CITY OF TAMPA

Bob Buckhorn, Mayor **CONTRACT ADMINISTRATION DEPARTMENT**

Michael W. Chucran, Director

ADDENDUM NO. 3

DATE: December 30, 2016

Contract 16-C-00019; University Pumping Station Pump #1 Replacement

Bidders on the above referenced project are hereby notified that the following addendum is made to the Contract Documents. BIDS TO BE SUBMITTED SHALL CONFORM TO THIS NOTICE.

Item 1: Replace Workmanship and Materials Sections listed below with the attached sections provided.

46 – Variable frequency drives
47 – Controls
76 – Conduit, wire, and grounding
13400 – General Instrumentation and Control
13451 – Programmable Logic Control (PLC) System

Item 2: Add to the General Notes on plan sheet 4, the following

G-30. ALL PAINTING SHALL BE LIMITED TO THE FOLLOWING ITEMS:
1. PROPOSED PUMP #1 AND ASSOCIATED PROPOSED PIPES, FITTINGS AND VALVES.
2. TOUCH-UP PAINTING ON EXISTING PIPING, WHERE EXISTING COATINGS ARE DAMAGED DUE TO CONSTRUCTION ACTIVITIES.
3. PROPOSED COVER PLATES OVER EXISTING CUT-OUTS IN VARIOUS ELECTRICAL ENCLOSURES (SEE ELECTRICAL SHEETS FOR DETAILS).

NO OTHER PAINTING IS REQUIRED ON THIS PROJECT.

All other provisions of the Contract Documents and Specifications not in conflict with this Addendum shall remain in full force and effect. Questions are to be e-mailed to Contract Administration@tampagov.net.

Jim Greiner

Jim Greiner, P.E., Contract Management Supervisor

SECTION 46 - VARIABLE FREQUENCY DRIVES

W-46.01 General

This section includes the requirements for the Variable Frequency Drive (VFD) equipment.

Provide all labor, materials, equipment and incidentals required; and install, place in operation and field-test the Variable frequency drive equipment.

One (1) 400 HP, 12-pulse VFD unit shall be provided and installed. The VFD unit shall be mounted in a NEMA Type 12 filtered and gasketed enclosure with full rear cover plates. The VFD shall also include an externally operated disconnect device.

The VFD system shall be designed to operate as specified hereinafter when powered by either the utility electrical service, or by the existing standby power facilities. Operational testing shall be performed under both normal and emergency power.

The AFD shall be designed with a rectifier input designed for 12-pulse minimum operation. Phase shifting transformers shall be housed in the AFD enclosure. Active harmonic filters and inductor-capacitor filters are not acceptable.

W-46.02 Acceptable Manufacturers

The Variable Frequency Drive (VFD) shall be a Yaskawa, Model iQ1000, provided by Icon Technologies. The Wastewater Department has officially standardized on this name brand and no alternates will be considered. The Standardization Certificate of Conditions and Circumstances is included hereinafter.

Alternate control techniques other than pulse width modulated (PWM) are not acceptable.

W-46.03 General Provisions

Governing Standards: The drive shall be designed to meet the following specifications:

1. NFPA 70 - National Electrical Code.
2. NEMA ICS 3.1 - Safety standards for Construction and Guide for Selection, Installation and Operation of Variable Speed Drive Systems.
3. NEMA 250 - Enclosures for Electrical Equipment.
4. UL 508C - Underwriters Laboratories.
5. CAN/CSA - C22 No. 14-M91 - Canadian Standards Association.
6. IEC 146 - International Electrical Code.

The drive shall conform to the following requirements:

1. NFPA 70
2. IEC 146

3. EN/CE
4. IEC 801
5. C-UL marking to provide an approved listing for both United States and Canadian users.
6. The Manufacturer shall furnish the product as listed and classified by Underwriters Laboratories as suitable for the purpose specified and indicated.

Warranty: All equipment furnished under this section shall be warranted by the Contractor and the equipment manufacturers for a period of two (2) years after final acceptance of the job. Warranty shall include all labor and material.

W-46.04 Submittals

Submittals shall be custom prepared by the VFD manufacturer for this specific application.

Submittal information shall include, but not be limited to:

1. Equipment dimensions, including stub-up locations, shipping splits and shipping weights.

2. Catalog cuts of major components/subassemblies showing all relevant electrical information.

3. Spare parts list.

4. Manufacturers installation instructions.

5. Shop drawings including wiring diagrams, panel layouts, nameplate legends, etc.

6. Warranty.

7. Efficiencies.

8. Power factor.

9. Harmonic Distortion Analysis.

10. Certification letter stating VFD has a documented Mean Time Between Failure (MTBF) rating of at least 28 years.

11. Certification that VFD is true 12-pulse with integral dual bridge rectifier.

W-46.05 Performance and Design Requirements

Performance: The Variable frequency drive (VFD) controller shall be of sufficient capacity and shall provide a quality output waveform for stepless motor control from 10% to 100% of base speed. The VFD controller shall be suitable for variable torque (VT) loads as required for the driven load. Requirements of the driven equipment are covered in the driven equipment specification. The VFD controller shall include the following ratings and parameters:

1. Input Voltage and Frequency: 480 VAC (±10%), 3-phase, 60 Hertz (±2 Hertz).

2. Displacement Power Factor: Between 0.96 and 1.0, lagging, over the entire speed range.

3. Minimum VFD Efficiency: 95% at half speed; 97% at full speed.

4. Ambient Temperature: -10°C to 40°C.

5. Humidity: Non-condensing to 95%.

6. Output Power: Output voltage adjustable from 0 to rated input voltage. Output frequency range adjustable from 1 to 66 Hertz. The inverter section shall produce a pulse width modulated (PWM) waveform using third generation IGBT's.

7. VFD Service Factor: 1.0.

8. Starting Torque: 100% starting torque from 0.5 Hertz to 60 Hertz.

9. Overcurrent Capability: 120% of rated FLA for one minute (variable torque); 180% of rated FLA-instantaneous.

10. Volts per Hertz Ratio: Constant over entire range of the unit except under voltage boost condition and at frequencies over 60 Hertz.

11. Frequency Regulation: 0.2% steady state.

12. Frequency Resolution: 0.1 Hertz

13. Radio Frequency Interference (RFI): Must meet FCC requirements for RFI above 7 MHz as specified in part 15, subpart J, Class A devices.

14. Harmonic Distortion: VFD power input harmonic attenuation shall be provided by the installation of true 12-pulse VFD units and associated 12-pulse isolation transformers.

15. Minimum carrier frequency of 2kHz without derating.

Hardware: The drive hardware shall employ the following components/technology:

1. Diode or fully gated bridge input with phase to phase and phase to ground metal oxide varistor (MOV) protection.

2. Input 12-pulse phase shifting transformer with DC bus reactor to bring reflected harmonics to IEEE 519 levels. The 12-pulse transformer shall be mounted in a weatherproof painted aluminum enclosure for outdoor installation, and be

manufactured by Hammond Power Solutions or as recommended by Yaskawa Electric America.

3. Critical VFD logic circuits shall be powered by the DC bus to facilitate an orderly shutdown and provide diagnostics during an AC power loss.

4. Gas tight plug-in connections on printed circuit boards to inhibit electrode corrosion.

5. Printed circuit boards shall have a conformal coating to help protect them from the effects of hydrogen sulfide gas.

6. Microprocessor-based inverter logic isolated from power circuits.

7. State-of-the-art insulated gate bipolar transistors (IGBT) inverter section. Inverter section shall not require commutation capacitors. Inverter section shall provide sine-coded PWM output to the motor.

8. Operator interface shall include an LCD digital display, programming keypad and operator keys option.

9. Internal communications bus to enable attaching common options.

Adjustment: Front panel facilities to adjust the following VFD parameters shall be provided:

Maximum Speed
Minimum Speed
Acceleration Time
Deceleration Time
Volts/Hertz Ratio
IR Compensation (DC BOOST)
Current Limit
Skip Frequencies

Fault Protection: Power circuit design shall provide for protection of power circuit components from fault conditions as follows:

1. Overload Protection: The drive shall provide NEC motor overload protection tested in accordance with UL Standard 991. Overload protection is speed sensitive and shall be adjustable for motors with speed ranges of 2:1, 4:1, and 10:1.

2. Fault Reset/Run: The drive shall provide multiple (as programmed) automatic fault reset and restarts following a fault condition before locking out and requiring manual restart. The automatic mode is not applicable to a ground fault or shorted output faults. The time between restarts shall be adjustable from 0.5 seconds to 30 seconds.

   A. Fault Memory: Data for at least the last four (4) faults shall be stored sequentially at the time of the fault. Information shall be maintained in non-volatile memory for later recall to aid in fault diagnosis.

3. Drive Circuit Breaker: An input thermal-magnetic circuit breaker, with lockable operator handle, shall be provided (operable with VFD door closed). The breaker shall meet the disconnect switch, short circuit and ground fault NEC requirements for motor branch circuits. The breaker shall be rated for 65,000 amperes short circuit interrupting capacity and be rated as shown on the Drawings or required. The drive circuit breaker shall be Square D model MJL36800, or equal.

