panel following a termination modification remains neat, secure and accessible.

The contractor shall ensure that the attenuation in each connector at the patch panel and its associated splice does not exceed 0.5 dB. The contractor shall repair or replace all terminations that exceed allowable attenuation at no cost to the contracting agency.

Termination type shall be SC unless otherwise requested by the contracting agency.

[d] Fiber Optic Installation, Splicing and Termination Hardware

All fiber optic splicing and termination hardware furnished and installed through this bid shall be new and in working condition. When applicable, all hardware shall be of a manufacture listed in the State of Florida's most current Qualified Product List (QPL).

Underground splice enclosures shall be used to house all fiber optic splices that are performed at a pull box ("Tyco" or equivalent). The splice enclosure shall have adequate storage for splices, non-spiced fiber, and uncut buffer tubes. The splice enclosure shall be airtight to prevent water intrusion. Hinges and latches shall be stainless steel, and the enclosure shall not require specialized tools or equipment to open or close it. All splice enclosures shall provide space for future expansion equal to 100% of fiber optic cable capacity. Prior to ordering and installing underground splice enclosures, the contractor shall provide the contracting agency with a manufacturer's specification for approval by Collier County.

Splice trays shall be securely attached to and accessible from within the splice enclosure, providing adequate storage for the fiber optic cable. All splice trays shall be fitted with a cover and locking mechanism to hold the cover in place. Splice trays shall provide access to individual fibers without disrupting other fibers in the tray, and allow visible inspection of the fiber. The splice tray shall hold buffer tubes rigidly in place and protect fusion splices. The raceway of the splice tray shall accommodate the minimum bend radius of the fiber.

Buffer tube fan-out kits shall be installed when fiber optic cables are terminated. The kit shall be compatible for use with single mode fiber optic cable, and shall be color-coded to match the fiber optic color scheme. The fan-out kit shall support a minimum of 12 fiber strands.

Patch panels shall be compatible for use with single mode fiber optic cable. Patch panels shall be color-coded to match the fiber optic color scheme. The patch panel shall have a minimum of 12 SC type panel connectors. The dimensions of the patch panel shall not exceed 6.5 inches long by 5.5 inches wide by 1.5 inches deep, and shall be suitable for mounting within an approved cabinet at the field device location ("Corning" or equivalent). Prior to ordering and installing patch panels, the contractor shall provide the contracting agency with a manufacturer's specification for approval by Collier County.

Fiber optic connector panels shall provide a minimum of 12 SC type, bulkhead-mount coupling connectors. The contractor shall ensure that each coupling connector allows connection of a cable terminated on one side of the panel to a cable on the opposite side. Each bulkhead-mount coupling connector shall include a lock nut for mounting the connector in pre-drilled or pre-punched holes in the connector panel.

Three-sided vertical markers shall be orange in color with a black end cap, 72 inches long and 4 inches per side ("Rhino" or equivalent). The markers shall bear a vertical legend on each face of the post reading "WARNING: FIBER OPTIC." The markers shall have an anchoring system and be installed directly at a depth of 18 inches, one foot offset from buried conduit. The fill dirt shall be packed and tamped around the base of the marker. The contractor shall ensure that the marker installation is straight and visible from the edge of the roadway, and that a clear line of sight is maintained from one marker to the next. Prior to ordering markers, the contractor shall provide the contracting agency with a manufacturer's specification and legend copy for approval by Collier County.

Fiber optic patch cables shall be three meters long, single mode, with outside cladding that is yellow in color. The contracting agency shall specify to the contractor at the time of work order whether the patch cable shall be simplex or duplex, and shall also specify at the same time which connectors shall be required. All duplex patch cables shall have cladding that fully connects the two strands of the cable for a minimum of 90% of the length of the cable. At the time of installation, fiber optic patch cables shall be loosely looped and secured such that excess cable does not drape inside its enclosure or cabinet. The insertion loss of any patch cable shall not exceed 0.2 dB.

[e] OTDR Testing

The purpose of OTDR testing is for verification of fiber optic length and attenuation, and for troubleshooting and locating possible

fiber optic damage. The contractor may invoice Collier County for any OTDR testing done at a contracting agency's request, except for pre- and post-installation testing (see Section [a]). Testing done at the contractor's discretion for his own verification shall not constitute a billable activity.

The contractor shall use an Optical Time Domain Reflectometer that is calibrated for the index of refraction of the fiber optic cable to be tested. The only acceptable testing wavelengths shall be 1310 nanometers (recommended) and 1550 nanometers. The contractor shall use a pulse width no greater than 50 nanometers. A test shall consist of one sweep of one strand in a single direction. Collier County shall specify to the contractor at the time of work order issue which strands of a cable the contractor shall test, and in which direction(s) the test shall be performed.

The contractor shall provide the contracting agency with results of OTDR testing, e.g., traces for each fiber tested, plus a loss table showing details for each splice or termination tested as a deliverable for this activity.

[f] Conduit: Installation and Relocation

All conduit shall be high-density polyethylene (HDPE), orange in color. Where two conduits are joined, the joint shall be a solid coupling the same material as the conduit, as recommended by the conduit manufacturer, using adhesive if necessary to form a complete and durable seal between the internal surface of the coupling and the external surface of the conduit. At no time shall adhesive tape be used as a joining method. At no time shall an internal, reduction coupling be used.

