

**Division 12 - Not Used**



## **Division 13 - Special Construction**



## SECTION 13400 – INSTRUMENTATION AND CONTROLS

### PART 1 - GENERAL

#### 1.01 SCOPE

- A. Work provided under this Division includes final system design implementation, furnishing all components, system installation services, required support services, and complete documentation for the Pretreatment Control System (PCS). This work shall include all materials, labor, and tools required to fabricate, deliver, unload, handle, erect, adjust, field calibrate, and test a complete and operable PCS as indicated on the Drawings and Specifications. This work shall not include system programming and configuration which is to be provided by the Engineer. Install all panels and designated instrumentation devices and provide all mechanical and pneumatic interconnections between the various components and their local sources of supply.
- B. The intent of these Specifications is for the System Manufacturer to provide a complete and operational PCS. Additional items of equipment, materials, or labor not specifically called for by these Specifications, which may reasonably be considered to make the system complete and operational, shall be supplied as part of this work.
- C. The new system shall be compatible with the existing Allen-Bradley protocol system previously installed at the plant.
- D. The Engineer shall be responsible for initial programming, data entry, alarms, events, reports and plant graphics display.

#### 1.02 DEFINITIONS

- A. Provide: Furnish, install, and connect.
- B. Product Data: Catalog cuts and descriptive literature.
- C. Shop Drawings: Factory prepared documentation, specific to the installation.
- D. Indicated: Shown on the Drawings.
- E. Noted: Indicated or specified elsewhere.

#### 1.03 WORK SPECIFIED ELSEWHERE

- A. Installation of Inline Instruments: Instruments such as magmeters, and control valves, which are specified in this Division and mounted in process piping, are installed under other Divisions.
- B. Vendor-Supplied Devices: Field instrumentation and panels supplied as part of mechanical equipment or equipment packages shall be furnished, installed, and calibrated under other Divisions.
- C. Conductors: Discrete signal conductors, twisted pair analog signal conductors, and RTD conductors are furnished and installed under Division 16. All other instrumentation and signal conductors, including digital data conductors and fiber optic cables are furnished under this

Division and installed under Division 16. Special cables for a particular instrument device which are specified in this Section are installed under Division 16.

- D. Raceways: All raceways and pulling of conductors are furnished under Division 16.
- E. Terminations: All control and signal conductor terminations are provided under this Section. This shall include, but not be limited to, terminations for all control panels and connections to motor protection relays, power monitoring units, and particle counters. Exceptions: HVAC control terminations are provided under Division 15. Interconnections between equipment and integral equipment control panels (i.e., package air compressors) are provided under the applicable equipment Section. Terminations to motor control centers and all power wiring terminations for new equipment are provided under Division 16.

1.04 PLANT CONTROL SYSTEM DESCRIPTION

- A. The PCS consists of operator interface, Plant Control Network, local control panels, field instruments and control devices, and other appurtenances noted in these Specifications. Also included are modifications to the existing FTTP PCS.
- B. Major components of the PCS are as follows:

Panel	Location	Area Controlled
HMI	Electrical Room	All Areas
LCP-PRET	Electrical Room	All Areas

- C. Modifications to Existing Panels
  1. When modifying existing panels in the Hypo Building, the System Manufacturer shall provide the required hardware and labor for installing all terminals, control system hardware, instrumentation devices, etc., including the termination of new signals in the existing panel.
  2. The System Manufacturer shall investigate the existing control panel prior to modification. Any installed new components, sub-panels, etc., shall not block access to any existing instrumentation, control system hardware, or terminations. Existing documentation may be of some help to the System Manufacturer, but may not be completely correct. The System Manufacturer shall determine the existing wiring, logic, and functionality via a combination of field investigation and communication with plant operation and maintenance personnel. Existing wiring, logic, and functionality shall be documented by the System Manufacturer prior to any changes being made or wires being disconnected so that re-wiring can be completed accurately.
  3. The modifications shall follow the general installation guidelines, where applicable, for new panels listed in Section 13482. Provide all nameplates, wire markers, wire duct, surge protection, and any additional components required by Section 13482 for new panels.

1.05 QUALITY ASSURANCE

- A. The Contractor shall ensure that the PCS is an integrated system furnished by the System Manufacturer who shall provide all of the equipment and appurtenances, regardless of manufacture and be responsible to the Contractor for correct operation of the entire system.

- B. The System Manufacturer shall be responsible for the detailed design implementation and the proper functioning of the PCS, preparation of required submittal data including operations and maintenance manuals, preparation of test procedures, factory and field tests, start-up including field calibration, operational demonstrations, providing technical supervision for installation and connections to equipment, and training of the Owner's operating personnel.
- C. The System Manufacturer shall be regularly engaged in the type of work called for under these Specifications and must have capital facilities, personnel, plant, and service capabilities required to successfully perform the work. The System Manufacturer shall employ competent personnel experienced in the design, and manufacture of equipment and systems required. The System Manufacturer shall assign an experienced person who shall act as Project Manager. This person shall have responsible project experience on similar systems of a comparable complexity to that specified herein.
- D. The System Manufacturer shall have in employment, a permanent field service organization capable of providing service and maintenance of the system.
- E. The System Manufacturer shall have installed similar systems which have been in satisfactory operation to establish the reliability of the equipment proposed to be furnished.
- F. Acceptable Manufacturers:
  - 1. ADGO Engineering & Controls, Cincinnati, Ohio.
  - 2. Rawdon Myers, Inc., Milford, Ohio.
  - 3. Panelmatic Cinti, Inc., Fairfield, Ohio.
  - 4. Panel FAB, Inc., Cincinnati, Ohio.

#### 1.06 SUBMITTALS

- A. The System Manufacturer shall make submittals in accordance with the requirements of Section 01340. The submittal shall be divided into separate sections as listed below. Refer to related work sections for additional requirements.
- B. Field Devices: This Section shall include primary elements, transmitters, switches, analytical instruments, etc. List all dimensions, power requirements, enclosure types, ranges, and signal form or value. Provide data, including proposed length, on special cables required between sensing elements and electronics units and data on any special equipment used for calibration or maintenance of a particular device. Field device submittals shall also include specific data sheets for each device which shall contain the following information:
  - 1. Tag number per Specifications and Drawings.
  - 2. Manufacturer's complete model number with complete model number breakdown.
  - 3. Input – output characteristics.
  - 4. Range, size, and graduations.
  - 5. Physical size with dimensions, NEMA enclosure classification and mounting details.
  - 6. Materials of construction of all components.
  - 7. Instrument or control device sizing calculations where applicable.
  - 8. Certified calibration data on all flow metering devices.
  - 9. Environmental requirements during storage and operation.

## 10. Power requirements.

- C. Digital System Hardware: This Section shall include computer hardware complete with printers, magnetic storage devices, cables, UPS systems, and other peripherals. Include PLC hardware, communications hardware, and LAN and data highway conductors.
- D. Digital System Software: This Section shall include documentation on system software, standard software packages supplied, and custom software developed for reports, process control, and graphic displays.
- E. Control Panels: This Section shall include dimensions, terminal block designations, front panel arrangement, back panel layout, and ladder logic diagrams for both PLCbased and discrete component type control panels, etc. Provide catalog sheets for all panel components, indicate ranges, and provide nameplate schedules. All connections for new instruments terminating in the System Manufacturer's panels shall be clearly shown. All devices installed in each panel or connected to each panel, shall be identified on the panel drawings by the tag number included in the Specifications and Drawings. Any miscellaneous equipment not clearly falling into one of the above volumes, including recommended spare parts list, shall be included in the control panel volume.
- F. Loop Diagrams: This Section includes no more than 10 typical loop diagrams for approval of format only. The submitted loop diagrams shall represent different types of process measurements.
- G. Factory Test: This Section shall include the witness test and final checkout procedural outline detailed in Article 3.04.

## 1.07 CONSTRUCTION DOCUMENTATION

The System Manufacturer shall provide loop diagrams to the Contractor. The Contractor shall provide loop diagrams to the electrical subcontractor. Loop diagrams shall be issued as a group with the delivery of their respective control panel or area instrumentation. Two sets of loop diagrams shall be issued to the electrical contractor and one set to the Engineer.

## 1.08 RECORD DOCUMENTATIONS

- A. General: Record documentation shall be provided in accordance with Section 01720. Additionally, provide all information listed in Article 1.06 above, corrected to reflect the system as installed. Include also any instruction books, operation manuals, and other information pertaining to service and maintenance. Bind record documents in 3-ring, hardback notebooks complete with tabs and index. Include name, address, and telephone number for each manufacturer's service contact. For all major components, provide a recommended spare parts list.
- B. Loop Diagrams:
  - 1. Provide an individual wiring diagram for each analog and discrete loop showing all terminations, terminal numbers, conductor numbers, cable numbers, the location of the DC power supply, power panel, and circuit numbers for all 120 VAC power to field instruments, signal polarity, the location of any dropping resistors, surge protectors, shielding, grounding, etc. Devices shall be identified by the tag number



included in the Specifications and Drawings. Cabling between sensors/elements and associated transmitter shall be included. The loop diagrams shall meet the minimum requirements of ISA S5.4 plus the requirements below.