4. Load Protection: The following features shall be provided to protect the drive motor:

   A. Inverse-time overload protection
   B. Overvoltage protection
   C. Overfrequency protection
   D. Short circuit protection
   E. Ground fault protection

Power Conditioning: The drive shall be designed to operate on an AC line which may contain line notching and up to 10% harmonic distortion. An input isolation transformer shall not be required for protection from normal line transients.

Operation: The VFD output waveform shall be suitable for operating a NEMA Design B squirrel cage induction motor without derating or requiring additional service factor. VFD output current and voltage waveform shall be inherently sinusoidal at all speeds, regardless of loading, with a total harmonic distortion not exceeding 10% at full load. The VFD output shall produce no pulsating torques to the output shaft or the mechanical system (therefore eliminating the chance of exciting a resonance caused by VFD induced torque pulsations). The VFD shall have an adjustable carrier frequency with a minimum of five field selectable settings.

The suppliers of the VFD equipment shall evaluate the proposed motor load and provide a product best matching this load characteristic. The sewage pump is a very critical load; therefore, all drive components must be fully compatible, reliable, and of the highest quality. The VFD shall have a minimum 590 amp continuous rating and 640 amp rating for 60 seconds.

Provide and install the following VFD controls as shown on the Drawings:

1. "MOTOR RUN" pilot light
2. "VALVE OPEN" pilot light
3. "VALVE CLOSED" pilot light
4. " PUMP OPERABLE" pilot light
5. "PUMP OFF" pilot light
6. "PUMP OVERTEMP" pilot light
7. Mushroom Head Push Button for Emergency stop
8. Push Button for Stop
9. Push Button for Drive Reset
10. "OFF-AUTO-HAND (OAH) switch (with overlapping auto-hand contacts)
11. "MANUAL SPEED ADJUST" potentiometer
12. "DIGITAL OPERATOR INTERFACE"

W-46.06 Construction

Small wiring, necessary fuse blocks, and terminal blocks within the VFD equipment shall be furnished as required. All control wires leaving the VFD shall be provided with terminal blocks with suitable numbering strips. All control wiring shall be durably marked at each end. Control components mounted within the assembly; such as fuse blocks, relays, push buttons, switches, etc.; shall be Specification grade, and be suitably marked for identification corresponding to appropriate designations on the manufacturer's wiring diagrams. All printed circuit boards shall be given a conformal coating, at the factory, to protect the circuitry from contamination.

The VFD shall be provided with adequate lifting means and shall be capable of being rolled or moved into the installation position and bolted directly to the subpanel.

W-46.07 Controls

Features: The VFD shall include the following features, in addition to all features indicated on the drawings:

1. IR Compensation (DC Boost): Digital programming shall provide a selectable range for offsetting motor losses at low frequency operation. DC Boost shall be current regulated and automatically adjusted, on each start, to motor temperature and load changes. DC Boost shall be adjustable from 15% to 120% of the drive current rating.

2. Volts Per Hertz Adjustments: Programming shall provide the ability to fully configure the volts per hertz for squared, cubed, straight line, pre-programmed or full custom patterns.

3. Current Limit: Programmable current limit from 30% to 200% of VFD rated full load current.

4. Acceleration/Deceleration: Acceleration and deceleration times shall be independently adjustable from 0 seconds to 3600 seconds. Provisions for a second set of remotely selectable acceleration/deceleration settings shall be provided.

5. Skip Frequencies: No less than two selectable, adjustable frequency bands shall be provided to lock out continuous operation at frequencies which may produce mechanical resonance.

6. Speed Regulation: The programmable speed regulation modes shall include the following:

    a. Open loop.
    b. Slip compensation with 0.5% speed regulation.
    c. Closed loop encoder feedback with 0.1% speed regulation (PID).

7. Control Logic: The drive shall be programmable or self adjusting for operation under the following conditions.

a. Operate drive with motor disconnected.
b. Controlled shut down with no component failure in the event of an output phase to phase or phase to ground short circuit and annunciation of the fault condition.
c. Adjustable PWM carrier frequency within a range of 2.5kHz-5kHz.
d. Multiple programmable stop modes including -ramp, coast, DC injection braking.
e. Multiple acceleration and deceleration rates.
f. All adjustments to be made with the door closed.
g. Adjustable output frequency up to 400 Hertz.

8. Control Inputs: Control interface cards shall provide input terminals for access to fixed drive functions that include start, stop, remote auxiliary, speed, and enable. Four additional inputs shall be available for functions such as reverse, preset speed access, jog, second acceleration/deceleration time access and local control selection. Inputs shall be programmable to configure the drive for standard 3-wire, 2-wire, and serial operation.

   The control terminals shall be rated for either 24 VDC or 115 VAC and shall be immune to the deleterious effects of surrounding electromagnetic radiation/noise. Each input shall be optically isolated from the drive control logic.

9. Ride Through: The drive shall have a minimum two (2) second carry-over during a utility power outage.

10. Analog Output: An output signal shall be jumper selectable for 0-10 VDC or 0-20 mA and be user programmable such that it is proportional to output frequency, output current, output voltage reference, or output power. A programmable offset shall be provided to allow modification of the analog output to obtain 2-10 VDC or 4-20 mA.

11. Reference Signals: The drive shall be capable of using the following inputs as a speed control:

    a. Remote potentiometer.
    b. 0-10 VDC
    c. 4-20 mA

12. Loss Of Reference: In the event of loss of the 4-20 mA reference signal, the drive shall be user programmable to either run at minimum speed, or at 80% of the most recent speed.

13. Digital I/O:

    Inputs: The VFD shall include a forward “run” input and a minimum of five (5) programmable multi-function inputs. The functions shall include, but are not limited to, the following:

a. External fault (NO)/(NC)
b. Fault reset
c. Remote/local selection
d. Stop command using deceleration timer
e. Jog command
f. Inertia ride-through command

Outputs: Contact output ratings shall be 250 VAC/30 VDC, minimum 1.0 ampere, and shall be provided as follows:

a. (1)- Form A run contact.
b. (1)- Form C contact programmable as follows:

1) Drive fault
2) Zero speed
3) @ frequency
4) Drive ready

14. Interface: The drive shall provide a removable Operator Interface Module with integral display to show drive operating conditions, adjustments, and fault indications. The display shall be removable under power without causing a fault and shall be visible and operable without opening the enclosure door. The display shall use either LED or backlit LCD technology; and be alpha numeric, or numeric only with an active cross-reference to facilitate intuitive use by a tyro. Units shall be user scalable. The display shall be capable of remote mounting by means of cable connection up to 10 meters (33 feet) from the drive and be capable of being used as a hand-held terminal.

15. Operator's Devices: The drive shall provide an option for Start, Stop, Jog, Reverse and Speed Control as an integral part of the Operator Interface Module.

16. Adjustments: The digital interface shall be used for all set-up, operation and adjustment settings. All adjustments shall be stored in non-volatile memory (EEPROM). No potentiometer adjustments shall be required. The drive shall provide EEPROM memory for factory default values.

17. Speed Profiles: Programming capability to produce speed profiles with linear acceleration/deceleration or "S-Curve" profiles that provide changing acceleration/deceleration rates. S-Curve profiles shall be selectable for fixed or adjustable values.

18. Run On Power Up: A user selectable restart function shall be provided to automatically restart the equipment after restoration of power after an outage.

19. Flying Start: The drive shall be capable of determining the speed and direction of a spinning motor and adjust its output to "pick-up" the motor at the rotating speed. The flying start feature shall be operable with or without encoder feedback.

Diagnostics: Diagnostic indicators located on the drive face shall show the type of fault responsible for drive shutdown, warning or failure. On occurrence of more than one condition, each condition shall be recorded or indicated by the diagnostic segment.

Testing: Drive manufacturer shall conduct all standard tests in accordance with NEMA and ANSI standards to ensure conformance to specified requirements. All power switching components shall be pre-run under temperature and load conditions. Tests shall include:

1. Factory testing.
2. Field acceptance testing.

W-46.08 Installation

Install and interconnect equipment as shown on the Drawings.

Contractor shall provide a factory-trained technician for on-site start-up and debugging at no additional cost.

W-46.09 Spare Parts

The following spare parts shall be furnished:

1. Three (3) each of each type of fuse used.

2. Four (4) of each type of converter power semiconductor.

3. Four (4) of each type of inverter power semiconductor.

4. One (1) of each type of printed circuit board, including diagnostic systems.

A spare parts list including original device manufacturer's part numbers for cross-referencing purposes shall be furnished. Lists containing only the VFD manufacturer's part numbers are not acceptable.

W-46.10 Training

A minimum period of one 8-hour day of on-site training by a factory-trained engineer or technician shall be provided for City technicians and operating personnel. This training shall include component level troubleshooting and software. This training shall be provided at no additional cost to the City.

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SECTION 47 - CONTROLS

W-47.01 General

Control components shall comply with the latest ANSI, IEEE, and NEMA standards where applicable.

Maximum control voltage shall be 120 VAC, 60 Hertz.

Control devices shall be of industrial grade, heavy-duty design, utilizing modular construction to increase flexibility.