All new conduit and relocated conduit shall be installed at a 30-inch depth from top of conduit to grade. All new conduit installations shall include a 12-gauge copper tracer wire with green shielding inside the full length of the conduit, plus a minimum of 24 inches of pull line on either open end of the conduit.

No horizontal or vertical conduit bends shall be at an angle less than the recommended bending radius of the fiber optic that will be installed inside it. Conduit being stubbed into a pull box shall be installed in a gradual sweep upward to the access point. At points where two conduits will meet at a 90-degree angle or less, the conduits shall sweep upward gradually to a pull box placed at the apex of the angle. All conduit stubs inside a pull box shall terminate within six inches of the bottom of the installed pull box lid with a bell end. The terminated conduit ends shall be protected from water ingress using a form-sealing material. Adhesive tape shall not be used to seal conduit openings.

All conduit shall be installed either by trenching or by directional bore. Saw-cutting of pavement shall not be permitted. All turf or planting areas in the right-of-way that are disturbed during conduit installation shall be restored by the contractor. All newly-installed conduit shall be blown or "rodded" before installing fiber optic cable, to clean the conduit run of loose debris.

If requested by the County's inspector, the contractor shall excavate windows along the newly-installed conduit trench to expose the conduit and joints for inspection.

When relocating a run of conduit containing fiber optic cable from one trench to another, the contractor shall feed out by hand sufficient slack from the fiber optic line to relocate the conduit without stretching or otherwise causing stress or permanent damage to the fiber optic cable. If sufficient slack does not exist on the fiber optic line to relocate the conduit to the proposed location with the cable inside, the contractor shall remove the fiber optic line as prescribed in Section [a] and relocate the empty conduit. If the condition of the conduit to be relocated shows cracks, breaks, or appears in any other way to be unfit for further use, the contractor shall immediately notify the contracting agency to inspect it to determine if the conduit will be replaced with a new run.

[g] Fiber Optic Pull Boxes and Fiber Optic Splice Boxes

Fiber optic pull boxes and splice boxes shall be H-20 rated, manufactured of heavy-duty composite material ("Quazite PG" or equivalent). Both the pull box or splice box and its lid shall be of a manufacture prescribed on the version of the State of Florida's Qualified Product List (QPL) that is most current at the time of installation. The minimum internal dimensions for a fiber optic pull box are: 24 inches wide by 36 inches long by 18 inches deep (24" x 36" x 18"). The minimum internal dimensions for a fiber optic splice box are: 30 inches wide by 48 inches long by 18 inches deep (30" x 48" x 18"). All pull and splice boxes shall be straight-sided and open-bottomed. Box lids shall be single-piece and skid resistant.

Prior to ordering and installing fiber optic pull boxes or fiber optic splice boxes, the contractor shall provide the contracting agency with a manufacturer's specification and cut sheet for approval by Collier County.

The area where a pull box or splice box is to be installed shall be excavated to a depth of no less than 30 inches. A bed of pea-rock or crushed stone 12 inches deep (minimum) and extended 4 inches wider than the outside length and width dimensions of the pull or splice box shall be poured prior to pull box placement to promote drainage. The pull box or splice box shall be installed such that the topmost rim of the box is at grade, and the bottom inside edge of the pull box rests entirely on the gravel bed. The contracting agency may adjust spacing of pull or splice boxes to ensure that the box is in a location that allows the lid to be as near to level as possible.

All new pull box or splice box installations shall include a 24-inch concrete apron extended all the way around the perimeter of the top edge of the pull box. The concrete shall be installed to a depth of four inches. A conductive metal rod not less than 5/8" diameter and 48 inches long shall be driven vertically into the ground within 3 inches of the inside edge of the pull box or splice box, leaving at least 10" of the rod exposed upward from the gravel base, for later attachment of tracer wire and locate equipment.

The tops of all box lids shall be integrally cast with the legend "COMMUNICATIONS."

Pull boxes shall be spaced a maximum of 1,000 feet apart, and within 20 feet of either side of every driveway opening, and within 10 linear feet of any fiber optic termination point. The contracting agency shall reserve sole determination whether spacing of pull boxes shall be less or more than the standard 1,000 feet apart.

Splice boxes shall be used wherever a splice enclosure will be present.