2. Each loop diagram shall be divided into areas for identification of device locations (e.g. panel face, back-of-panel, field, etc.). Loop diagrams shall be on 11 x 17 inch drawings.
  3. The loop number shall be incorporated into the loop diagram drawing number. If the System Manufacturer does not have any specific loop diagram drawing number requirements, the drawing number shall be the loop number (the drawing number for loop F-1004 would be 1004). If a requirement exists (one requirement may be to incorporate the project number XXXXXX), the loop number shall be included as the suffix. The drawing number for loop F-1004 would be XXXXXX1004.
- C. Instrument Hardware: Record documents shall include bills of material, front views, assembly drawings, component layout drawings and schematics, nameplates, schedules, electrical schematics, electrical connection diagrams, and tubing/piping connection diagrams. Electrical and piping connection diagrams shall show all terminations of equipment, complete with instrumentation, wire, equipment, and cable designations. Interconnecting diagrams shall be prepared in a neat and legible manner on 11 x 17-inch or 24 x 36-inch sheets.
- D. Software Documentation: In addition to the hard copies of drawings, programming and literature generated specifically for the project, two sets of compact disks shall be provided to the Owner with copies of all custom files specifically created for the project, including all panel drawings, I/O drawings, termination drawings, communication architecture drawings, data sheets, bills of material, operating procedures, etc. Additional files included in this set shall be PLC programs and copies of the operator interface software application program. Drawing format shall be the latest version of AutoCAD. All Drawings shall also be furnished as Acrobat \*.pdf files. Include copies of all \*.shp and \*.shx files used in the AutoCAD drawings. Compact discs shall have a complete listing of their contents along with the names and version numbers of the software used to generate each file. Discs shall be clearly identified by the following:
1. Project Name
  2. Volume Number
  3. Labeled "AS-INSTALLED"
- E. Configuration Documentation: Instrument Configuration and Calibration sheets shall be generated for all instruments requiring configuration and/or calibration. The intent of the Instrument Configuration and Calibration sheets is to provide all necessary information required to enable the Owner to calibrate and/or configure a replacement instrument identical to the original instrument. One sheet shall be provided for each instrument. The sheets shall be 8-1/2 x 11 inch size and shall be included in the O&M Manual. Each sheet shall list the instrument tag number (as depicted on the Drawings and Specifications), the date, the System Manufacturer company name and phone number, the name of the individual who filled out the sheet, the instrument manufacturer's name and phone number, the complete model number, the calibrated range, and all configuration information.
- F. SCADA Documentation: Generate a SCADA software document containing the following information for each SCADA related software product purchased.
1. The facility/plant name where the software is installed.

2. The computer name that the software is installed on (master SCADA workstation, historical data computer, etc.).
3. The computer manufacturer and model, processor speed, and installed RAM.
4. The computer operating system (model and version).
5. The product name, version, and serial number.
- f. The name and quantity of client licenses (if applicable).
6. The product name and version of all supporting software installed.
7. The date purchased and the company name it was purchased from.
8. The name of the person purchasing the software, and the person's company name.
9. The date the software was installed.

#### 1.09 ENVIRONMENT

- A. Local Control Panels: Local control panels shall be capable of operating between 32 degrees and 120 degrees F and 5 to 95 percent relative humidity without condensation. A 120 VAC single-phase, three-wire grounded power source will be supplied.
- B. Field Devices: Field devices shall be housed in NEMA 4X enclosures. Ambient temperature rating shall be suitable for the project locale. All enclosures, including field instruments and control panels, which are located out-of-doors shall be provided with adequate sunscreens.

#### 1.10 DELIVER, STORAGE, AND HANDLING

- A. After completion of shop assembly and tests, control panels shall be enclosed in heavy polyethylene envelopes to provide complete protection from dust and moisture. Desiccant materials shall be placed inside the envelope prior to sealing. The equipment shall then be mounted on skids, enclosed in protective boxes, and braced for final transport. Removable lifting rings shall be provided on all sections weighing more than 150 pounds to permit moving without removal of protective covering. Shipping weights shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling on the job site. If practical, termination cabinets shall be delivered first to permit field wiring to be complete and checked out before receipt of remainder of equipment. None of the control room equipment shall be delivered until the environmental services required by the Specifications and Drawings are available and operating in accordance with manufacturer's specifications.
- B. The Contractor shall be fully responsible for moving the equipment through new and existing facilities and setting it in the proper location.

#### 1.11 WARRANTY

- A. Warranty Period: One year following the date of system acceptance.
- B. Warranty Requirements: In accordance with Division 1 and the following:
  1. Corrective hardware maintenance shall be performed by a trained service technician specifically trained to service the equipment involved. The technician shall be available, on-site, within 24 hours after notification by the Owner.
  2. Software maintenance shall be performed by suitably qualified individuals from the System Manufacturer's software service staff. Representatives from third party software sources may additionally be involved, but the System Manufacturer shall be represented at all times during on-site services. Software service representative shall be

available for consultation within four hours and, if required, on-site within 16 hours after notification by the Owner.

3. Deliver a copy of all service reports to the Owner on the day the work is performed.

## PART 2 - PRODUCTS

### 2.01 EQUIPMENT

- A. **Quality Standards:** It is not the intention of these Specifications to detail every component, accessory, signal conditioning device, etc. that is required to provide a complete system. The System Manufacturer shall provide all required components, using equipment from established manufacturers with a proven history of service and support.
- B. **Electronic Equipment:** All solid state, printed circuit boards and components shall be suitable for the specified environment. Provide complete circuit diagrams for troubleshooting and repair. All parts shall be replaceable with standard commercial components without degrading the performance of the completed assembly.

### 2.02 SPARE PARTS

- A. The System Manufacturer shall supply spare parts for the Plant Control System.
- B. The System Manufacturer shall provide a list of all spare parts being provided under this Division. The spare parts list shall be included in the documents to be reviewed by the Engineer during the shop drawing review process. The spare parts shall include, but shall not be limited to, the items included in the list below.
  1. One lot of PLC I/O Card Fuses, 5 spare fuses for each type of fuse used in PLC I/O cards.
  2. One lot of PLC Fuses, 5 spare fuses for each type of fuse used in PLC hardware (excluding I/O cards).
  3. One lot of Terminal Fuses, 5 spare fuses for each type of miscellaneous fuse used in local control panels.
  4. One lot of surge protectors, including 5 spare of each type used.
  5. One 24 VDC power supply

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. The System Manufacturer shall assign a full time representative to provide coordination and supervision of on-site PCS construction work. The individual is to be on-site during all times when PCS work is being done.
- B. The system, peripherals, and accessory equipment shall be installed in accordance with the manufacturer's instructions and located as shown on the Drawings unless otherwise approved by the Engineer.

- C. All work shall be executed in full accordance with all applicable codes and local rulings. Should any work be performed contrary to said rulings, ordinances, or regulations, the System Manufacturer shall bear the full responsibility for such violations and assume all costs arising therefrom.
- D. The Contractor shall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the manufacturer shall ship the equipment in sections sized to permit passage through such areas.

### 3.02 SYSTEM NOISE REJECTION

- A. Electrical isolation shall be provided between input systems and the processor units. Noise rejection for common mode shall be at least 100 decibels from 0 to 100 Hertz, and up to 175 volts. Normal voltage rejection shall be not less than 35 decibels at 60 Hertz.
- B. All instrument signal wiring, control wiring, and AC control power wiring shall be protected against lightning, spikes, and other transient surges at all field and control panel termination points per the requirements of Section 13401.

### 3.03 GROUNDING

- A. Bond all instrument and control panel enclosures to the power system ground.
- B. Ground analog signal conductor shields at the control panel end only.

### 3.04 TESTS AND ACCEPTANCE

- A. The equipment and programs shall be factory-tested prior to shipment for compliance with the conditions of this Section, these Specifications, and for environmental conditions. If the factory acceptance test is conducted outside a 150 miles radius of FTTP, then the Contractor shall include in their bid, the cost for two (2) NKWD employees to witness the test. This includes airfare, ground transportation, meals and lodging.
- B. Factory Testing: Factory-test setup shall demonstrate peripheral performance. All discrete and analog points shall be verified. A 100-hour burn-in test shall be performed on all solid-state devices. The Owner reserves the right to witness the factory tests. At least 20 days written notice shall be given to the Owner and the Engineer by the Contractor prior to the date of starting factory tests. Submit detailed witness test and final checkout procedural outlines for approval to the Engineer not less than 60 days prior to starting factory tests. Testing shall include the complete system with all cabinet doors in place and peripherals attached, for an agreed to period time, with documentation via periodic printouts.
- C. After installation of the complete system, the System Manufacturer shall provide the services of a qualified systems engineer to test the complete system under the observation of the Owner or Owner's representative to verify that all functions specified are performed without error or malfunction. As a part of the test procedure, Contractor's personnel, when requested by the system supplier, shall cause each remote process to change state or value three times to verify all functions during the checkout period. This shall be repeated until the system performs correctly to the satisfaction of the Owner or Owner's representative.