W-47.02 Switches and Push Buttons

Switches and push buttons shall be heavy-duty, oil-tight, watertight, NEMA Type 4X, corrosion resistant units intended for industrial applications. The operator shall mount in a 1.20-inch diameter opening and be provided with the proper legend plate.

Switches and push buttons shall be as manufactured by Square D, General Electric, Allen-Bradley, or equal.

W-47.03 Pilot Lights

Pilot lights shall be heavy-duty, oil-tight, NEMA Type 4X, corrosion resistant, push to test, 120 VAC light emitting diode (LED) type, and intended for industrial applications. The operator shall mount in a 1.20-inch diameter opening and be provided with the proper legend plate and lens color.

Pilot lights shall be as manufactured by Square D, General Electric, Allen-Bradley, or equal.

W-47.04 Circuit Breakers

Circuit breakers shall be of the molded case, air-break type designed for 600 volt, 60 Hertz service or as shown on the Drawings. They shall have both thermal and magnetic elements on all three poles. These elements will actuate a common tripping bar to open all poles when an overload or short circuit occurs.

The circuit breakers shall have an AIC rating greater than the available fault current at the panel.

The equipment shall be as manufactured by Square D, General Electric, Cutler-Hammer or equal.

W-47.05 Industrial IEC Relay

Industrial Control Relays shall match the units used in the existing pump control panel and shall have the following features:

1. conform to IEC 947-5-1 and IEC 377-1 standards
2. 120 VAC, 60 Hertz, 6.3 VA nominal, coil.
3. four-pole— two (2) N.O. and two (2) N.C. bifurcated contacts rated 6.0A at 120VAC
4. availability of two and four pole adder decks, timers, and accessories for field installation
5. modular construction with replaceable coils
6. guarded contacts with retained visibility for protection and ease of wiring
7. clearly visible terminal markings
8. surface or DIN rail mounting
9. mechanical life of 20 million operations

The industrial control relay shall be Allen Bradley, model 700-F220A1 with adder decks as required.

W-47.06 General Purpose Control Relays

Relays for general control switching applications shall have the following features:

1. 120 VAC, 60 Hertz, 2 VA nominal, coil.
2. Two (2) Form C (2PDT), 10 ampere, silver-cadmium oxide contacts.
3. Eight pin octal-type plug (provide matching screw terminal sockets).
4. Clear, high-impact polycarbonate dust cover.

The control relay shall be Potter & Brumfield KRPA-11AG-120 with 27E122 socket, or equal.

W-47.07 Instrumentation Signal Multicontact Relays

Relays for switching instrumentation level signals shall have the following features: 120VAC coil; 4PDT gold-flashed silver, gold-silver nickel, or gold bifurcated crossbar contacts; socket mount; sealed plastic cover; and hold-down spring.

The contact ratings shall exceed the requirements for the application, and shall be no less than 1 Amp at 120VAC. The expected life shall be a minimum of 100,000 operations at rated load.

The socket shall be of the surface or rail-mount design with screw terminals to facilitate circuit connections.

The relay and socket shall be Omron model MYQ4, or equal.

W-47.07 Elapsed Time Meters

Elapsed time meters shall be furnished and installed where shown. Time meters shall register up to 9999.9 hours, be non-resetable, have square cases suitable for panel mounting, and have coils for 120 volt, 60 Hertz operation. The units shall be as manufactured by Eagle Signal, Crammer, or equal.

W-47.08 Surge Protection Device (SPD)

The SPD shall be able to suppress lightning induced voltage surges three times greater than the industry standards. The rated line voltage for SPD shall be 480 VAC, 3-phase 3-wire delta. The maximum single impulse current shall be 100kA per phase.

1. The SPD shall have line to neutral protection on all phases, and also neutral to ground protection.

2. The SPD shall have a 5 year warranty. Under that warranty, the SPD shall be replaced if it is destroyed by lightning or other impulses.

3. The SPD shall have an LED failure indicator on all three phases.

4. The clamp voltages for the SPD shall be the following:

    Line to neutral - 700 volts
    Line to ground - 700 volts
    Neutral to ground - 700 volts
    Line to line - 1200 volts

The SPD shall be Advanced Protection Technologies model TE05XDS104X, or equal.

W-47.09 Panel Mount Terminal Blocks

Control terminal blocks shall be single pole units constructed of a thermo-set phenolic base with wire clamp terminals attached. The terminals shall be rated for 25 amps, 600 volts. The terminals shall accommodate #16 to #12 AWG conductors. The block shall have a dovetail base that facilitates joining of the blocks into a rigid, self-supporting assembly.

The terminal blocks shall be as manufactured by Allen Bradley, Square D, or equal.

W-47.10 Control Transformers

The control transformer shall be a single output type for primary and secondary voltages as shown. Primary and secondary protection fuse blocks shall be prewired and mounted on top of the transformer. The secondary side neutral leg shall be grounded. The control transformer shall have sufficient capacity to provide the energy demands for all connected control

components. They shall be designed with low impedance windings for excellent voltage regulation, and shall accommodate the high inrush current associated with contactors, starters, solenoids, relays and other connected devices. The control transformers shall be designed for a 55°C temperature rise at full load.

The electrical performance shall exceed the requirements of ANSI/NEMA ST-1 (Specialty Transformers). The transformers shall be as manufactured by Square D, General Electric, Cutler-Hammer, or equal.

W-47.11 Vibration Transmitters

The Vibration Transmitter shall be 4-channel to allow for monitoring of both pump vibration and temperature, as well as motor vibration and temperature.

Vibration Transmitter shall be provided with fiberglass enclosure and be powered by a single 120V source.

Vibration Transmitter shall be as manufactured by Connection Technology Center, Inc. (CTC), VP series, Model #VPR100-2S-D0-BB.

Accelerometers shall be 100mV/g type, CTC Model #AC102 with appropriate cables and connectors.

Signal Conditioners shall be CTC type SC200 with 4-20mA outputs for their associated signals.

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SECTION 76 - CONDUIT, WIRE, AND GROUNDING

W-76.01 General

Conduit, wire, and grounding includes furnishing and installing all conduits, underground ducts, bus ducts, wires, cables, and grounding systems as shown, specified, and required for a complete installation. The work includes the furnishing and installation of wires and cables in flexible and rigid conduits, underground ducts, all as required, shown, and specified.

Descriptive literature and technical information relative to conduits, wires, and grounding shall be submitted by the Contractor in conformance with the requirements of the General Provisions.

The Contractor shall, with reference to approved drawings of equipment being installed, prepare detailed plans showing the layout and size of all conduits, ducts, bus ducts, cables and wires, connections between the point of service connection and all utilizing equipment. These plans shall be in sufficient detail to serve as working drawings for the installing electricians. The drawings shall be to scale not less than the Plans and be prepared as the work develops with approval by the Engineer before major steps of work are undertaken.

During construction, careful notes shall be kept of all deviations or changes in the layout or connection diagrams. Upon completion of the work, all working drawings shall be corrected and then marked “Record Drawings”. Four sets of final prints, along with an equal number of bound instruction manuals and parts lists shall be given to the Engineer at the end of the job.

Excavation, backfill, form work, concrete, and reinforcing shall be in accordance with the applicable Workmanship and Materials sections.

W-76.02 Underground Ducts

In general, underground ducts for feeders and control wiring shall be plastic conduit. The plastic conduit shall be PVC, Schedule 80, and U.L. Inc. listed for direct burial, as manufactured by Carlon, Triangle, Allied Tube, or equal. The conduit shall be buried a minimum of 18 inches below grade. Manufactured fitted plastic duct spacers shall be used for installation spacing.

Ducts installed under streets, roads, alleys, driveways, and parking lots shall be rigid aluminum conduit covered with no less than 40 mils of PVC, as manufactured by Robroy, Ocal or equal. The PVC material shall conform to the applicable ASTM standards. The conduit shall be buried a minimum of 24 inches below grade.

Each duct shall be carefully cleaned before and after installation. All inside surfaces shall be free from imperfections likely to injure the cable. After installation of complete duct runs in sizes 2 inches and larger, ducts shall be snaked with an approved tube cleaner equipped with an approved cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the duct. Ducts through which the mandrel will not pass shall not be incorporated in the work. After snaking, the ends of dead-ended ducts shall be protected with standard conduit caps to prevent the entrance

of water or other foreign matter.

Where ducts enter buildings or at stub-ups to equipment, transitions to aluminum conduits shall be made as noted and detailed. Where it is not otherwise shown, all ducts entering buildings and structures shall have transitions to aluminum conduit at least 5 feet from the outermost edge of the pile cap or footing supporting the outermost vertical wall of the building or structure.

Transitions from above-grade rigid aluminum conduit to nonmetallic conduit shall be accomplished with a threaded adapter. Rigid aluminum conduit installed above grade and extending below grade shall include the first 90° elbow. All rigid aluminum conduits extending below grade shall be coated with two coats of an asphaltum-type paint along its entire length below grade and extending 6" above grade or above the top of the finished slab. The asphaltum-type paint shall conform to Fed. Spec. TT-V-51 and equivalent to Koppers Bitumastic Super Service Black.