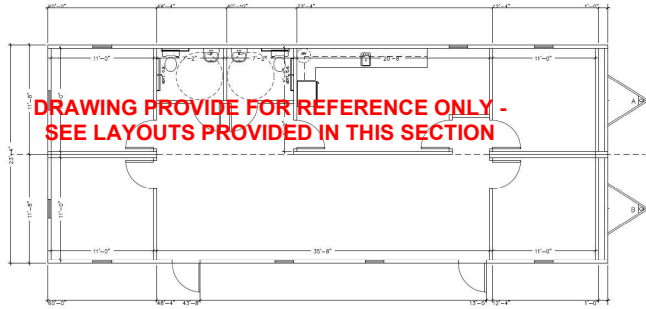
Service Type 5: Documentation

Collier County maintains documentation of its fiber optic network using, as-built plans, Google Earth, and Visio fiber optic diagrams. The contractor shall be required to submit all fiber network updates and changes to Collier County within (10) business days of project completion. Contractors will be responsible for including the cost (in their line item pricing) of providing documentation for third party as-built plans converted to Google Earth and to Visio Fiber Optic Diagrams formats for the County's use. Collier County shares fiber optic network resources between two distinct networks the Collier County Traffic Operations (CCTO) and the Collier County Information Technology (CCIT). Maintaining clearly defined, as-built plans, fiber optic diagrams, and Google Earth location information is paramount for maintenance of the fiber optic network. All work is to be documented and presented to the representative Collier County department requesting the fiber optic work. Any projects that involve splicing onto another departments fiber optic network requires said departments permission, as built plans, and Fiber Optic Diagrams showing which fiber buffers were spliced into.

[h] Labor

Contractors must furnish hourly rates for all labor in the categories stated in the Bid Schedule. Labor may be billed in quarter-hour increments. Collier County may request from the contractor a written estimate of labor hours required for a task prior to requesting certain services.

NO. 6 - Trailer Specifications



Model Year: 2024

Sq Feet: 1,440.00

| Qty | Description | Color/Location |
|-----|-------------|----------------|
|-----|-------------|----------------|

SPECIFICATIONS:

Quote Expiration:

****Please note that this quote is only valid for 30-days from issuance. Please call or contact a salesperson for an updated quotation if this quotation is later than 30-days(No Exceptions)****

Module Dimensions / Doublewide Base
 (2) 11'-8" x 60' Modules

Occupancy: Business

State/Code Requirements/Insignias
 IBC/FL

160 MPH Wind Speed

Destination:
 Fort Myers, FL.

1.00 Florida

CHASSIS:

120.00 96" On Center outriggers (UT12)

120.00 Outrigger with 95.5" I-Beam Spacing

"I"-Beam Will Be Sized As Required

Axle Quantity Will Be Calculated As Required
 (Recycled axles, an option for new axles is available upon request)

Select Tires
 (An option for new tires is available upon request)

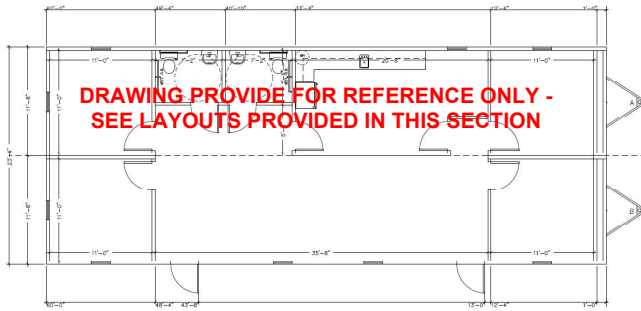
Hitches are Detachable

FLOOR

Bottom Board Material Has Nylon Impregnation

2" x 8" Floor Joist @ 16" O.C.

3/4" Plywood / Advantech Floor Sheathing/Decking



Model Year: 2024

Sq Feet: 1,440.00

| Qty | Description | Color/Location |
|-----|-------------|----------------|
|-----|-------------|----------------|

FLOOR

VCT {Vinyl Composite Tile} Installed Per The Print
 ****Thru-Out****

Manufacturer's standard is "Armstrong" brand VCT. If an alternate brand or a color that differs from manufacturer's standard color selections is chosen, an additional cost will be assessed.

WALL SECTION:

122.00 Interior Wall Height: 8'0"

1.00 Double Top-Plate On Exterior Walls

168.00 2" x 6" Exterior Wall Height: 8'0"

48.00 2" x 6" End-Wall Construction To The Roof Decking

5/8" VCG {Type "X" Gypsum}

Interior Trim Package: Standard Battens
 {UNLESS OTHERWISE NOTED}

412.00 4" VCB (Vinyl Cove Base)
 ****Thru-out****

ATTENTION: HURRICANE STRAPS NOT INSTALLED
 Please note that no hurricane tie-down straps will be included installed from the FSSI factory. Please see options if this is needed.

INTERIOR DOORS SECTION:

8.00 36" x 80" H.C. Flush Door w/ Steel Jamb
 {Includes Timely or Redi-Frames, Lever; Unless Otherwise Noted, Door Frame Will Be Painted The Standard Finish Color (Bronze) & door has imperial oak finish}

6.00 Passage Locks

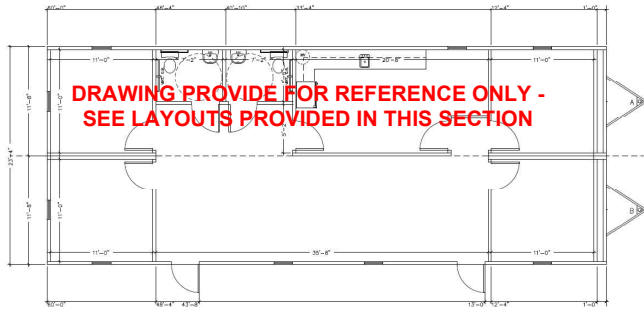
2.00 Privacy Locks for Restrooms

ROOF/CEILING SECTION:

Truss Spacing @ 16" O.C.