### 3.05 START-UP ASSISTANCE

The System Manufacturer shall provide the on-site services of a project engineer for a minimum of one day for start-up assistance. The individual provided shall be familiar with the Project and with all software packages and supplied hardware.

### 3.06 TRAINING

- A. The cost of training programs shall be included in the Control Price. The training and instruction shall be directly related to the PCS being supplied.
- B. The System Manufacturer shall provide system hardware maintenance training courses for designated Owner's personnel. The courses shall be taught by professional, full-time instructors. All course materials required to adequately support the material presented shall be included. The System Manufacturer shall bear the cost of student transportation, meals, and lodging for any courses taught away from the Owner's facility. The System Manufacturer shall set the schedule for all courses with the Owner at least 20 days prior to the proposed date.
- C. The System Manufacturer shall videotape all training sessions and deliver to the Owner one (1) copy of each session.

END OF SECTION



## SECTION 13401 – SURGE PROTECTION

### PART 1 - GENERAL

#### 1.01 SCOPE

Comprehensive surge protection for all instrumentation devices supplied as part of these Specifications.

#### 1.02 GENERAL

- A. It is the responsibility of the System Manufacturer to provide appropriate protection against transients and surges for all field instruments, field wiring, and devices interfacing with control panels. All instrument signal wiring, control wiring, telephone wiring, and data transmission wiring which enters or exits buildings shall be protected against lightning strikes, and other transient surges at all control panel termination points. All instrument signal wiring, control wiring, telephone wiring, and data transmission wiring which terminates out-of-doors shall be protected against lightning strikes, and other transient surges at all termination points. All AC control power wiring shall be protected against lightning strikes, and other transient surges at all control panel termination points. Lightning and surge devices shall protect the system from induced surges in analog, discrete, and control circuitry and power supply lines. The protective devices shall not interfere with the normal operation of the panel hardware and shall be designed not to have a maximum clamping voltage in excess of what the protected device is capable of withstanding.
- B. All field instruments located indoors or out-of-doors provided by the System Manufacturer under this contract shall be supplied with surge protection for 120 VAC power to the instrument.
- C. Surge protectors shall include a combination of surge suppression technologies including metal oxide varistors, gas discharge tubes, diodes, and 3AG size fuses for line-to-line and line-to-ground protection.

#### 1.03 SUBMITTALS

Submit detailed product data.

### PART 2 – PRODUCTS

#### 2.01 FIELD INSTRUMENTS – ANALOG SIGNALS

- A. Direct mounted surge protectors for analog signals shall screw directly into the unused conduit entry hub of the instrument. The surge protector housing shall be 304 stainless steel minimum. Surge protectors shall be specifically manufactured for protecting field instruments.
- B. Where direct mount is not possible, the surge protectors for analog signals shall be

located as close to the field instrument as practical. The surge protector shall berated NEMA 4X or shall be mounted in a stainless steel NEMA 4X enclosure.

2.02 FIELD INSTRUMENTS – DISCRETE SIGNALS

Surge protectors for discrete signals wiring shall be located as close to the field instrument as practical. The surge protector shall be NEMA 4X or shall be mounted in a 304 stainless steel NEMA 4X enclosure.

2.03 CONTROL PANELS

- A. All instrument analog and discrete signal wiring, data transmission wiring, and 120 VAC power supply wiring which enters or exist buildings or which terminates out-of-doors shall be individually protected against lightning strikes and other transient surges at all control panel termination points.
- B. Provide surge protectors for all power wiring to control panels whether located indoors or out-of-doors.

2.04 INSTRUMENT POWER WIRING

Provide surge protectors for all power wiring to individual instrument devices whether located indoors or out-of-doors. For instrument devices, protection shall be located as close to the device as practical. The surge protector shall be NEMA 4X or shall be mounted in a NEMA 4X enclosure. Outdoor enclosures shall be NEMA 4X stainless steel. Indoor enclosures shall be NEMA 4X, fiberglass.

2.05 MISCELLANEOUS DIGITAL EQUIPMENT

Provide surge protection for all computers, printers, uninterruptible power supplies, digital equipment power supplies, PLCs, fiber optic modems, telephone modems, digital signal converters, and other miscellaneous digital hardware to include communications wiring and 120 VAC power supply wiring for each device.

Surge Protector Acceptable Model Numbers		
	Telematic	Phoenix Contact
Field Instrument Analog Signals Direct Mounted	TP48	S-PT1-2PE-24VDC
Field Instrument Analog Signals Remote Mounted	SD Series	UFBK-M2-PE Series
Analog Signals Control Panel	SD Series	UFBK-M2-PE Series
120 VAC Power Control Panel	MA Series	UAK2-PE/S Series
Discrete Inputs/Outputs Control Panel	SD Series	UFBK-2/2 Series
RS-232	NP Series	MT Series, D-UFB
RS-485	NP Series	MT Series, D-UFB



Telephone Line	DP200 Series	TELETRAB-4X Series
Ethernet	NP Series	D-ETH Series
Antenna Cable	CA Series	COAXTRAB Series

## PART 3 – EXECUTION

### 3.01 INSTALLATION

- A. Install all surge protection equipment in strict accordance with manufacturer's guidelines.
- B. For surge protectors located out-of-doors and for antenna surge protectors, surge protector grounding shall use individual ground rods located as close to the surge protector as possible. The grounding conductor shall be sized in accordance with manufacturer's recommendations and be routed via the shortest path possible. Bends in the grounding conductor shall be avoided. If bends in the grounding conductor are unavoidable then the number of bends shall be kept to an absolute minimum.
- C. Provide installation for all field mounted surge protection equipment. Provide for all wiring terminations for surge protection equipment.
- D. If a particular piece of equipment is protected by two surge protectors in series, ensure that the resulting equipment protection is not diminished.

END OF SECTION



## SECTION 13402 - INSTRUMENT I/O LISTING

### PART 1 - GENERAL

#### 1.01 SCOPE

- A. This Section includes a detailed listing of control system I/O requirements associated with this Project. Different numbers of I/O may be required, based on System Manufacturer design. The following lists are attached:

1. LCP-PRET
  - a. PLC Rack Configuration
  - b. I/O List



<b>LCP-PRET Rack Configuration</b>		
<b>Slot</b>	<b>Part No.</b>	<b>Module Type</b>
--	1756-PA75	Power Supply
0	1756-L62	ControlLogix Processor w/4MB user memory
1	1756-ENBT	Ethernet Module 10/100MB
2	1756-N2	Slot Filler
3	1756-1F8	8-channel Isolated Analog Input Module
4	1756-1F8	8-channel Isolated Analog Input Module
5	1756-1F8	8-channel Isolated Analog Input Module
6	1756-OF8	8-channel Isolated Analog Output Module
7	1756-OF8	8-channel Isolated Analog Output Module
8	1756-N2	Slot Filler
9	1756-IB16	16-Channel 24 VDC Input Module
10	1756-IB16	16-Channel 24 VDC Input Module
11	1756-IB16	16-Channel 24 VDC Input Module
12	1756-IB16	16-Channel 24 VDC Input Module
13	1756-IB16	16-Channel 24 VDC Input Module
14	1756-N2	Slot Filler
15	1756-OA16	16-channel Isolated AC Output Module
16	1756-N2	Slot Filler