W-76.03 Liquidtight Flexible Nonmetallic Conduit (Size 2 Inch or Less)

All flexible conduits size 2 inch or less in non-classified areas shall be nonmetallic, liquidtight, and have a circular cross section. The conduit shall be resistant to oil, water, heat, sunlight, corrosion, most acids, ozone, alkali, strains, abrasions, and crushing. The conduit shall be rated for continuous use at 140°F and be U.L. Inc. listed. Compatible liquidtight nonmetallic fittings shall be used for conduit installation. The flexible conduit and fittings shall be as manufactured by Carlon, Kellems, K-Flex, or equal.

W-76.03(a) Liquidtight Flexible Metallic Conduit (Greater Than 2 Inch)

All flexible conduits greater than 2 inch in non-classified areas shall be metallic, liquidtight, and have a circular cross section. The conduit shall be of a light-weight aluminum core, coupled with a PVC jacket. The conduit shall be resistant to sunlight, acid, and oil. The conduit shall be rated for a working temperature between -20°C to 80°C and U.L. Inc. listed. Compatible liquidtight metallic fittings shall be used for conduit installation. The flexible conduit and fittings shall be as manufactured by Thomas & Betts or equal.

W-76.04 Metallic Conduit and Boxes

All conduit shall comply with the requirements of the U.L. Inc. Standards. Conduit shall be delivered to the job site in standard bundles having each length suitably marked with the manufacturer's name or trademark and bearing the label of the U.L. Inc. inspection service. The minimum size conduit service shall be 3/4 inch.

All exposed conduit within buildings and exposed on outdoor structures shall be rigid heavy wall, 6063 alloy, T-1 temper, aluminum conduit. Aluminum conduit shall conform to Fed. Spec. WW-C-540 and ANSI C80.5.

All conduit encased in building structures, exposed in the screen room/wet well area, or otherwise noted, shall be rigid aluminum covered with not less than 40 mils of PVC outside, and 2 mils of urethane inside, as manufactured by Robroy, Ocal, or equal. The physical properties of the PVC and urethane materials shall conform to the applicable ASTM standards.

Cast aluminum shall be used for outlet boxes and fittings in aluminum conduit systems. Outlet and junction boxes shall be of proper dimensions for each application. Cast metal boxes shall have watertight gaskets and covers secured with nonferrous screws.

PVC coated boxes and fittings shall be used in PVC coated conduit systems.

Conduit fittings, such as elbows, tees, couplings, caps, bushings, nipples, and locknuts shall be threaded to provide watertight connections.

Where it is necessary to use electrical unions, Universal, Erikson, or equal conduit couplings shall be used.

W-76.05 Conduit Installation

All conduits shall be installed as required. The conduit system shall be installed complete with all accessories, fittings, and boxes, in an approved and workmanlike manner to provide proper raceways for electrical conductors.

The Contractor shall note that conduit runs shown are for the purpose of outlining the general method of routing the conduits to avoid interferences.

All other conduit shall be run exposed, except where shown otherwise.

Sizes not shown shall be one size larger than indicated in Tables 1 or 4, Chapter 9, of the NEC. Exposed conduit shall be run parallel to or at right angles from walls or beams and plumb on columns and on walls. Conduit shall not be run through beams except where approved by the Engineer or specifically detailed. Where possible, conduit shall be pitched slightly to drain to the outlet boxes or otherwise installed to avoid trapping of condensate. Where necessary to ensure drainage, Appleton Type ECD, Crouse-Hinds, or equal, 1/4-inch drain fitting shall be installed in the trapped conduit at low points.

Factory made bends or elbows shall be used wherever possible. Field bends shall be carefully made to prevent conduit damage or reduction in the internal area. The bending radius shall be not less than six times the nominal diameters of the conduit with carefully matched bends on parallel runs to present a neat appearance. The number of crossovers shall be kept to a minimum.

All conduit shall be reamed to remove burrs before installation. Aluminum conduit shall be cut with a saw to prevent reduction in internal area. All threads in steel conduit shall be given a coat of zinc dust in oil or other approved corrosion-preventive compound before making connections. Threads on aluminum conduit shall be given a coat of graphite or other approved compound. All connections and joints in all conduit runs shall be watertight and ensure a low resistance ground path in the conduit system. All conduit runs shall be swabbed to remove foreign matter before wires are pulled in. Conduit terminations in boxes, panels, switchboards, motor control centers, and other sheet metal enclosures shall be bonded together for grounding and be fitted with insulating bushings, O.Z./Gedney Type A, Thomas and Betts, or equal. Where grounding bushings are required by code or shown, O.Z./Gedney Type SBLG, Thomas and Betts, or equal shall be furnished.

Conduit shall be neatly grouped where several lines follow a parallel course, and shall be well supported, using galvanized clips or hangers of the ring or trapeze type. Clips, hangers, and support rods shall be held by self-drilling anchors, power-driven fasteners, or steel channel insets in the concrete ceilings or walls. Perforated strap hangers will not be accepted.

Conduit runs that enter the building from outdoors, or that pass through refrigerated or air conditioned areas, are subject to moisture accumulation due to condensation. A pull box shall be provided in the conduit run near the point of temperature change to prevent trapping of moisture within the conduit system. A 1/4-inch weep hole shall be drilled in the bottom of the pull box. After the wires and cables are installed, the end of the conduit continuing into the warmer area shall be packed with a nonsetting sealing compound.

W-76.06 Conduit Connections to Equipment

The conduit system shall terminate at the terminal box or at the conduit connection point of electric motors, devices, and equipment. Terminations of conduits at such locations shall permit direct wire connections to the motors, devices, or equipment.

Conduit connections shall be made with rigid conduit if the equipment is fixed and not subject to adjustment, mechanical movement, or vibration. Myers water-tight /dust-tight hubs shall be used for outdoor, below grade, or wash down areas. Rigid conduit connections shall have union fittings to permit removal of equipment without cutting or breaking the conduit.

Conduit connections shall be made with approved flexible nonmetallic conduit if the equipment is subject to adjustment, mechanical movement, or vibration. Flexible conduit connections shall be watertight.

W-76.07 Expansion Fittings

Expansion fittings shall be installed at all expansion joints and where required by codes. Conduit expansion fittings shall be Crouse-Hinds Type XD, O.Z./Gedney Type DX, or equal.

W-76.08 Terminal, Junction, and Pull Boxes

Junction and pull boxes shall be installed as shown and as required.

Surface-mounted junction and pull boxes, unless specified otherwise herein, shall be of cast aluminum complete with mounting lugs, threaded entry bosses and flange or rabbeted gasketed covers.

Surface-mounted junction and pull boxes which would exceed 50 pounds weight if cast or which are shown as fabricated sheet metal boxes shall be made of 1/8-inch sheet aluminum with sides return channel flanged around the cover opening or with approved welded angle or channel supporting frames. Sheet aluminum boxes shall be provided with mounting lugs or channels and with conduit termination hubs. All seams in sheet aluminum boxes shall be continuously welded and ground smooth. All surface boxes larger than 6 inches square shall be mounted a minimum of

3/4 inch clear of the mounting surface by means of offset lugs or support channels.

Fabricated junction and pull boxes which are partially or fully encased in concrete shall be made of 10-gauge sheet stainless steel and fabricated in a similar manner to the sheet aluminum pull boxes specified herein, complete with mounting lugs or channels and conduit termination hubs. Cast steel boxes shall be provided in smaller sizes where required for full or partial encasement in concrete.

All junction and pull boxes shall be provided with covers or doors as shown or required. Covers and doors shall be fabricated of materials equal in weight, gauge, structure, and metallic composition as the basic box. All covers shall be gasketed and held in place with nonferrous captive knurled head screw slot bolts. All pull and junction boxes shall be provided with hinged doors. Doors shall have continuous hinges, and 3-point catches with external handles and hasps for padlocks. All doors shall be gasketed.

All boxes shall be provided with partitions as shown and as required.

Fabricated boxes shall be rated NEMA 12 for indoor, above grade areas; rated NEMA 4X for outdoor areas; and manufactured by Hoffman, Hope, or equal.

W-76.09 Hazardous Areas

All conduit and equipment installed in or routed through hazardous areas, as well as other electrical appurtenances installed therein, shall be installed to conform in every respect to Chapter 5 of the NEC for Class I, Division 1, Group D hazardous locations. All material installed in hazardous areas shall be listed as complying with the requirements of the U.L. Inc. for use in Class I, Group D atmospheres. Terminal Boxes and Enclosures mounted in Hazardous Areas shall be NEMA 7, cast aluminum.

Sealing shall be provided for all conduits within and leaving hazardous areas as required.

W-76.10 Grounding System

A complete grounding system shall be in accordance with applicable ANSI, IEEE, and NEC Standards and local codes.

All noncurrent-carrying metal parts of the electrical wiring system shall be grounded. The grounding system shall include, but not be limited to, the following:

1. Motor control center controllers, ground bus, and enclosures.
2. All motor frames.
3. All conduit systems.
4. All mechanical equipment and structures.
5. Distribution and lighting panelboards.
6. Control, relay, and instrumentation panels.
7. Lighting fixtures and receptacles.
8. Fans, blowers, pumps, and similar equipment.