(UT12w) Box Truss (Double Or Single Box Peak)

Snow Load Only as Required



Model Year: 2024

Sq Feet: 1,440.00

| Qty | Description | Color/Location |
|-----|-------------|----------------|
|-----|-------------|----------------|

ROOF/CEILING SECTION:

Roof Load Only as Required

7/16" x 4 x 8 EPDM underlayment

Roof Covering: 45 mil. Black EPDM (DOUBLE WIDE)

9"peel & stick Black mate-line tape

1/2" Pre-Finished Sea-Spray Ceiling (Doublewide)

Ceiling Finish Is 8'0" Above Finished Floor

60.00 4-Layer 24" Ridge-Beam Construction:
 {This Beam Will Be Constructed From 4-Layers Of 3/4"
 Structural Grade Plywood Installed as Required And Fastened
 as Per Approved Fastening Schedule}

2.00 Power Gable Vent with Passive Gable Vent
 ****As required****

ATTENTION: HURRICANE STRAPS NOT INSTALLED
 Please note that no hurricane tie-down straps will be included
 installed from the FSSI factory. Please see options if this is
 needed.

PLUMBING SECTION:

2.00 Restroom Description: Single-Station Handicap RR

2.00 Standard Lavatory (Wall Mount Type)
 {Includes A Standard Faucet & Mirror}

2.00 Handicap Sink Protection - Sock for P-trap

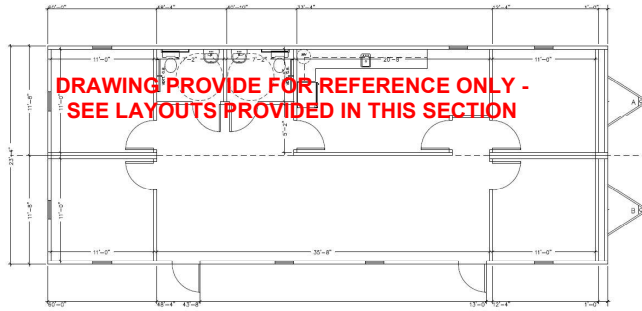
2.00 Water Closet Type: HC Accessible W/ Std. Grab Bars
 {Includes a Standard Toilet Paper Holder; Unless An Upgraded
 Toilet Paper Holder Is Listed}

1.00 6 Gallon Water Heater w/Disconnect

Supply Lines Are CPVC

Drain/Waste Lines Are PVC
 {Please Note That All Manifolding Is Done On-Site By Others}

1.00 Rough-in Plumbing for a Refrigerator Icemaker
 {Unless Otherwise Noted, All Appliances Are by Others}



Model Year: 2024

Sq Feet: 1,440.00

| Qty | Description | Color/Location |
|-----|-------------|----------------|
|-----|-------------|----------------|

ELECTRICAL SECTION:

- 2.00 Panel Type: Standard 125 AMP 240V
- 20.00 Standard Surface Mounted 232 Fluorescent Lights
{This Is Standard Diffused Fluorescent Light Fixture With Wrap Around Prismatic Type Lens, Electronic Ballast & T-8 Bulbs}
- 2.00 Standard 60 Watt Porch Light With Photo-Cell
- 9.00 OCCUPANCY SENSOR
- 2.00 Combo Dual Head Emergency Light / Exit Sign
{QUANTITY SHOWN IS BUDGETED, ACTUAL QUANTITY WILL BE AS REQUIRED AFTER REVIEW AND PER THE FINAL APPROVED CUSTOMER DRAWING}
- 2.00 Double Exterior Emergency Light Remote Heads
{Exterior Type To Match Porch Lights}
- 8.00 2" x 4" Junction Box With 3/4" Conduit (Standard)
{These Junction Boxes Will Be Stubbed-up into The Attic Cavity for T-grid Unless Otherwise Instructed By The Customer On The Print & Stubbed Into The Crawl Space On All Other Ceiling Types Unless Otherwise Instructed; All Boxes & Conduit Are Empty, All Wiring & Devices For Monitoring, Alarms & Security Are Entirely By Others}
- 2.00 Combination- 100CFM Exhaust Fan With 60 Watt Light

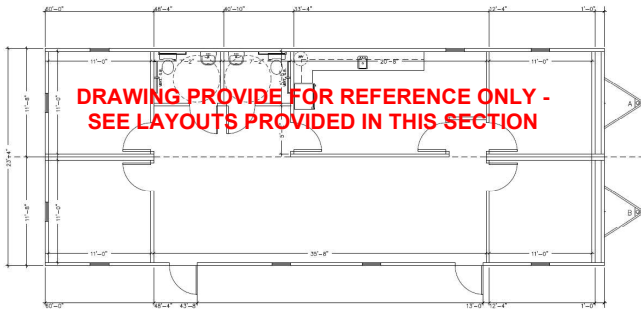
110 Volt Receptacles @ Approximately 12' O.C.
{Standard}