I/O Type	I/O Ref	Control/Logix Address	Field Device	P&ID	Tag	Description 1	Description 2	Description 3	Description 4	EGU Min	EGU Max	EGU units	Comments
AI	1	LOCAL:3:I:Ch00Data	FCP-Copper-FDR-1	I-2	SI-110	FT-Copper-FDR-1	Speed			0	100 %		
AI	2	LOCAL:3:I:Ch01Data	FCP-Copper-FDR-2	I-2	SI-210	FT-Copper-FDR-2	Speed			0	100 %		
AI	3	LOCAL:3:I:Ch02Data	FCP-Copper-MP-1A	I-2	SI-130	FT-Copper-MP-1A	Speed			0	100 %		
AI	4	LOCAL:3:I:Ch03Data	FCP-Copper-MP-1B	I-2	SI-140	FT-Copper-MP-1B	Speed			0	100 %		
AI	5	LOCAL:3:I:Ch04Data	FCP-Copper-MP-2A	I-2	SI-230	FT-Copper-MP-2A	Speed			0	100 %		
AI	6	LOCAL:3:I:Ch05Data	FCP-Copper-MP-2B	I-2	SI-240	FT-Copper-MP-2B	Speed			0	100 %		
AI	7	LOCAL:3:I:Ch06Data	FE/FIT-170	I-2	FI/RQ-170	Copper Sulfate	Solution Line	Flow		0	100 %		
AI	8	LOCAL:3:I:Ch07Data	FCP-Carbon-Silo	I-3	SI-310A	FT-PAC-FDR-1	Speed			0	80	GPH	
AI	9	LOCAL:4:I:Ch00Data	FCP-Carbon-Silo	I-3	SI-310B	FT-PAC-FDR-2	Speed			0	100 %		
AI	10	LOCAL:4:I:Ch01Data	FE-370A/FIT-370	I-3	FI/RQ-370A	PAC	Solution Line	Flow		0	100 %		
AI	11	LOCAL:4:I:Ch02Data	FE-370B/FIT-370	I-3	FI/RQ-370B	PAC	Solution Line	Flow		0	20	GPM	
AI	12	LOCAL:4:I:Ch03Data	LIT-430	I-4	LIR-430	FT-KMNO4-ST-1	Tank Level	Flow		0	20	GPM	
AI	13	LOCAL:4:I:Ch04Data	FCP-KMNO4-MP-1	I-4	SI-440	FT-KMNO4-MP-1	Speed			0	7	Feet	
AI	14	LOCAL:4:I:Ch05Data	FCP-KMNO4-MP-2	I-4	SI-450	FT-KMNO4-MP-2	Speed			0	100 %		
AI	15	LOCAL:4:I:Ch06Data	FE/FIT-470	I-4	FI/RQ-470	Potassium Perm	Solution Line	Flow		0	100 %		
AI	16	LOCAL:4:I:Ch07Data	Spare							0.6	60	GPH	
AI	17	LOCAL:5:I:Ch00Data	Spare										
AI	18	LOCAL:5:I:Ch01Data	Spare										
AI	19	LOCAL:5:I:Ch02Data	Spare										
AI	20	LOCAL:5:I:Ch03Data	Spare										
AI	21	LOCAL:5:I:Ch04Data	Spare										
AI	22	LOCAL:5:I:Ch05Data	Spare										
AI	23	LOCAL:5:I:Ch06Data	Spare										
AI	24	LOCAL:5:I:Ch07Data	Spare										
AO	25	LOCAL:6:O:Ch00Data	FCP-Copper-FDR-1	I-2	SHK-110	FT-Copper-FDR-1	Speed Control			0	100 %		
AO	26	LOCAL:6:O:Ch01Data	FCP-Copper-FDR-2	I-2	SHK-210	FT-Copper-FDR-2	Speed Control			0	100 %		
AO	27	LOCAL:6:O:Ch02Data	FCP-Copper-MP-1A	I-2	SHK-130	FT-Copper-MP-1A	Speed Control			0	100 %		
AO	28	LOCAL:6:O:Ch03Data	FCP-Copper-MP-1B	I-2	SHK-140	FT-Copper-MP-1B	Speed Control			0	100 %		
AO	29	LOCAL:6:O:Ch04Data	FCP-Copper-MP-2A	I-2	SHK-230	FT-Copper-MP-2A	Speed Control			0	100 %		
AO	30	LOCAL:6:O:Ch05Data	FCP-Copper-MP-2B	I-2	SHK-240	FT-Copper-MP-2B	Speed Control			0	100 %		
AO	31	LOCAL:6:O:Ch06Data	FCP-Carbon-Silo	I-3	SHK-310A	FT-PAC-FDR-1	Speed Control			0	100 %		
AO	32	LOCAL:6:O:Ch07Data	FCP-Carbon-Silo	I-3	SHK-310B	FT-PAC-FDR-2	Speed Control			0	100 %		
AO	33	LOCAL:7:O:Ch00Data	FCP-KMNO4-MP-1	I-4	SHK-440	FT-KMNO4-MP-1	Speed Control			0	100 %		
AO	34	LOCAL:7:O:Ch01Data	FCP-KMNO4-MP-2	I-4	SHK-450	FT-KMNO4-MP-2	Speed Control			0	100 %		
AO	35	LOCAL:7:O:Ch02Data	Spare										
AO	36	LOCAL:7:O:Ch03Data	Spare										
AO	37	LOCAL:7:O:Ch04Data	Spare										
AO	38	LOCAL:7:O:Ch05Data	Spare										
AO	39	LOCAL:7:O:Ch06Data	Spare										
AO	40	LOCAL:7:O:Ch07Data	Spare										
DI	41	LOCAL:9:I:Ch00Data	FCP-Copper-FDR-1	I-2	YI-110A	FT-Copper-FDR-1	In Remote						
DI	42	LOCAL:9:I:Ch01Data	FCP-Copper-FDR-1	I-2	YI-110B	FT-Copper-FDR-1	In Auto						
DI	43	LOCAL:9:I:Ch02Data	FCP-Copper-FDR-1	I-2	LAL-110A	FT-Copper-FDR-1	Hopper						
DI	44	LOCAL:9:I:Ch03Data	FCP-Copper-FDR-1	I-2	LAL-110B	FT-Copper-FDR-1	Mix Tank	Low Level					
DI	45	LOCAL:9:I:Ch04Data	FCP-Copper-FDR-1	I-2	MN-110	FT-Copper-FDR-1	Running	Low Level					
DI	46	LOCAL:9:I:Ch05Data	FCP-Copper-FDR-1	I-2	XA-110	FT-Copper-FDR-1	Fault						
DI	47	LOCAL:9:I:Ch06Data	FCP-Copper-FDR-2	I-2	YI-210A	FT-Copper-FDR-2	In Remote						
DI	48	LOCAL:9:I:Ch07Data	FCP-Copper-FDR-2	I-2	YI-210B	FT-Copper-FDR-2	In Auto						
DI	49	LOCAL:9:I:Ch08Data	FCP-Copper-FDR-2	I-2	LAL-210A	FT-Copper-FDR-2	Hopper						
DI	50	LOCAL:9:I:Ch09Data	FCP-Copper-FDR-2	I-2	LAL-210B	FT-Copper-FDR-2	Mix Tank	Low Level					
DI	51	LOCAL:9:I:Ch10Data	FCP-Copper-FDR-2	I-2	MN-210	FT-Copper-FDR-2	Running	Low Level					
DI	52	LOCAL:9:I:Ch11Data	FCP-Copper-FDR-2	I-2	XA-210	FT-Copper-FDR-2	Fault						
DI	53	LOCAL:9:I:Ch12Data	FS-160	I-2	FA-160	Eyewash							
DI	54	LOCAL:9:I:Ch13Data	FCP-Copper-MP-1A	I-2	YI-130A	FT-Copper-MP-1A	In Remote						
DI	55	LOCAL:9:I:Ch14Data	FCP-Copper-MP-1A	I-2	MN-130	FT-Copper-MP-1A	Running						
DI	56	LOCAL:9:I:Ch15Data	FCP-Copper-MP-1A	I-2	XA-130	FT-Copper-MP-1A	Fault						
DI	57	LOCAL:10:I:Ch00Data	PSH-130	I-2	PAH-130	FT-Copper-MP-1A	High Pressure						