9. Hoist beams, cranes, and similar items.

A grounding connection from the transformer to the City water pipe shall be provided. The wire and conduit shall be attached to the City water pipe with a U.L. Inc. listed cast bronze U-bolt connector with silicon bronze bolts and nuts.

Motor frames shall be grounded by means of stranded, 600-volt insulated copper cables installed within the motor feeder conduit system. The cable shall be lug bolted to the motor terminal box and the ground bus of the motor control center serving the motor.

An equipment grounding conductor shall be installed in all electrical raceways, and shall be sized in accordance with Article 250.95 of the National Electrical Code (NEC).

Exposed or buried ground conductors shall be bare copper wires or bars of the proper sizes.

All exposed ground cables or bars shall be firmly and neatly supported in place at proper intervals. Where subjected to mechanical abuse, protective enclosures shall be provided.

Grounding conductors run in conduits with circuit conductors shall be stranded cable with 600-volt green XHHW, TW, THW, or RHW Code insulation.

Stainless steel ground rods shall be 5/8-inch diameter with the length as required, and made up of a 10-foot section with 5-foot sections added as required. Rods shall be driven to permanently moist soil.

Connections to ground rods, transformer case ground bus bars, case grounds, bare ground grid conductors, and the like, shall be made by an exothermic welding process or by clamps specifically designed for this application.

Ground conductor connections to ground bus bars in motor control centers, and the like, shall be cable lug bolted terminations equal to line conductor terminations specified hereinafter.

Welds embedded in the ground or concrete shall be cleaned and painted with an asphaltum base paint.

Tests shall be conducted by the Contractor and witnessed by the Engineer to determine the ground impedance for the entire system. The test shall be accomplished by using a ground loop impedance tester. The result shall not exceed 2 ohms at any point of test. If necessary, additional ground rods shall be installed at locations approved by the Engineer.

Care shall be exercised to ensure good electrical connections between the conduits and metallic enclosures of switchgear, control centers, and the like. Grounding jumpers shall be installed where necessary to accomplish this purpose.

W-76.11 Wires and Cables - General

Wires and cables required for all systems shall be complete, connecting all equipment and

control components. Conductors shall be of ample size, with suitable insulation as specified hereinafter.

W-76.12 600-Volt Wire and Cable - Conductors

All ground conductors and power, control, and lighting conductors shall be soft-drawn or annealed stranded copper wire meeting the requirements of ASTM B 3 or B 33. For lighting fixture and convenience outlet wiring only, conductors No. 10 AWG and smaller may be solid conductor. Conductors shall be sized to limit the maximum conductor temperature to less than 75°C, except where specifically stated otherwise. Table 310.16 of the NEC shall be the guide in determining 600-volt conductor sizes. The minimum size of conductor for power and lighting wiring shall be No. 12 AWG.

W-76.13 600-Volt Power and Control Cable - Insulation

Low voltage circuits shall be wired with 600-volt insulated conductors, sized as shown, or as required by the actual load to be served, whichever is larger.

Single Conductor: Insulation for single 600-volt copper conductors shall be cross-linked polyethylene compound, U.L. Inc. listed, NEC Type XHHW-2, with surface print cable identification; as manufactured by Okonite, American, Southwire or equal.

Multiconductor Cables: Individual conductors shall be insulated with 15 mils of polyethylene or PVC and 4-mil nylon jacket. The bundle of conductors shall be wrapped with tape binder and an outer jacket of not less than 45 mils of PVC. Use ICEA Method 1 for color coding wires.

W-76.14 Instrumentation / Data Cables - Insulation

4-20 mA Analog: Shielded two-conductor No. 16 AWG cables for instrumentation shall be properly stranded 600-volt insulated copper wire twisted cables as shown. Conductor insulation shall be polyethylene. Shields shall be overlapped metalized tape providing 100% coverage with tinned copper drain wire. Cable outer jacketing shall be of polyvinyl chloride. Cables shall be Belden #8719, or equal.

Three Conductor: Stranded No. 16 wire, 600 volt polyethylene insulation, twisted conductors, tinned copper drain wire, overlapped metalized tape overall shield providing 100 percent shield coverage and outer jacket of PVC. Belden Cat. No. 8618.

Category 5: Provide cable having third party verification to TIA/EIA 568-A Category 5 requirements and constructed of four pair of stranded No. 24 AWG solid copper wire, polyethylene or polypropylene insulation, stranded No. 24 AWG tinned copper drain wire, overlapped metalized tape overall shield providing 100 percent shield coverage and outer jacket of gray PVC. Belden Cat. No. 1624R.

Twinaxial (Data Highway): Provide stranded No. 20 AWG tinned copper wire (9.5 ohms/mile), 78 ohm nominal impedance, 300 volt polyethylene insulation, tinned copper drain wire,

overlapped metalized tape overall shield providing 100 percent shield coverage and 55 percent tinned copper braid shield (4.1 ohms/mile) and outer jacket of blue PVC. Belden Cat. No. 9463.

1-1/2 Pair (RS-485): Provide three stranded No. 22 AWG tinned copper wires with 300 volt FHDPE insulation, a tinned copper drain wire, overlapped metalized tape overall shield providing 100 percent shield coverage, 90 percent tinned copper braid shield and a PVC outer jacket. Insulated wires shall be configured as one twisted pair and one reference conductor— 120 Ohms characteristic impedance. Belden Cat. No. 3106A.

W-76.15 600-Volt Wire and Cable - Installation

The 600-volt wires and cables pulled into ducts and conduit shall be installed without the use of lubricants, except where such use is necessary and approved by the cable manufacturers and the Engineer. Wires and cables shall be carefully handled to avoid twists and kinks in the conductors or damage to the insulation. All trapped conduit and duct lines shall be swabbed to remove any accumulated moisture or debris before wires or cables are pulled in.

Cable reels shall be stored on concrete or other hard surface, or shall be lagged with 2 x 4 wood laggings providing 100% coverage.

No splicing will be permitted, except in junction boxes.

Lug bolting at terminals, devices, or bus bars shall be made up with a flat washer, a Belleville washer, and a locknut.

Lines of nylon or polypropylene, propelled by carbon dioxide or compressed air, shall be used to snake or pull wire and cable into conduits. Flat steel tapes or steel cables shall not be used.

W-76.16 600-Volt Wire and Cable - Splices and Terminations

Splices between copper conductors, size no. 10 AWG and smaller, shall be made up with compression type butt connections. Splices between copper conductors, size no. 8 AWG and larger, shall be made up with U.L. Inc. listed compression type tube connectors. Lug bolting at devices or bus bars shall be made up with a flat washer, a Belleville washer, and a locknut.

Splices and pigtail connections for lighting and receptacle wiring inside the buildings, no. 10 AWG and smaller, shall be made with a pre-insulated spring connectors, or equal.

Splices and lug terminations in 600-volt insulated cables shall be carefully taped and covered, using materials recommended by the cable manufacturer, to provide watertight insulation equal to that of the conductors.

Splices shall not be made within manholes unless specifically approved by the Engineer.

W-76.17 600-Volt Wire and Cable - Tests

The 600-volt insulated cables shall be factory tested prior to shipment in accordance with

IPCEA standards for the insulation specified.

The following 600-volt wires and cable shall be tested after installation but before final connections are made up:

1. All feeders from motor control centers to motors 30 horsepower and larger.
2. All feeders from variable speed drive units.
3. All feeders from motor control centers to lighting panels and dry-type transformers.

For the above listed cables, a test voltage of 1,500 volts AC shall be applied for a period of 1 minute between all conductors in the same conduit, and between each conductor and ground.

All tests shall be made at the Contractor's expense, and certification of the tests shall be submitted to the Engineer. If any failures occur during the tests, the Contractor shall replace the cable.

W-76.18 Identification of Circuits

All wires and cables shall be banded with an identifying number and color code at each end termination and at each splice point in junction boxes. The identifying number of each wire shall be determined at the point of circuit origin, and shall continue unchanged to the point of circuit termination. In each conduit system, the wire identifying numbers shall include the conduit designation with a numeral suffix. The numeral suffix shall start with No. 1 and continue as required.

Where conduits enter motor control centers, switchgear terminal cabinets, and the like, the identification tag shall be fastened to the wire bundle near the conduit termination. The tag shall be held by an adjustable, self-locking nylon "Ty-Rap" as manufactured by Thomas and Betts Co., or equal. The identifying tag shall be of aluminum, brass, rigid fiber, and shall be engraved, stamped, or painted with the scheduled conduit number.

The wire identifying numbers and color code shall be applied as PVC slip-on sleeves, properly fitted to the wire diameter. The sleeves shall be as manufactured by Brady Co., Thomas and Betts Co., or equal. Wires shall be color coded in conformance with the requirements of applicable codes.

W-76.19 Wire and Cable Connections to Equipment

Electrical connections shall be made to all equipment in strict accordance with the manufacturer's approved wiring diagrams, the Plans, or as approved by the Engineer. The Contractor shall be responsible for the accuracy of his work, and shall repair any damage and replace any damaged equipment resulting from erroneous connections.