Receptacles / Switches / Covers are White
- 4.00 GFI Receptacles As Required (See Prnt)
{GFI= Ground Fault Interupter}
- 2.00 Exterior Use GFI With Weather-Proof Cover
{In Use Type}
- 1.00 Heat Tape Receptacle

Standard Race-Way: 12-2 Romex Wiring

HVAC SECTION

- 2.00 3 Ton Wall Mounted Unit With 10kw Heat Strip



Model Year: 2024

Sq Feet: 1,440.00

| Qty | Description | Color/Location |
|-----|-------------|----------------|
|-----|-------------|----------------|

HVAC SECTION

- 112.00 Linear Feet of Fiberglass Supply Duct with Grilles
{Oversized as Needed}
- 100.00 Linear Feet of Fiberglass Return Duct with Grilles
- 24.00 Plenum / Chase Wall Per The Print
- 2.00 Digital Thermostat

DEHUMIDIFICATION NOT INCLUDED:

Please note that First String Space is not quoting humidity control (dehumidification) as part of the mechanical system. See options for a price per HVAC unit for dehumidification to be included.

CABINETS & FURNISHINGS

- 16.00 Linear Foot Of "Oak" Base Cabinets
LWES
- 16.00 Linear Foot Of "Oak" Overhead Cabinets
{Includes Center Shelf}****LWES****
- 1.00 Bar Sink With Gooseneck faucet
****DELTA****

EXTERIOR SECTION:

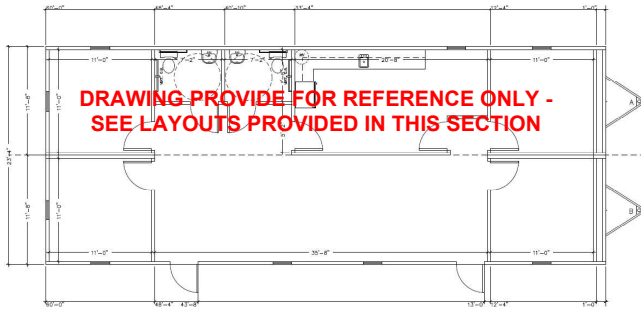
- Smart Panel Siding (Double Wide)
- 168.00 Smart Panel Siding Mansard
****False Mansard****
- Standard House Wrap Installed 100%
{All wrap installed right side up & in a shingled fashion}

WINDOWS SECTION:

- 9.00 Vinyl Mini-Blinds
{Standard Colors Only}
- 9.00 24x54 VS Bronze Metal Frame & Low E Ins Glass
Vertical Sliding Low E Insulated

EXTERIOR DOORS:

- 2.00 36"x80" Steel/ Steel Exterior Door w/ 6"x30" VB
- 2.00 Standard Lever
- 2.00 Standard Closure



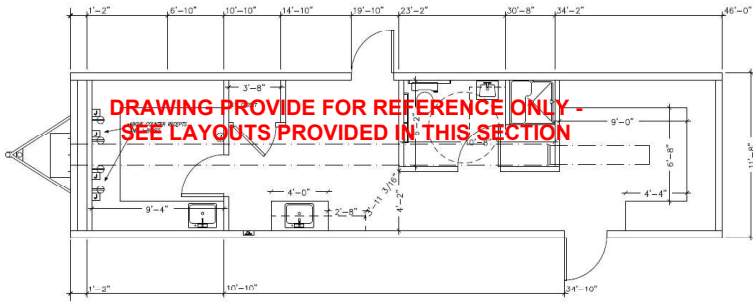
Model Year: 2024

Sq Feet: 1,440.00

| Qty | Description | Color/Location |
|-----|-------------|----------------|
|-----|-------------|----------------|

INSULATION SECTION:

- 1344.00 Exterior Wall Includes R -19
(Requires 2" x 6" minimum exterior walls)
- 1440.00 Floor Includes R-30
- 1440.00 Roof Includes R-49
- 976.00 R-11 Sound Reduction Batts In All Interior Walls



| Qty | Description | Color/Location |
|-----|-------------|----------------|
|-----|-------------|----------------|

SPECIFICATIONS:

****PLEASE NOTE; WALL MOUNTED BARD HVAC UNIT IS INCLUDED IN THIS QUOTE****

Quote Expiration:

****Please note that this quote is only valid for 30-days from issuance. Please call or contact a salesperson for an updated quotation if this quotation is later than 30-days(No Exceptions)****

Module Dimensions / Singlewide Base

(1) 11'-8" x 46' Modules

Occupancy: Business

State/Code Requirements/Insignias

IBC/FL

160 MPH Wind Speed

Destination:

Fort Myers, FL

1.00 Florida

CHASSIS:

46.00 96" On Center outriggers (UT12)

46.00 Outrigger with 95.5" I-Beam Spacing

"I"-Beam Will Be Sized As Required

Axle Quantity Will Be Calculated As Required

Select Tires

(An option for new tires is available upon request)

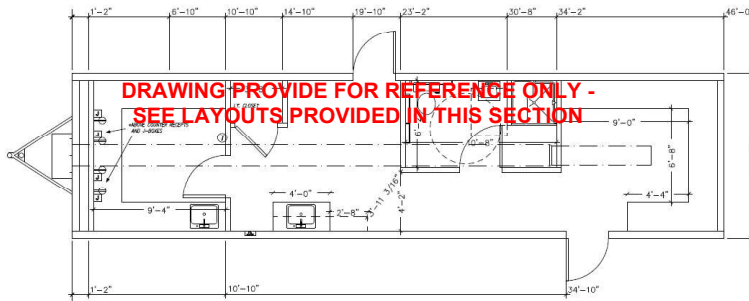
Hitches are Detachable

FLOOR

Bottom Board Material Has Nylon Impregnation

2" x 8" Floor Joist @ 16" O.C.