I/O Type	I/O Ref	Control/Logic Address	Field Device	P&ID	Tag	Description 1	Description 2	Description 3	Description 4	EGU Min	EGU Max	EGU units	Comments
DI	58	LOCAL:101:Ch01Data	FCP-Copper-MP-1B	I-2	YI-140A	FT-Copper-MP-1B	In Remote						
DI	59	LOCAL:101:Ch02Data	FCP-Copper-MP-1B	I-2	MN-140	FT-Copper-MP-1B	Running						
DI	60	LOCAL:101:Ch03Data	FCP-Copper-MP-1B	I-2	XA-140	FT-Copper-MP-1B	Fault						
DI	61	LOCAL:101:Ch04Data	PSH-140	I-2	PAH-140	FT-Copper-MP-1B	High Pressure						
DI	62	LOCAL:101:Ch05Data	FCP-Copper-MP-2A	I-2	YI-230A	FT-Copper-MP-2A	In Remote						
DI	63	LOCAL:101:Ch06Data	FCP-Copper-MP-2A	I-2	MN-230	FT-Copper-MP-2A	Running						
DI	64	LOCAL:101:Ch07Data	FCP-Copper-MP-2A	I-2	XA-230	FT-Copper-MP-2A	Fault						
DI	65	LOCAL:101:Ch08Data	PSH-230	I-2	PAH-230	FT-Copper-MP-2A	High Pressure						
DI	66	LOCAL:101:Ch09Data	FCP-Copper-MP-2B	I-2	YI-240A	FT-Copper-MP-2B	In Remote						
DI	67	LOCAL:101:Ch10Data	FCP-Copper-MP-2B	I-2	MN-240	FT-Copper-MP-2B	Running						
DI	68	LOCAL:101:Ch11Data	FCP-Copper-MP-2B	I-2	XA-240	FT-Copper-MP-2B	Fault						
DI	69	LOCAL:101:Ch12Data	PSH-240	I-2	PAH-240	FT-Copper-MP-2B	High Pressure						
DI	70	LOCAL:101:Ch13Data	Spare	I-2	Spare								
DI	71	LOCAL:101:Ch14Data	Spare	I-2	Spare								
DI	72	LOCAL:101:Ch15Data	Spare	I-2	Spare								
DI	73	LOCAL:111:Ch00Data	FCP-Carbon-Silo	I-3	XA-310A	FT-PAC-FDR-1	Alarm						
DI	74	LOCAL:111:Ch01Data	FCP-Carbon-Silo	I-3	XA-310B	FT-PAC-FDR-2	Alarm						
DI	75	LOCAL:111:Ch02Data	FCP-Carbon-Silo	I-3	LAL-313A	FT-PAC-FDR-2	Low Level						
DI	76	LOCAL:111:Ch03Data	FCP-Carbon-Silo	I-3	LAL-313B	FT-PAC-FDR-2	Low Level						
DI	77	LOCAL:111:Ch04Data	FCP-Carbon-Silo	I-3	LAL-313A	FT-PAC-FDR-2	High Level						
DI	78	LOCAL:111:Ch05Data	FCP-Carbon-Silo	I-3	LAL-313B	FT-PAC-FDR-2	High Level						
DI	79	LOCAL:111:Ch06Data	FCP-Carbon-Silo	I-3	FAL-313A	FT-PAC-FDR-2	Low Pressure						
DI	80	LOCAL:111:Ch07Data	FCP-Carbon-Silo	I-3	FAL-313B	FT-PAC-FDR-2	Low Pressure						
DI	81	LOCAL:111:Ch08Data	FCP-Carbon-Fill	I-3	LAH-314	FT-PAC-FDR-1/2	High Level						
DI	82	LOCAL:111:Ch09Data	FCP-Carbon-Fill	I-3	LAM-314	FT-PAC-FDR-1/2	Mid Level						
DI	83	LOCAL:111:Ch10Data	FCP-Carbon-Fill	I-3	LAL-314A	FT-PAC-FDR-1	Low Level						
DI	84	LOCAL:111:Ch11Data	FCP-Carbon-Fill	I-3	LAL-314B	FT-PAC-FDR-2	Low Level						
DI	85	LOCAL:111:Ch12Data	YS-510A	I-4	YA-510A	Pret Building	Intrusion Alarm						
DI	86	LOCAL:111:Ch13Data	YS-510B	I-4	YA-510B	Carbon Silo Ladder	Intrusion Alarm						
DI	87	LOCAL:111:Ch14Data	YS-510C	I-4	YA-510C	Carbon Silo Door	Intrusion Alarm						
DI	88	LOCAL:111:Ch15Data	LSH-401	I-4	LAH-401	FT-KMNO4-SP-1	High Level						
DI	89	LOCAL:121:Ch00Data	LSH-501	I-4	LAH-501	FT-PIPE-SP-1	High Level						
DI	90	LOCAL:121:Ch01Data	FS-460	I-4	FA-460	Eyewash	Flow Alarm						
DI	91	LOCAL:121:Ch02Data	Mixer Starter	I-4	MN-420	KMNO4 Mixer	Running						
DI	92	LOCAL:121:Ch03Data	FS-461	I-4	FA-461	Eyewash	Flow Alarm						
DI	93	LOCAL:121:Ch04Data	FCP-KMNO4-MP-1	I-4	YI-440A	FT-KMNO4-MP-1	In Remote						
DI	94	LOCAL:121:Ch05Data	FCP-KMNO4-MP-1	I-4	MN-440	FT-KMNO4-MP-1	Running						
DI	95	LOCAL:121:Ch06Data	FCP-KMNO4-MP-1	I-4	XA-440	FT-KMNO4-MP-1	Fault						
DI	96	LOCAL:121:Ch07Data	PSH-440	I-4	PAH-440	FT-KMNO4-MP-1	High Pressure						
DI	97	LOCAL:121:Ch08Data	FCP-KMNO4-MP-2	I-4	YI-450A	FT-KMNO4-MP-2	In Remote						
DI	98	LOCAL:121:Ch09Data	FCP-KMNO4-MP-2	I-4	MN-450	FT-KMNO4-MP-2	Running						
DI	99	LOCAL:121:Ch10Data	FCP-KMNO4-MP-2	I-4	XA-450	FT-KMNO4-MP-2	Fault						
DI	100	LOCAL:121:Ch11Data	PSH-450	I-4	PAH-450	FT-KMNO4-MP-2	High Pressure						
DI	101	LOCAL:121:Ch12Data	Fire Alarm CP	I-4	YA-520	Fire Alarm	Fire Alarm						
DI	102	LOCAL:121:Ch13Data	FCP-SEW-GP-1/2	I-4	XA-531	Grinder PUMP 1	Fault						
DI	103	LOCAL:121:Ch14Data	FCP-SEW-GP-1/2	I-4	XA-532	Grinder PUMP 2	Fault						
DI	104	LOCAL:121:Ch15Data	FCP-SEW-GP-1/2	I-4	LAH-533	Grinder Wet Well	High Level						
DI	105	LOCAL:131:Ch00Data	Spare	I-4	Spare								
DI	106	LOCAL:131:Ch01Data	Spare	I-4	Spare								
DI	107	LOCAL:131:Ch02Data	Spare	I-4	Spare								
DI	108	LOCAL:131:Ch03Data	Spare	I-4	Spare								
DI	109	LOCAL:131:Ch04Data	Spare	I-4	Spare								
DI	110	LOCAL:131:Ch05Data	Spare	I-4	Spare								
DI	111	LOCAL:131:Ch06Data	Spare	I-4	Spare								
DI	112	LOCAL:131:Ch07Data	Spare	I-4	Spare								
DI	113	LOCAL:131:Ch08Data	Spare	I-4	Spare								
DI	114	LOCAL:131:Ch09Data	Spare	I-4	Spare								
DI	115	LOCAL:131:Ch10Data	Spare	I-4	Spare								
DI	116	LOCAL:131:Ch11Data	Spare	I-4	Spare								
DI	117	LOCAL:131:Ch12Data	Spare	I-4	Spare								

I/O Type	I/O Ref	Control/Logix Address	Field Device	P&ID	Tag	Description 1	Description 2	Description 3	Description 4	EGU Min	EGU Max	EGU units	Comments
DI	118	LOCAL:13:Ch13Data	Spare		Spare								
DI	119	LOCAL:13:Ch14Data	Spare		Spare								
DI	120	LOCAL:13:Ch15Data	Spare		Spare								
DO	121	LOCAL:15:O:Ch00Data	FCP-Copper-FDR-1	I-2	HS-110	FT-Copper-FDR-1	Start/Stop						
DO	122	LOCAL:15:O:Ch01Data	FCP-Copper-FDR-2	I-2	HS-210	FT-Copper-FDR-2	Start/Stop						
DO	123	LOCAL:15:O:Ch02Data	FCP-Copper-MP-1A	I-2	HS-130	FT-Copper-MP-1A	Start/Stop						
DO	124	LOCAL:15:O:Ch03Data	FCP-Copper-MP-1B	I-2	HS-140	FT-Copper-MP-1B	Start/Stop						
DO	125	LOCAL:15:O:Ch04Data	FCP-Copper-MP-2A	I-2	HS-230	FT-Copper-MP-2A	Start/Stop						
DO	126	LOCAL:15:O:Ch05Data	FCP-Copper-MP-2B	I-2	HS-240	FT-Copper-MP-2B	Start/Stop						
DO	127	LOCAL:15:O:Ch06Data	FCP-Carbon-Silo	I-3	HS-110A	FT-PAC-FDR-1	Start/Stop						
DO	128	LOCAL:15:O:Ch07Data	FCP-Carbon-Silo	I-3	HS-110B	FT-PAC-FDR-2	Start/Stop						
DO	129	LOCAL:15:O:Ch08Data	LCP-410	I-4	LSH-430	FT-KMNO4-ST-1	High Level						
DO	130	LOCAL:15:O:Ch09Data	Mixer Starter	I-4	LSL-430	FT-KMNO4-ST-1	Low Level						
DO	131	LOCAL:15:O:Ch10Data	FCP-KMNO4-MP-1	I-4	HS-440	FT-KMNO4-MP-1	Start/Stop						
DO	132	LOCAL:15:O:Ch11Data	FCP-KMNO4-MP-2	I-4	HS-450	FT-KMNO4-MP-2	Start/Stop						
DO	133	LOCAL:15:O:Ch12Data	Spare		Spare								
DO	134	LOCAL:15:O:Ch13Data	Spare		Spare								
DO	135	LOCAL:15:O:Ch14Data	Spare		Spare								
DO	136	LOCAL:15:O:Ch15Data	Spare		Spare								



## SECTION 13460 – CONTROL DEVICES

### PART 1 - GENERAL

#### 1.01 SCOPE

General purpose control components for control panels.

#### 1.02 SUBMITTALS

Submit product data.