W-76.20 Painting

Where aluminum surfaces such as boxes, conduit, or structural supports come in contact with incompatible metals, lime, mortar, concrete, or other masonry materials, the contact areas shall

be given one field coat of Koppers Metal Passivator No. 40 and one coat of Koppers Bitumastic Super Service Black or two coats of asphalt varnish conforming to Fed. Spec. TT-V-51.

* * *

SECTION 13400

GENERAL INSTRUMENTATION AND CONTROL

PART 1 GENERAL

1.1 SUMMARY

A. Section includes requirements for furnishing and installing instrumentation and annunciator systems including all work and materials necessary to perform control and monitoring functions as illustrated on drawings, and as specified in the following sections:

1. Section 13451 - PLC Systems

1.2 REFERENCES

A. Codes and Standards referred to in this Section are:

1. IEEE 802.3 10/100/1000 Mbps baseband networks
2. ISA-S5.4 Instrument Loop Diagrams.
3. NFPA 70 National Electrical Code
4. UL Underwriter's Laboratory
5. NEMA National Electrical Manufacturers Association

1.3 DEFINITIONS

A. Terminologies

1. Systems Integrator: Firms regularly engaged in providing instrumentation, Supervisory Control and Data Acquisition (SCADA) systems.

2. PLC: Programmable Logic Controller system, including power supply, central processing unit (CPU), communication controller, interconnect cables, and input and output interface.

3. HMI: Operator Workstation. Touch screen based operator interface system, including hardware, operating system software, and operator interface HMI system software; generally referred to as SCADA or HMI workstation.

4. SCADA (Supervisory Control and Data Acquisition): SCADA is an integrated network of PLCs, OITs, HMIs, servers, PCs, printers and network switches. It serves as the computer based system-wide monitoring and control system.

1.4 SYSTEM DESCRIPTION

A. General Description of Work

1. Provide a new Annunciator for monitoring and alarm for the existing Sewage Pumps as shown. The Annunciator cubicle shall contain a new General Electric (GE) Programmable Logic Controller (PLC) and Maple Systems Human Machine Interface (HMI).

2. The existing I/O signals connected to the existing hardwired Annunciators (associated with the existing pumps) will remain and be reused. All wired I/O will be terminated at the new Annunciator cubicle as shown on the drawings.

3. The Contractor shall be responsible for all hardware and software development and the subsequent fabrication of the proposed Annunciator System. The Contractor shall also be responsible for all conduit and conductor installation as shown on the drawings. City of Tampa (C.O.T.) Personnel will make the final connections to the existing SCADA PLC. All modifications to the existing SCADA PLC (hardware and software) will be performed by C.O.T. Personnel. The Contractor shall carefully identify all conductors, as specified, at each termination point to facilitate final SCADA connections by the C.O.T. The Contractor shall also assist C.O.T. Personnel with the Modbus mapping required for proper communications between the proposed Annunciator and existing SCADA PLC.

B. Programming and Software Configuration

1. Provide all programming and software configuration for the new Annunciator PLC as part of this contract work.

2. Provide all communications configuration and messaging as required to allow the new Annunciator PLC to communicate with the existing SCADA PLC currently located at the University Pump Station.

3. All I/O shall be shared between the new Annunciator PLC and the existing SCADA PLC

C. Provide all materials and work necessary for complete and fully functional systems.

1. Provide instrumentation and control components as well as system integration. Provide all mounting hardware and supports. Work shall include panel mounting and the completion of all wiring terminations within the Anunciator PLC Panel.

2. Coordinate work with all electrical, mechanical, and structural work furnished in this contract.

3. Ensure proper interface between PLC, HMI and network systems and equipment furnished in this contract.

4. Install, make final connections, adjust, test, start-up systems per manufacturer's instructions and recommendations.

C. Design Requirements

1. General: Provide instrumentation and control system for the University pumping station as indicated herein and as shown on drawings.

2. Provide the new PLC System to monitor all PLC controlled systems, which include all work performed in this contract.

D. Source Code Ownership

1. Any developed ladder logic (along w/ source code) shall become property of the City of Tampa. This applies to any Annunciator graphic screen development for the HMI as well.

1.5 SUBMITTALS

A. General: Provide submittals as specified in the Specific Provisions and as required below. Submit documents as follows:

1. Provide cover sheet on each submittal with the following information:

a. Project Title, Location and Owner

b. Submittal Title

c. Submittal Order (First Submittal, Re-submittal Number, etc.)

2. Organize and divide documents, using tagged dividers, into logical divisions.

3. Provide index sheets.

4. Minimum drawing size: 8-1/2 by 11 inches. Put drawings, larger than 11 by 17 inches, in three-hole plastic pockets.

5. Type all text.

6. Do not submit faxed documents.

B. Action Submittals

1. Product Data: Submit manufacturer’s official and published product data, specifications, and installation recommendations for each item.

2. Shop Drawings: Submit shop drawings as per the Specific Provisions, and as required below. Include the following information in each submittal:

   a. Instrument index, including tag number, description, location, and calibrated range for each instrument.

   b. Individual instrument specification sheet, including manufacturer's name and complete catalog number.

   c. PLC Input and Output drawings, containing, but not limited to, the following information:

      (1) Instrument tag numbers
      (2) Individual component locations
      (3) Actual equipment wiring terminal designations, point to point wiring, and cable shield terminations
      (4) Wire type, size and identification number
      (5) Signal types (e.g., 120 Volt ac, 4-20 mA DC, pulse frequency, etc.)
      (6) Contact orientations (e.g., normally open, normally closed, etc.)
      (7) Equipment grounding requirements
      (8) Signal boosters, interposing relays, optical isolators, and shunt resistors.

C. Information Submittals (for owner information, not for approval)

1. Test Reports: Submit all loop field calibration reports.

2. Manufacturer's Instructions: Submit manufacturer published installation manuals for each instrument.

D. Contract Closeout Information Submittals (for owner information, not for approval): Provide submittals as required below.

1. Project Record Documents: In addition to requirements described in the Specific Provisions, provide the following:

a. PLC program documentation: Provide paper copies of all PLC software development and configuration including listing of all PLC register tables.

b. Include functional narrative description of the developed ladder logic to describe each control system. Ladder logic is to be annotated as specified in Section 13451 to include functional alphanumeric description of logic elements to assist Owner in understanding the ladder logic for troubleshooting and future modification.

c. PLC program copies: Provide two digital copies of fully configured PLC systems. Digital copies shall be in CD-ROM format.

d. HMI program copies: Provide hard copy printouts and digital copies of new HMI screens and database listings. Digital copies shall be in CD-ROM format.

2. Operation and Maintenance Data: Provide operation and maintenance manuals as specified in the Specific Provisions. Include the following information:

a. Recommended spare parts list.

b. Manufacturer approved repair and service centers list.

c. Replacements part sources.

d. Recommended maintenance procedures and frequencies.

3. Warranty: Provide warranty certificate as described in the Specific Provisions.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements

1. Code Compliance: Comply with National Electrical Code (NFPA 70) and any and all local codes, applicable to construction and installation of electrical wiring, devices, material and equipment.

2. ECA Standards: Comply with applicable portions of National Electrical Contractor's Association's "Standard of Installation".

3. UL Labels: Provide control panel components, power supplies, controllers, relays, etc., which have been listed and labeled by Underwriter's Laboratories.

B. The purpose of contract drawings and specifications is to convey information required for complete and functioning systems. Systems Integrator is responsible for all details necessary to properly install, adjust, and place in operation, intended systems. "Instrument Schedules" and "PLC I/O Summaries" are provided for convenience; their accuracy is not guaranteed.

1.7 DELIVERY, STORAGE, AND HANDLING

A. General: Deliver, store, and handle all products and materials as specified in the Specific Provisions.

B. Packing and Shipping

C. Acceptance at Site: Inspect all materials and equipment against approved shop drawings at time of delivery. Immediately return for replacement or repair any equipment or materials damaged or not meeting requirements of approved shop drawings.

D. Storage and Protection: Label all equipment and materials after they have been inspected. Store all equipment and materials in dry, covered, ventilated location. Protect from harm in accordance with manufacturer's recommendations.

1.8 PROJECT/SITE CONDITIONS

A. Environmental Requirements: Protect all equipment and instruments specified herein from moisture.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Allowable hardware manufacturers are listed in the respective specification sections.

2.2 MONITORING AND CONTROL – GENERAL

A. These sections contains functional descriptions of the pump station equipment and processes to be monitored by (or through) the new PLC system.

B. Configure the PLC system to meet the functional requirements specified herein.

C. Make all register and I/O data available to the new Annunciator PLC and existing SCADA PLC.

D. PLC shall examine status of the input from each equipment item/group. PLC control logic and outputs shall be activated if the equipment begins to operate outside of normal limits.

2.2 HUMAN MACHINE INTERFACE (HMI) PANELS:

A. General: A human machine interface (HMI) shall be provided on the outer door of the enclosure for the annunciator panel and for the pump control panel.