Standard Plywood Floor Sheath/Decking {5/8" T & G}



| Qty | Description | Color/Location |
|-----|-------------|----------------|
|-----|-------------|----------------|

FLOOR

VCT {Vinyl Composite Tile} Installed Per The Print

****Thru-out****

Manufacturer's standard is "Armstrong" brand VCT. If an alternate brand or a color that differs from manufacturer's standard color selections is chosen, an additional cost will be assessed.

WALL SECTION:

47.00 Interior Wall Height: 8'0"

1.00 Double Top-Plate On Exterior Walls

116.00 2" x 6" Exterior Wall Height: 8'0"

5/8" VCG {Type "X" Gypsum}

Interior Trim Package: Standard Battens
{UNLESS OTHERWISE NOTED}

210.00 4" VCB (Vinyl Cove Base)

****Thru-out****

ATTENTION: HURRICANE STRAPS NOT INSTALLED

Please note that no hurricane tie-down straps will be included installed from the FSSI factory. Please see options if this is needed.

INTERIOR DOORS SECTION:

3.00 36" x 80" H.C. Flush Door w/ Steel Jamb

{Includes Timely or Redi-Frames, Lever; Unless Otherwise Noted, Door Frame Will Be Painted The Standard Finish Color (Bronze) & door has imperial oak finish}

2.00 Passage Locks

1.00 Privacy Locks for Restrooms

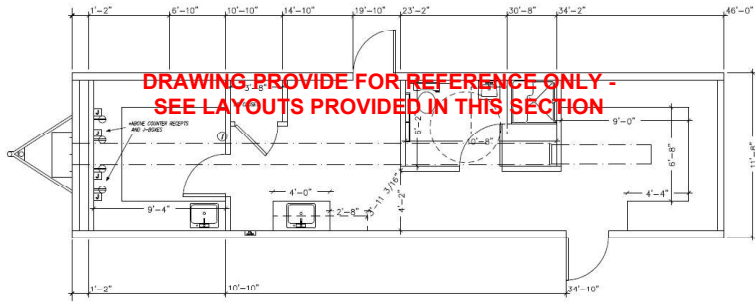
ROOF/CEILING SECTION:

Truss Spacing @ 16" O.C.

(UT12w) Box Truss (Double Or Single Box Peak)

Snow Load Only as Required

Roof Load Only as Required



| Qty | Description | Color/Location |
|-----|-------------|----------------|
|-----|-------------|----------------|

ROOF/CEILING SECTION:

7/16" x 4 x 8 EPDM underlayment

Roof Covering: 45 mil. Black EPDM (single wide)

1/2" Pre-Finished Sea-Spray Ceiling (Doublewide)

Ceiling Finish Is 8'0" Above Finished Floor

1.00 No Overhang/Projection on the Roof

1.00 Power Gable Vent with Passive Gable Vent
****As required****

ATTENTION: HURRICANE STRAPS NOT INSTALLED
Please note that no hurricane tie-down straps will be included installed from the FSSI factory. Please see options if this is needed.

PLUMBING SECTION:

1.00 Restroom Description: Single-Station Handicap RR

1.00 Standard Lavatory (Wall Mount Type)
{Includes A Standard Faucet & Mirror}

1.00 Handicap Sink Protection - Sock for P-trap

1.00 Water Closet Type: HC Accessible with VA Grab Bars
{Includes a Standard Toilet Paper Holder; Unless An Upgraded Toilet Paper Holder Is Listed}

1.00 30 Gal water heater - Lo- Boy water heater
With Disconnect

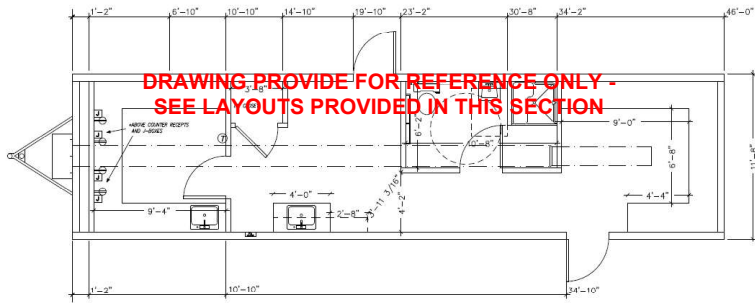
1.00 Handicap Accessible Shower

Supply Lines Are CPVC

Drain/Waste Lines Are PVC
{Please Note That All Manifolding Is Done On-Site By Others}