### PART 2 - PRODUCTS

#### 2.01 General Purpose Control Components

- A. Manual Operators: 30.5 mm, heavy duty, oil tight; industrial grade pushbuttons and selector switches with octagonal ring; contacts rated 10 amps continuous, 6 amps break at 120 VAC. Provide flush head for "start" pushbuttons, extended head for "stop" pushbuttons, and spring return for "jog" selector switches.
- B. Pilot Lights: 30.5 mm, heavy duty, oil tight; industrial grade transformer type pilot light with octagonal ring; 6 volt LED lamp.
- C. Elapsed Time Indicators: Six-digit, hour, non-reset, 3-1/2-inch square case; equal to Yokogawa Type 240.
- D. Acceptable Manufacturers: Allen-Bradley, Cutler-Hammer, General Electric, or Square D.

#### 2.02 RELAYS

- A. Relays which interface with motor controls shall be heavy duty industrial grade; 600 volt; contacts rated 10 amps continuous, 6 amps break (5 and 3 amps respectively for time delay forms); 120 VAC; convertible contacts; coils suitable for continuous duty. Relays shall be manufactured by Allen Bradley, General Electric, or Square D.
- B. Non-motor control relays shall be double pole relay contacts, rated 10 amps at 120 VAC. Interposing relays for PLC discrete outputs may be single pole. Coil duty shall be continuous, with coil voltage suitable for application. Open contact breakdown voltage shall be 500 volts rms. Provide with polycarbonate dust cover, DIN rail mount socket and holddown spring. The unit shall have a minimum expected life of 100,000 operations at rated loads. Relays shall be equal to Potter & Brumfield, Type KAP or KUP.

END OF SECTION



## SECTION 13465 – PROGRAMMABLE LOGIC CONTROLLERS

### PART 1 – GENERAL

#### 1.01 SCOPE

- A. Programmable logic controllers (PLC), as follows: Chemical Building - Install new Allen-Bradley Control Logix processor.
- B. The PLC software shall be provided by the Owner, programmed by the Engineer.

#### 1.02 SYSTEM DESCRIPTION

- A. This Section covers the technical requirements for programmable logic controllers (PLC) that will receive discrete and analog inputs, and through the use of an internal ladder logic program, control output relay operations and perform data handling functions.
- B. The capabilities of the PLC shall be as required to perform the control functions associated with the particular control panel or system.
- C. The PLC shall be configured as shown on the Drawings and specified herein.

#### 1.03 RELATED WORK

- A. Section 13482 - Control Panels.
- B. Section 13402 - Instrument I/O Listing.

#### 1.04 SUBMITTALS

- A. For the PLC, the following record documentation shall be furnished in addition to documentation requirements in other Sections:
  - 1. Complete software documentation, including annotated ladder logic diagram printout. Printout shall include a complete set of comments identifying relays, function of logic blocks, I/O points, etc.
  - 2. Narrative description of the sequence of operation. Description shall reference, as applicable, the ladder diagram.
- B. For the PLC system, documentation shall consist of descriptive literature and installation, operation, and instruction manuals, and shall be included in prints for approval and prints for record. In addition, record drawings shall include PLC manufacturer' s recommended list of spare parts with prices, and availability/cost of maintenance contracts and similar support services available.

## PART 2 – PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

Programmable logic controllers shall be manufactured by Allen-Bradley Control Logix, as called for on the Drawings.

### 2.02 GENERAL REQUIREMENTS

- A. All components in the PLC system shall be the product of a company who regularly manufactures and services this type of equipment. Wherever possible, all assemblies and sub-assemblies performing similar functions in separate controllers purchased under this Section shall be interchangeable.
- B. Components: In compliance with normally recognized industry standards and regularly sold to heavy industry installations. All connecting cables shall be constructed so as to withstand, without damage, all normal use and handling.
- C. The PLC system shall be of a modular design with a plug-in processing unit, input/output frames or assemblies, and plug-in peripherals. All necessary cables shall be included.
- D. Mark all major assemblies, sub-assemblies, circuit cards, and devices with the manufacturer's part or identification number.
- E. All components of the PLC system shall be capable of continuous operation at temperatures of 0-60 degrees C, and humidity levels of 5-95 percent.
- F. Electrical supply voltage to the individual controllers shall be 115 VAC  $\pm$  10 percent 48-63 Hz. Controller system power supplies shall have circuit breakers or fuses for overload protection.
- G. Each controller, including output devices, shall orderly shut down and alarm in the event of a disruption of program execution or scan, a loss of logic power, loss of communication between controller essential devices, or a memory error. A failure of one controller shall not disrupt operation of other controllers in the system.

### 2.03 CENTRAL PROCESSING UNIT (CPU)

- A. The CPU shall contain the program memory in static RAM, PROM, or a combination of both.
  - 1. CMOS or RAM shall have a battery backup system capable of retaining all memory for a minimum of six months and shall require no external cooling or special vents. The backup battery shall be capable of being replaced without interruption of memory integrity with AC power off.
  - 2. Provide visual indication of backup battery status with alarm in the event of low battery voltage before battery failure.

3. Provisions shall be made for connecting an external DC voltage to the system to provide auxiliary protection for CMOS RAM memories.
- B. The program memory shall be capable of being expanded in the field by card exchange.
- C. At least 1,024 internal storage registers shall be available for data storage. These registers shall be independent of and in addition to program storage memory.
- D. Provisions shall be made for the processor to check all logic words for parity when read from memory. A parity error shall cause an immediate shutdown with alarm and visual indication.
- E. Nominal memory scan time shall be no longer than 4 milli-seconds per 1K of ladder logic memory. Only the portion of memory being used shall be scanned, and the memory shall be automatically repositioned up or down when contacts and rungs are added or deleted. Service each input on every scan.
- F. The system shall have the capability of servicing the I/O at any point in the user program as many times as desired during a scan. Provide the capability of not servicing the I/O during a scan if the user so chooses.
- G. The processor unit shall be expandable to a minimum of 208 Kbytes of I/O memory storage. Any number of normally open or normally closed contacts shall then be available from these references for use in the program. Any internal coil shall be capable of assuming a relay, latch relay, one-shot, timer, or counter function.

## 2.04 INPUT/OUTPUT (I/O) DEVICES

### A. DISCRETE INPUTS/OUTPUTS

1. Discrete inputs shall be available in 24 and 115 VAC/DC. Discrete outputs shall be available in 24 VDC and 115 VAC.
2. Discrete inputs shall be guaranteed "on" if at least 78 percent of nominal voltage is present. Discrete inputs shall be guaranteed "off" if 20 percent or less of the nominal voltage is present.
3. Minimum isolation between input/output and logic voltage shall be 1,500 V RMS per NEMA standards via optoisolation.
4. AC discrete outputs shall be rated at 20 amps inrush, 2 amps continuous. DC discrete outputs shall have a 2 amp rating. All outputs shall have 3 amp normal fuse protection.
5. Each discrete input and output shall have an LED or other visible indication of on/off status.

### B. ANALOG INPUTS/OUTPUTS

1. Analog inputs shall be available in 4-20 mA DC, 1-5 VDC, and 0-10 VDC. Analog outputs shall be available in 4-20 mA DC, 0-10 VDC, and - 10 to +10 VDC.
2. All of the above inputs and outputs shall have at least 11 bit resolution with an accuracy of  $\pm 1$  percent over the rated temperature range.

3. Minimum isolation between input/output and logic voltage shall be 1500 VDC per NEMA standards via optoisolation.
  4. All analog inputs interfacing with 120 VAC or 24 VDC (non-loop) powered devices shall be provided with isolated analog input modules.
  5. All analog outputs shall be isolated.
- C. Frames or racks for mounting all types of inputs and outputs shall be interchangeable, and inputs and outputs shall be interchangeable within the same frame.
  - D. All PLC terminal blocks shall be 300 V minimum NEMA rated, and accommodate no fewer than two #14 gauge wires.
  - E. Marker strips shall be attached adjacent to the field wiring and the status indicating lights to allow easy identification of inputs and outputs by the user. These markers shall not change when devices are replaced during repair or maintenance. Color code marker strips according to voltage.
  - F. Field wiring shall not have to be removed in order to replace an I/O device during repair or maintenance.

### PART 3 – EXECUTION

#### 3.01 INSTALLATION

- A. PLC equipment is to be mounted on the back panel of the local control panels, unless otherwise noted, and incorporated in the panel design by the System Manufacturer.
- B. For specific requirements regarding layout, racks, power supplies, I/O modules, communication modules, etc. refer to the Drawings.

END OF SECTION

## SECTION 13470 – INSTRUMENTATION DEVICES

### PART 1 - GENERAL

#### 1.01 SCOPE

- A. Primary elements.
- B. Transmitters.

#### 1.02 SYSTEM DESCRIPTION

- A. System consists of all field and panel mounted instrumentation devices as noted, complete with all necessary signal converters, isolators, amplifiers, power supplies, and other appurtenances necessary for interfacing with other components.
- B. Except as noted, scale all indicators in engineering units.

#### 1.03 SUBMITTALS

Submit product data.