B. HMI Annunciator Panel:

1. All alarm statuses, motor run statuses, and control statuses shall be through the HMI annunciator panel.
2. The HMI annunciator panel shall operate from 24 VDC, 1.6A max.
3. The HMI annunciator panel shall include a 15” color analog resistive touch screen with VGA 1024 x 768 resolution and 16 BIT color graphics.
4. The HMI annunciator panel shall be standard with 256 MB flash/RAM.

5. The HMI annunciator panel shall be compatible with serial protocol and Ethernet protocol.
6. The HMI annunciator panel shall include an RS-232 port, an Ethernet 10 Base-T port and two (2) USB ports.
7. The HMI annunciator panel shall be pre-programmed with graphical screen software, including alarms, trends, event logging, animation, security and symbol library.
8. The HMI annunciator panel shall be rated for NEMA 4/12 and IP65.
9. The HMI annunciator panel shall be a Maple Systems HMI 5150P touch screen or equal.

2.3 ALARM PROCEDURES

A. Program the PLC and local HMI to annunciate alarms.

1. When an alarm occurs, program associated PLC to function as follows:

a. Display alarm event in annunciator table format on the OIT.

B. Program the PLC to permit user to acknowledge the alarm from the OIT.

A. Alarm Schedule :

1. Pump No. 1 Drive Failure
2. Pump No. 1 Power Sense Relay
3. Pump No. 1 Motor Stator High Temperature
4. Pump No. 1 Motor Excessive Vibration
5. Pump No. 1 Pump Excessive Vibration
6. Pump No. 1 Discharge Valve Failed to Open
7. Pump No. 2 Drive Failure
8. Pump No. 2 Power Sense Relay
9. Pump No. 2 Motor Stator High Temperature
10. Pump No. 2 Motor Excessive Vibration
11. Pump No. 2 Pump Excessive Vibration
12. Pump No. 2 Discharge Valve Failed to Open
13. Pump No. 3 Drive Failure
14. Pump No. 3 Power Sense Relay
15. Pump No. 3 Motor Stator High Temperature
16. Pump No. 3 Motor Excessive Vibration
17. Pump No. 3 Pump Excessive Vibration
18. Pump No. 3 Discharge Valve Failed to Open
19. Pump No. 1 South Wet Well Low Level

20. Pump No. 3 North Wet Well Low Level
21. Pump No. 3 Overload Relay
22. Pump No. 3 E.C.C. Failure
23. Pump No. 3 E.C.C. High Discharge Air Temperature
24. South Bar Rack High Differential
25. South Wet Well High Level
26. Sump High Water Level
27. Door Security Switches
28. Engine-Generator Dry Tank
29. North Wet Well High Level
30. North Wet Well Low Level
31. North Bar Rack High Differential
32. Combustible Gas Detector
33. Combustible Gas in Screen Room
34. Automatic Transfer Switch
35. Low Air Pressure
36. Exhaust Blower Fault
37. Odor Control Stage-1 Fault
38. Odor Control Stage-2 Fault
39. Pump 1 Dangerous Vibration Shutdown
40. Pump 2 Dangerous Vibration Shutdown
41. Pump 3 Dangerous Vibration Shutdown

2.4 HUMAN MACHINE INTERFACE (HMI) SCREENS

A. HMI Screens:

1. The application programming for the integrated graphic display system for the pump control panel mounted HMI shall be provided by the Systems Integrator and coordinated with the OWNER. The HMI graphic screens shall be graphic representations of the equipment and processes controlled and monitored by the control panel. Each screen shall be developed, printed and submitted for approval by the OWNER.

2. Sample screen "A" is provided at the end of this specification section for reference. These sample screens portray the overall intent of what the Contractor is to provide in the development of the HMI graphic screens. These sample screens are not intended to provide a detailed representation of the graphics that are to be provided for the pumping station.

PART 3 EXECUTION

3.1 ERECTION, INSTALLATION AND APPLICATION

A. General

1. Install all instruments and equipment in strict compliance with manufacturer's instructions.

2. Mount all gages and indicators in upright position.

3. Provide sufficient space around equipment for maintenance and removal of equipment.

4. Cover front panels, gages and indicators during construction for protection from dust, weld and paint splatter.

5. Unless otherwise impractical, mount all indicating instruments at eye level (5 feet).

6. Unless otherwise impractical, support instruments independent of process piping.

B. Installation Hardware

1. Provide stainless steel nuts and bolts.

2. Provide aluminum or stainless steel support channels.

3. Provide 1/4-inch thick minimum, clear anodized aluminum equipment mounting plates.

4. Provide gaskets to prevent galvanic reaction between dissimilar metal surfaces.

C. Equipment Identification and Instrument Tags

1. Provide embossed stainless steel tags as specified in Section 13420.

2. Provide an engraved laminated plastic plate at each wall-mounted instrument panel, indicating panel and instrument function and tag.

3. Engraved laminated tag colors: Provide black lettering on white background. Mount tags at eye level.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspection: Provide tests as required in the Specific Provisions.

B. Inspection: Demonstrate that instruments, panels, and PLC equipment,

1. Has not been damaged by transportation or installation,

2. Has been properly installed,

3. Has no mechanical defects,

4. Has been properly connected.

C. Tests: Perform the following tests:

1. Field-calibrate all field instruments. Test all analog input loop zeroes and spans by disconnecting wiring at each transmitter and by connecting a 4-20mA generator.

2. Test all external alarm contacts by placing jumpers across normally open contact inputs, or by physically disconnecting wiring on normally closed contact inputs. These procedures shall be done at location of field contacts.

3. Conduct all tests in presence of Owner personnel or Engineer.

D. Manufacturers Field Service: Provide manufacturer field service for calibration, initial setup, programming and commissioning of each instrument.

END OF SECTION

PUMP #1	PUMP #2	PUMP #3		SWITCHGEAR
STOPPED	RUNNING	STOPPED		MAIN "A" CLOSED
0.0 % SPEED	67.8 % SPEED	0.0 % SPEED		MAIN "B" CLOSED
0.0 KW	97.3 KW	0.0 KW		TIE OPENED
0.0 AMPS	146 AMPS	0.0 AMPS		MAIN "A" AMPS
FAIL TO START	FAIL TO START	FAIL TO START		MAIN "B" AMPS
AFD READY	AFD READY	AFD NOT READY		MAIN "A" KW

W. W. UPSTREAM HIGH WARNING	P#2 FAILED TO START	P#2 STATOR SEAL LEAK
W. W. UPSTREAM HIGH ALARM	P#2 DISH. VALVE FAIL TO OPEN	P#2 CABLE SEAL LEAK
W. W. DWNSTREAM LOW WARNING	P#2 DISH. VALVE FAIL TO CLOSE	P#2 BEARING OVERTEMP.
BUBBLER CNTRL PWR FAIL	P#2 AFD FAIL	P#4 FAILED TO START
LEL GAS 25%	P#2 MTR STATOR OVERTEMP.	P#4 DISH. VALVE FAIL TO OPEN
LEL GAS 50%	P#2 STATOR SEAL LEAK	P#4 DISH. VALVE FAIL TO CLOSE
GAS DETECTOR OK	P#2 CABLE SEAL LEAK	P#4 AFD FAIL
P#1 FAILED TO START	P#2 BEARING OVERTEMP.	P#4 MTR STATOR OVERTEMP.
P#1 DISH. VALVE FAIL TO OPEN	P#3 FAILED TO START	P#4 STATOR SEAL LEAK
P#1 DISH. VALVE FAIL TO CLOSE	P#3 DISH. VALVE FAIL TO OPEN	
P#1 AFD FAIL	P#3 DISH. VALVE FAIL TO CLOSE	WASTEWATER FLOW MGD
P#1 MTR STATOR OVERTEMP.	P#3 AFD FAIL	
P#1 STATOR SEAL LEAK	P#3 MTR STATOR OVERTEMP.	
ALARMS		

PROPOSED ANNUNCIATOR SAMPLE SCREEN 1

PUMP #1	PUMP #2	PUMP #3	PUMP #4	SWITCHGEAR
STOPPED	RUNNING	STOPPED	STOPPED	MAIN "B" KW
0.0 % SPEED	67.8 % SPEED	0.0 % SPEED	0.0 % SPEED	MAIN "A" PF
0.0 KW	97.3 KW	0.0 KW	0.0 KW	MAIN "B" PF
0.0 AMPS	146 AMPS	0.0 AMPS	0.0 AMPS	MAIN "A" KVA
FAIL TO START	FAIL TO START	FAIL TO START	FAIL TO START	MAIN "B" KVA
AFD READY	AFD READY	AFD NOT READY	AFD READY	MCC-65A AMPS

SUMP PUMP LEVEL	SCREEN CONTROL POWER	COMPACTOR RUNNING
PLANT WATER PRESSURE	SCREEN RUNNING	COMPACTOR FAULT
HVAC TROUBLE	SCREEN FAULT	COMPACTOR LOW LOAD
	SCREEN SPRAY WASH FAILURE	COMPACTOR HIGH LOAD
LIGHTING ATS TROUBLE	SCREEN SPRAY WATER FLOW GPM	
LIGHTING ATS ON BUS "A"		
LIGHTING ATS ON BUS "B"	SCREEN ATS TROUBLE	
	SCREEN ATS ON BUS "A"	
	SCREEN ATS ON BUS "B"	
ALARMS		

PROPOSED ANNUNCIATOR SAMPLE SCREEN 2

NOTE:
1. THE ANNUNCIATOR HMI IS A MAPLE SYSTEMS # HMI015KP.
2. SCREEN 1 AND SCREEN 2 SHOWS THE INFORMATION DISPLAYED ON THE SAME HMI AT DIFFERENT TIMES AS CONTROLLED BY OPERATOR TOUCH-SCREEN INPUT.
3. DISPLAY GRAPHICS AND CHARACTERISTICS SHALL FOLLOW THE STANDARDS SET FORTH AT SULPHUR SPRINGS AND YBOR PUMPING STATIONS.