1.00 Rough-in Plumbing for a Refrigerator Icemaker
{Unless Otherwise Noted, All Appliances Are by Others}

1.00 Special Item:
Rough In For Stackable Washer & Dryer w/ Vent



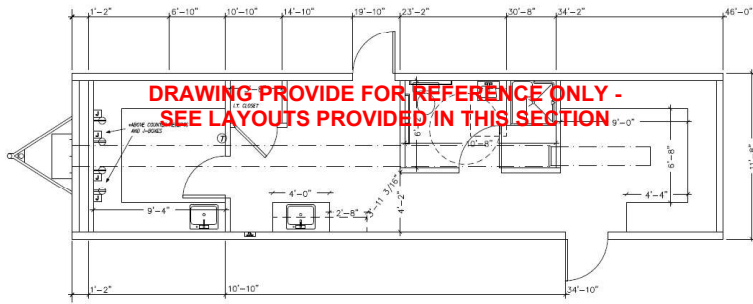
| Qty | Description | Color/Location |
|-----|-------------|----------------|
|-----|-------------|----------------|

ELECTRICAL SECTION:

- 1.00 Panel Type: Standard 150 AMP 240V
- 9.00 Standard Surface Mounted 232 Fluorescent Lights
{This Is Standard Diffused Fluorescent Light Fixture With Wrap Around Prismatic Type Lens, Electronic Ballast & T-8 Bulbs}
- 2.00 Standard 60 Watt Porch Light With Photo-Cell
- 4.00 OCCUPANCY SENSOR
- 2.00 Combo Dual Head Emergency Light / Exit Sign
{QUANTITY SHOWN IS BUDGETED, ACTUAL QUANTITY WILL BE AS REQUIRED AFTER REVIEW AND PER THE FINAL APPROVED CUSTOMER DRAWING}
- 2.00 Double Exterior Emergency Light Remote Heads
{Exterior Type To Match Porch Lights}
- 6.00 2" x 4" Junction Box With 1/2" Conduit (Standard)
{These Junction Boxes Will Be Stubbed-up into The Attic Cavity for T-grid Unless Otherwise Instructed By The Customer On The Print & Stubbed Into The Crawl Space On All Other Ceiling Types Unless Otherwise Instructed; All Boxes & Conduit Are Empty, All Wiring & Devices For Monitoring, Alarms & Security Are Entirely By Others}
- 1.00 Combination- 100CFM Exhaust Fan With 60 Watt Light

110 Volt Receptacles @ Approximately 12' O.C.
{Standard}

Receptacles / Switches / Covers are White
- 4.00 GFI Receptacles As Required (See Prnt)
{GFI= Ground Fault Interupter}
- 1.00 Exterior Use GFI With Weather-Proof Cover
{In Use Type}
- 2.00 110 Volt Dedicated Receptacle
Washing Machine and Fridge
- 1.00 Heat Tape Receptacle
- 1.00 220 Volt Stove Receptacle Per The Print
- 1.00 220 Volt Dryer Receptacle Per The Print
{Includes Vent and Exterior Vent Louver If Needed}



| Qty | Description | Color/Location |
|-----|-------------|----------------|
|-----|-------------|----------------|

WINDOWS SECTION:

- 4.00 Vinyl Mini-Blinds
{Standard Colors Only}
- 3.00 48"x28" H/S White Vinyl. Low E Ins. Glass
Vertical Sliding Low E Insulated
- 1.00 30x27 VS Vinyl White Frame & Low E Ins Glass

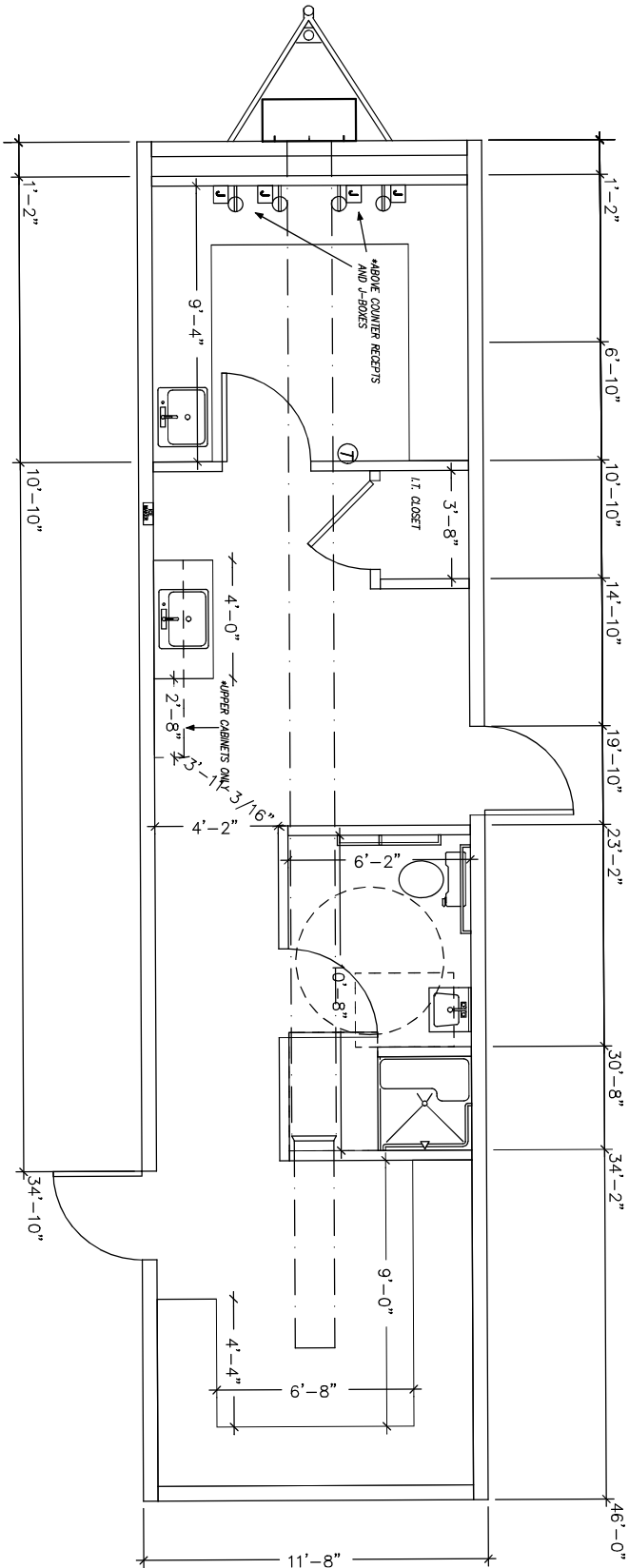
EXTERIOR DOORS:

- 2.00 36"x80" Steel/ Steel Exterior Door w/ 6"x30" VB
- 2.00 Standard Lever
- 2.00 Standard Closure

INSULATION SECTION:

- 928.00 Exterior Wall Includes R -19
(Requires 2" x 6" minimum exterior walls)
- 552.00 Floor Includes R-30
- 552.00 Roof Includes R-49
- 480.00 R-11 Sound Reduction Batts In All Interior Walls

ADMINISTRATIVE TRAILER LAYOUT AND DIMENSIONS



NO. 7 - Construction Trailer Equipment List

CONSTRUCTION TRAILER EQUIPMENT LIST
COLLIER COUNTY
GOLDEN GATE MASTER PUMP STATION & SITE IMPROVEMENTS

| | | |
|---|----|---|
| Conference room chairs | 8 | Staples: Item #: 24398920, Model #: UN59414 |
| Kitchen Chairs | 10 | Staples: Item #: 257019, Model #: 4RUT238ABK |
| Microwave | 2 | Staples: Item #: 23973657, Model #: PHPNNSU656B |
| Kuerig | 2 | Staples: Item #: 24433122, Model #: KSLIM Home Depot: Internet # 317450098, Model # LRTL52403S, Store SKU # 1006527267, Store SO |
| Fridge | 2 | SKU # 1006514046 Home Depot: Internet # 321035878, Model #JB258RTSS, Store SKU # 1007946975, Store SO SKU |
| Oven | 1 | # 1007946975 |
| Toaster | 1 | Staples: Item #: 1643439, Model #: BTWTS292B |
| Office Tv w/wall mount, ~43in. | 4 | Staples: Item #: IM107GA67, Model #: HG43BU800NFXZA |
| Conference room Tv w/wall mount, ~65in. | 1 | Staples: Item #: IM19JG109, Model #: HG65Q60AANFXZA |
| Printer/ Scanner/Copier | 1 | Konica Minolta bizhub C224e |
| Desks | 4 | Staples: Item #: 24337153, Model #: CAB043EPO |
| Desk Filing Cabinet | 4 | Staples: Item #: 147136 Model #: WC31880 |
| Desk, hutch, file cabinet, bookcase set | 1 | Staples: Item #: 24462980, Model #: SAL007DG |
| Filing Cabinet | 2 | Staples: Item #: 2806660, Model #: ST52152-CC |
| Bookcase Small - 2 shelf | 4 | Amazon: HON Brigade Steel Bookcase |
| Bookcase Large - 5 shelf | 2 | Amazon: HON Brigade Steel Bookcase |
| Metal storage cabinet | 2 | Amazon: Metal Garage Storage Cabinet with Lock and 5 Adjustable Shelves, Metal Storage Cabinet Steel Tool Cabinets with Locking Door for Home, School, Office, Garage (Black-Style 2) |
| Kitchen Table | 1 | Amazon: White Dining Table Round Small Office Table Conference Table Coffee Meeting Table w/Stainless Steel X-Shaped Pedestal for Office Boardroom Kitchen Living Room 31.5 inch |
| Conference room table - 10ft | 1 | Amazon: Modern Boat Shaped 10' Feet Conference Table, OF-CON-C133 |
| Boot brush | 2 | Amazon: WORKPRO Boot Scrubber, Heavy Duty Boot Cleaning Scraper Brush, Shoe Mud Cleaner, for Indoor and Outdoor Use |
| Jacket/vest shelf/Hooks | 2 | Garage Wall Shelving with Hooks,2-Pack 1.64 x 6ft Garage Storage Shelving Wall Mounted,Loads 1050 lbs Heavy Duty Metal Wall Shelves,20" x 72"Garage Storage Rack Floating Shelf,Black |