### PART 2 - PRODUCTS

#### 2.01 TRANSIT TIME FLOW TRANSMITTER

- A. The meter must be a clamp-on design with no liquid contact that mounts externally on the pipe.
- B. The meter must utilize the transit-time flow measurement technique and employ the use of two (2) microprocessor and have the ability to monitor two (2) independent flow channels simultaneously.
- C. The meter must also have the ability to employ an alternate Doppler measurement technique for liquids with high air or solid content.
- D. The meter must have a multi-point (7 points minimum) wet flow calibration certificate accredited from an international standards agency with an accuracy of better than 1%.
- E. The meter must have a transducer encased in stainless steel with an integral armored stainless steel jacketed triax cable. The use of coax cable and BNC cable connections will not be acceptable.
- F. The transducers are to be mounted in a fully sealed (water tight) stainless steel mounting track and have the ability to be coupled using permanent coupling pads (grease is not acceptable).

- G. All transducer markings and identification must be laser scribed and solvent resistant. The use of adhesive labels for transducer identification will not be acceptable.
- H. All transducers supplied must have a multi-point (7 points minimum) wet flow calibration certificate accredited from an international standards agency with an accuracy of better than 1%. All calibration and transducer data must reside in a non-volatile memory chip located in the transducer junction box or flow meter.
- I. The meter must have the ability to automatically recognize the transducers when connected. Programming of the transducer type into the meter will not be acceptable.
- J. The meter must be of a type that requires no zero calibration. The zero calibration must be factory preset automatic without the need for zero check/calibration after installation. There must not be any zero drift mechanisms (i.e. temperature change related drift) as the meters cannot be installed with any low flow cutoff or "deadband."
- K. The meter must also provide automatic Reynolds number, liquid sonic velocity compensation, and have built-in liquid tables for automatic sound velocity, viscosity, and density settings.
- L. The flow meter electronics shall be housed in a NEMA-4X enclosure and must have the ability to indicate flow rate, flow velocity, mass flow, total flow, signal strength, signal quality, liquid sonic velocity, Reynolds regime (laminar/turbulent/transition).
- M. The meter must have the ability to have dynamic (automatic) compensation for changes in viscosity and density.
- N. The meter shall have the ability to status alarm for conditions of fault, flow direction, sound velocity limit, flow velocity limit.
- O. Transmitter:
  - 1. Power: 120 VAC.
  - 2. Enclosure: NEMA 4, coated cast aluminum or fiberglass.
  - 3. Mounting Bracket: Wall mount.
  - 4. Local Indicator: Included.
  - 5. Cabling: Sufficient to connect flow element and transmitter.
  - 6. Output: Isolated 4-20 mADC.
- P. Schedule:

Flow Element	Transmitter	Pipe	Calibrated Range	Display Scale Units	Number of Channels	Location/ Area Class
FE-170	FIT-170	1½"	0.8 - 80	GPH	1	Copper Sulfate
FE-370A/ FE-370B	FIT-370	1½"	0 - 20	GPM	2	PAC
FE-470	FIT-470	1½"	0.6 - 60	GPH	1	Pot. Perm.

- Q. Acceptable Manufacturers: Flexim 7407.



## 2.02 LEVEL SWITCH - ULTRASONIC

- A. Type: Non-Contact, ultrasonic.
- B. Probe: Teflon.
- C. Mounting: Provide 316 stainless steel mounting bracket per manufacturer's recommendation. Unit is to be mounted vertically against a concrete wall.
- D. Output: One switch output with SPDT contacts rated at 5 Amps, 120 VAC.
- E. Power: 120 VAC, 60 Hz.
- F. Enclosure: Enclosure for probe and electronics shall be NEMA 4X. Unit shall be suitable for mounting in non- hazardous or hazardous area as defined in table below.
- G. Schedule:

Tag	Service	Actuation Length
LSH-401	KMN04 Area Spill	50"
LSH-501	Pipe Gallery Flood	50"

- H. Acceptable Manufacturers" Magnetrol Model 911.

## 2.03 LEVEL TRANSMITTER - ULTRASONIC

- A. Type: Non-contact, ultrasonic, microprocessor-based with input or output filter capability.
- B. Sensor:
  - 1. Mounting: The System Manufacturer shall coordinate mounting to ensure that the sensor is mounted away from vessel walls and other obstructions in accordance with the manufacturer's recommendations. The System Manufacturer shall provide appropriate standoff distance for sensor face from the highest liquid level to accommodate blanking distance.
    - a. Tank Level Sensors: Flange Mounted
  - 2. Range: Sufficient range for the application.
  - 3. Cable Length: Sufficient to connect sensor and transmitter.
  - 4. Enclosure: NEMA 4X, rated for mounting in hazardous area as required by schedule.
  - 5. Automatic Temperature Compensation: Required.
  - 6. Face Material: CPVC or PTFE.
  - 7. Process Connection: 8 inch ANSI flange.
- C. Transmitter:
  - 1. Digital Indicator: Required.
  - 2. Output: Isolated 4-20 mADC.
  - 3. Enclosure: NEMA 4X, aluminum, polycarbonate, or fiberglass.
  - 4. Power Supply: 120 VAC.

- 5. Accuracy:  $\pm$  1.0 percent of calibrated range or better for ranges greater than 25-inches.
- 6. Mounting:
  - a. Tank Transmitters: Wall Mount.
  - b. Filter Level Transmitters: Handrail/Stainless Steel Mounting Bracket.

D. Schedule:

Tag	Level Range (Feet)	Service
LE/LIT-430	0 - 10	FT-KMN04-ST-1

- E. Acceptable Manufacturers: Siemens Milltronics, Endress+Hauser, or STI Magnetrol.

2.04 PRESSURE GAUGE

- A. Type: Bourdon tube or bellows, as required by pressure range, with blowout protection. Provide glycerin filled gauge as required by schedule.
- B. Dial: 4.5-inch, white face with black lettering.
- C. Materials:
  - 1. Case: Phenolic.
  - 2. Lens: Acrylic.
  - 3. Bourdon Tube and Socket: 316 stainless steel (bronze and brass if diaphragm seal is used).
  - 4. Movement: Stainless steel.
- D. Accuracy:  $\pm$  0.5 percent (Grade 2A).
- E. Connection Size/Location: 1/2 inch/lower.
- F. Snubber: 316 stainless steel as required by schedule.
- G. Diaphragm Seal: As required by schedule, provide diaphragm seal with flushing connection:
  - 1. Seal: Welded diaphragm.
  - 2. Upper Housing Material: Carbon steel.
  - 3. Lower Housing Material: 316 stainless steel.
  - 4. Upper Connection Size/Type: 1/2 inch/NPT.
  - 5. Lower Connection Size/Type: 1 inch/NPT.
  - 6. Diaphragm Material: 316 stainless steel.
  - 7. Fluid Fill: Glycerin.

H. Schedule:

Tag	Range	Diaphragm Seal	Gauge Fill
PI-130	0 - 100	Teflon	Silicone
PI-140	0 - 100	Teflon	Silicone
PI-230	0 - 100	Teflon	Silicone
PI-240	0 - 100	Teflon	Silicone
PI-440	0 - 100	Teflon	Silicone
PI-450	0 - 100	Teflon	Silicone

Note 1: Gauge shall be assembled with pressure element and vacuum-filled per manufacturer's recommendations. See Pressure Element paragraph below.

I. Acceptable Manufacturers: Ashcroft, Dwyer, U.S. Gauge.

2.05 PRESSURE SWITCH – SPRING AND PISTON

- A. Type: Spring-opposed piston assembly with externally adjustable setpoint and deadband.
- B. Contacts: Snap-action switch, SPDT or DPDT, rated at 4 Amps/120 VAC.
- C. Enclosure: NEMA 4X. Exception: Provide NEMA 7 explosion proof enclosure where hazardous areas are indicated in schedule.
- D. Diaphragm Seal: Provide diaphragm seal with flushing connection as required by schedule:
  - 1. Seal: Welded diaphragm.
  - 2. Upper Housing Material: Carbon steel
  - 3. Lower Housing Material: 316 stainless steel.
  - 4. Upper Connection Size/Type: By System Manufacturer.
  - 5. Lower Connection Size/Type: 1-inch/NPT.
  - 6. Diaphragm Material: 316 stainless steel.
  - 7. Fill Fluid: Glycerin.

E. Schedule:

Tag	Range	Setpoint
PSH-130	0 - 100 psi	50 psi
PSH-140	0 - 100 psi	50 psi
PSH-230	0 - 100 psi	50 psi
PSH-250	0 - 100 psi	50 psi
PSH-440	0 - 100 psi	50 psi
PSH-450	0 - 100 psi	50 psi

F. Acceptable Manufacturers: ASCO, Ashcroft, Static-O-Ring.

2.06 WATER FLOW SWITCH

A. Provide watertight pressure switch to monitor flow at each eyewash station and the water supply for potassium permanganate. The switch is to transmit an alarm to SCADA if the eyewash station is in use or if the potassium permanganate water pressure is too low.