PLOT

FILENAME

ROMAN D. KORCHAK, P.E. #42626
ELECTRICAL SECTION HEAD
WASTEWATER DEPARTMENT

No.	DATE	REVISIONS
3		
2		
1		

DES: RDK
DRN: RDK
CKD:
DATE: 7/08/13

CITY of TAMPA
WASTEWATER DEPARTMENT

UNIVERSITY PUMPING STATION
PROPOSED ANNUNCIATOR SCREENS

W.O.
SHEET XXX OF

13400-13

UNIVERSITY PUMP STATION
PUMP No. 1 REPLACEMENT
CITY OF TAMPA
12/29/16

SECTION 13451

PROGRAMMABLE LOGIC CONTROL (PLC) SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. This section includes requirements for providing a Programmable Logic Control (PLC) system, local operator interface systems and all appurtenances required for monitoring of equipment and unit processes. The PLC will serve as the digital system interface to field devices and signals. The new PLC shall be connected to a OIT (OIT to serve as system Annunciator).

B. Programming and Software Configuration

1. All programming and software configuration for the new PLC shall be included as part of this contract work.

2. All programming and software configuration for the Annunciator shall be included as part of this contract.

C. Provide all submittal documents within 90 days of Notice to Proceed.

D. Work includes all elements of the systems specified. Provide all control hardware complete with power supplies, enclosures, accessories, and other appurtenances. Provide installation of new equipment, and testing necessary for the proper operation of the control system.

E. Related Sections

1. Section 13400 - General Instrumentation and Control

1.2 SYSTEM DESCRIPTION

A. Design Requirements

1. Program the PLC to achieve Sewage Pump monitoring described herein Section 13400.

2. Fully configure PLC system and appurtenances to form a complete working system.

C. Provide complete systems, which shall include, but not be limited to I/O racks or chassis, power supplies, input and output modules, special communication modules, local operator interface systems, and power and communication cables.

D. Provide one copy of PLC programming software and one copy of Annunciator system programming software as specified herein. Software licensing to be for the City of Tampa. Turn all software and manuals over to City personnel at job completion.

1.3 SUBMITTALS

A. Submit product data as required in Section 13400.

1. Submit data sheets and catalog literature on each type of equipment.

2. Submit programming and installation manuals for each type of equipment.

B. Documentation:

1. Provide all documentation related to PLC configuration.

2. Furnish all manuals, PLC logic documentation and application programmer's notes.

3. Furnish listing of PLC register tables.

4. Furnish hard copy printout of all PLC logic at project closeout.

C. Operation and Maintenance Manuals: Submit operation and maintenance manuals.

1.4 SPARE PARTS

A. Provide the following spare parts:

1. One PLC processor

2. One digital input module of each type utilized

3. One digital output module of each type utilized

4. One analog input module of each type utilized

5. One power supply assembly of each size utilized

6. One dozen fuses of each size furnished

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. General

1. Provide PLC as a versatile system that is easily user programmable, and assembled from a wide variety of modular, plug-together components. The PLC system shall comprise the Power Supply, CPU Serial Communications Module, I/O Modules, Backplane, and Cables as indicated on the drawings.

B. Manufacturer

1. To ensure compatibility with other Department of Sanitary Sewer control systems, and to limit the City's inventory of spare parts, the Programmable Logic Controller shall be a GE RX3i : IC695CPE305-ABAG. Do not substitute.

C. Baseplates

1. Provide as a basic minimum, at least one baseplate onto which all other PLC modules attach.

D. Power Supplies

1. Provide the power supply module to plug into the baseplate's left-most slot and be rated to power a fully loaded baseplate (CPU and maximum I/O). Provide power supply suitable for 120-VAC single phase input power.

E. CPU

1. Provide CPU to use the instructions in its firmware and application program to direct the PLC’s operation and to monitor the system to make sure there are no basic faults. Design the CPU to plug into the baseplate as a module; a CPU built into the baseplate is not acceptable.

F. Input and Output (I/O) Modules

1. Provide the required I/O modules to enable the PLC to interface with input and output field devices such as switches, sensors, relays, and solenoids.

Provide both discrete and analog I/O types as required by the application. Provide 16 channel discrete input and output modules. Provide a minimum of 25% spare I/O, or 2 spare I/O, (whichever is greater) for each type used.

H. Cables

1. Provide PLC manufacturer's standard prefabricated cables to connect the PLC components together or to other systems. For example, cables shall be provided to:

   a. interconnect baseplates
   b. connect a programmer to the CPU or to an option module
   c. connect option modules to field devices or other systems.

2. Provide cables of the proper length. No splices shall be allowed.

I. Software and Documentation

1. Program the PLC in ladder logic using IBM compatible software. Provide all configuration software and all necessary interface hardware and cables under this Contract to become the property of the City. The software is to be designed, developed, and documented by the Contractor. The Contractor shall be responsible for providing the details of the design and supplying the City with a set of reproducible as-built drawings. The Operation and Maintenance Manual shall include program documentation containing ample comments and a narrative of the actual working program with a symbol cross-reference legend for the system.

K. Operator Interface Terminal (to serve as Annunciator)

1. Provide 15-inch diagonal color graphic Operator Interface Terminal (HMI).

2. Display: 1024x768 TFT color.

3. Touchscreen: analog resistive

4. Communications:

5. Ethernet port

6. 3 serial ports, RS-232/RS-485

7. 2 USB ports

8. Multiple simultaneous protocols for multi-controller communications.

9. 256MB flash memory, 256MB SDRAM.

10. NEMA 4 enclosure suitable for 32-122 degrees F.

11. Power: 24VDC. Integrator to provide suitable DC power supply for the HMI.

12. Provide complete with Windows based configuration software and cables for the HMI.

13. Manufacturer: Maple Systems model HMI5150P. Do not substitute.

2.2 POWER SUPPLY

A. Provide a small UPS at PLC panel as indicated on the drawings for power conditioning and short duration power outages.

PART 3 EXECUTION

3.1 INSTALLATION AND APPLICATION

A. Inputs and Outputs Isolation

1. Design PLC discrete inputs to monitor dry contact closures, sourced from the PLC enclosure.

B. Provide all communication cables necessary for complete working systems. Provide surge protection on all communication ports as necessary.

C. Interface with Other Products

1. Provide all special interface modules necessary for complete working systems. These shall include all necessary cables and connectors as required.

D. Testing

1. Test all control function as described in Section 13400.

3.2 INPUT/OUTPUT SIGNAL SUMMARY SCHEDULE

A. Input and output signals for the Annunciator system shall be as specified in section 13400 and as shown on the drawings. The I/O is summarized by location in the table below.

B. The I/O summary represents the PLC hard-wired inputs and outputs for the Annunciator system specified in this Section.

C. Spare I/O shall be installed, wired and interfaced to the terminal strips.

D. Expandability. Allow any or all prewired spare points to become active points. Include related documentation changes. Spares utilization will be subject to following limitations.

1. Change will not be made subsequent to Submittal approval of PLC panel or process area loop drawings.

2. Treat changing of active points to spare points in same manner as incorporation of spares.

D. Signal types are as follows:

1. DI Digital (discrete) Input
2. DO Digital (discrete) Output

PLC Location	Signal Quantity			
	DI	DO	AI	AO
Annuciator PLC	43	1	0	0

3.3 ANNUNCIATOR PLC OPERATION

A. The PLC shall monitor the inputs as shown and allow the new HMI to display any alarm. The HMI display shall show the each alarm individually in a flashing box mimicking the Annunciator(s) to be replaced (subject to approval of the City of Tampa, shop drawing for the Annunciator screen(s) shall be submitted for review).

B. Each alarm shall be announced by the new horn to be provided. If an operator depresses the ‘Silence’ push button the alarm horn will no longer announce the initial alarm. Pressing the ‘Silence’ button shall not affect the HMI display.

C. If the operator depresses the ‘Acknowledged’ push button, the individual alarm on the HMI will no longer flash.

D. The individual alarm will remain on the HMI display until the situation generating the initial alarm is no longer present.

E. The initiation date and time of each individual alarm, the time and date of the alarm acknowledgement and the date and time at which an alarm is individual alarm no longer persists shall be provided to the existing SCADA PLC.

F. Refer also to specification section 13400 for other requirements.

END OF SECTION