B. Contacts: 15A, 120 VAC.

C. Enclosure: NEMA 4X.

D. Range 0-100 psi.

E. Connection: 1/2" NPTE pressure connection, 316 SS.

F. Schedule:

Tag	Location	Function
FS-160	Copper Sulfate Area	Eyewash
FS-460	KMNO4 Eductor Area	Eyewash
FS-461	KMNO4 Storage Tank Area	Eyewash
FSL-410	KMN04 Eductor	KMN04 Water Supply

PART 3 – EXECUTION

3.01 INSTALLATION

A. Locate field instruments so they are accessible for maintenance and orient so that indicators are readily visible. Unless otherwise indicated, mount instruments 36 to 60-inches above work surface. Provide 2-inch diameter, 304 stainless steel, Schedule 10 pipe welded to a 10-inch square by 1/4-inch thick stainless steel base plate for support unless wall or other mounting arrangement is indicated. Space instruments at least 1/2-inch off concrete walls by stainless steel channels or phenolic spacers.

B. Provide stainless steel or aluminum sun screens or shades for all electronic instruments located outdoors.

C. Provide stainless steel identification tags attached with stainless steel wire or screws for all field instruments.

3.02 TESTS AND CALLIBRATION

A. Perform continuity and insulation resistance tests on instrumentation conductors in accordance with Section 16120.

- B. Calibrate each instrument to its published accuracy. Submit calibration sheets including the instrument tag number or name, the date, name of individual performing calibration, procedures and equipment used, and results obtained.

END OF SECTION



## SECTION 13480 – DIGITAL SYSTEM HARDWARE

### PART 1 – GENERAL

#### 1.01 SCOPE

Digital system hardware.

#### 1.02 SYSTEM DESCRIPTION

- A. The system consists of PLC hardware and associated components (Sect 13465), Plant Control System network hardware and associated components, computers, monitors, keyboards, and human machine interface (HMI) workstations as described below and on the Drawings. The hardware shall form a complete system including all components necessary to support the specified software. System shall include, but not be limited to, items listed in Part 2 below.
- B. All computer hardware shall comply with the latest amendment to Part 15 of the FCC Rules and Regulations, Dockets No. 20780 and 80-284 relating to restricted radiation devices and low power communication devices.
- C. All applicable computer hardware must be compatible with the Operating System and shall be listed on the Operating System's approved hardware list.

#### 1.03 SUBMITTALS

Submit product data for all components. Include a comprehensive bill of materials.

### PART 2 – PRODUCTS

#### 2.01 GENERAL REQUIREMENTS

- A. All digital hardware shall be modular construction to provide for future hardware expansion.
- B. All devices located on the control system network shall continuously perform on-line diagnostics and failure reporting to the master operator interface workstations.

#### 2.02 SCADA View Node

- A. The workstation is based on Intel Core QX6800 CPU operating at a minimum clock speed of 3.2 GHz. Provide three year same day, 4-hour response, 7 days x 24 hours, on-site parts and labor warranty in the Owner's name from the PC manufacturer. Acceptable manufacturer is Dell XPS 720 HP or IBM. This workstation shall be provided with the following devices as a minimum:
- B. Memory: 2GB dual-channel DDR2.
- C. Video Card: Required.
- D. Mass Storage: 2 x 500 GB SATA II HDDs.

- E. DVD/CD combo drive with 4x DVD rewriteable and CD rewriteable. Provide 20 spare writeable blank DVD and CD discs.
- F. Keyboard and Pointing Device: Provide detachable, Microsoft Windows compatible keyboard with 104 ASCII Keys (minimum). Provide mouse pad and mouse.
- G. Ports:
  - 1. Video: 2 DVI and 1 S-video
  - 2. IEEE 1394: 2 ports
  - 3. USB: 10 ports
  - 4. Audio: 7.1 Channel Out (3 jacks)
  - 5. Network: Ethernet
  - 6. Legacy: 2 PS/2 Ports, 1 Serial Port
- H. Ethernet Interface: Provide one 100 MB Fast Ethernet network interface card with RJ-45 ports, SNMP enabled. Acceptable Manufacturer: 3 COM or equivalent.
- I. The HMI Operating System shall be Microsoft Windows XP Professional (latest version).
- J. Monitor: 21 inch (19.8 inch viewable, minimum) color 1280x1024 high resolution multisync. Acceptable Manufacturer: Dell.
- K. Speakers: Harmon Kardon or equivalent.

## 2.03 STANDARD ETHERNET SWITCH

Standard Ethernet switches shall be dual speed 10/100 Mbps with RJ-45 autosensing ports for 10- or 100-Mbps Ethernet. Switches shall comply with 10BASE-T Ethernet standard for single speed or 10BASE-T and 100BASE-TX standards for dual speed. Number of ports shall be dependent upon specific application. Each switch shall have one spare Ethernet port dedicated to a portable laptop. The switch shall be SNMP enabled for extensive diagnostics and configuration functions. Acceptable Manufacturers: Cisco, Hewlett-Packard, Black Box, 3 COM.

## 2.04 FIBER OPTIC CABLE AND FIBER OPTIC PATCH CORDS

- A. The fiber optic cable for communication between control panels shall be all-dielectric. Fiber optic cable and patch cords shall be multimode, graded index profile, dual window type, with the following characteristics:
  - 1. Core diameter: 62.5 microns.
  - 2. Cladding diameter: 125 microns.



3. Attenuation at 850 nm: 3.5 dB/km (maximum).
  4. Attenuation at 1300 nm: 1.5 dB/km (maximum).
  5. Bandwidth at 850 nm: 160 MHz/km (minimum).
  6. Bandwidth at 1300 nm: 500 MHz/km (minimum).
- B. The fiber optic cable shall be loose tube style, waterblocking water-swellaible tape and yarn type, with non-metallic strength members. Patch cords shall be provided with connectors installed. Cable shall be provided with a minimum number of fibers as shown on the Plant Control System Architecture drawing. Cable shall be suitable for continuous underwater submergence within underground ductbanks.
- C. All fiber optic connectors shall be “ ST” type, or as required to match device connections.
- D. Acceptable Manufacturers: Corning Cable Systems (Altos or Altos/LST), Comm Scope Arid Core (LST/CT), or Optical Cable Corp.

#### 2.05 FIBER OPTIC PATCH PANELS

- A. Provide one fiber optic panel for each fiber cable entering each LCP as shown on the Plant Control System Architecture drawing. Each fiber cable shall have a separate fiber optic patch panel. All fibers within each fiber cable shall be terminated in their respective patch panel. Fiber optic patch cords shall be installed between the patch panels for all spare fibers.
- B. Acceptable Manufacturers: Leviton, Corning Cable Systems, CommScope, or Black Box.

#### 2.06 UNINTERRUPTIBLE POWER SUPPLY

- A. Provide one uninterruptible power supply (UPS) at the LCP-PRET. The UPS unit shall be sized to provide nominal power requirements for a minimum of 10 minutes at full load (unless noted otherwise). The UPS shall be provided with a 10/100 Base-T port (RU-45) and shall be SNMP enable for extensive diagnostics and configuration functions.
- B. Acceptable Manufacturers: MGE (Pulsar Ex) or APC( “ Smart-UPS” ).

#### 2.07 ETHERNET FIBER/COPPER MEDIA CONVERTER

Provide Ethernet fiber/copper media converters as shown on the Plant Control System Architecture drawing. The converter shall be compatible with 62.5/125 micron fiber optic cable and shall be compliant with the 10BASE-FL standard and/or the 10/100BASE-T standards, as required. Converters shall have ST style fiber connectors. Acceptable Manufacturers: Phoenix Contact, Hirschmann, Modicon, or Black Box.

## 2.08 FIBER TERMINATION KIT

Provide one fiber terminating kit for installation of fiber connectors. Acceptable Manufacturers: Corning Cable Systems, CommScope, or Black Box.

## PART 3 – EXECUTION

### 3.01 LABELING

Fiber optic patch panel fiber connectors shall be individually labeled on the outside of the panel. Labels shall be made of engraved lamacoid and shall be permanently affixed to the panel side. Labels shall bear the numbers 1 through X, with X being the total number of fibers in the cable. A directory card shall be provided with each panel and shall list the service of each fiber. Spare fibers shall be listed as such. All plant control system network backbone fiber optic patch panels shall use the same numbering scheme such that fiber No. 1 is always in the same location.

### 3.02 FIBER OPTIC CABLE TESTING

- A. The System Manufacturer shall perform testing on all fiber optic cable provided under Division 13.
1. Provide all equipment, instrumentation, and supplies necessary for testing.
  2. After on-site receipt of each cable, and prior to installation of the cable, conduct an end-to-end attenuation test on each fiber on the shipping spool, in both directions, at 850 nm wavelength. The end-to-end test shall verify that each fiber meets the manufacturer' s attenuation specifications and that the cable was not damaged during shipment. Testing should be completed immediately after receipt of cable. Provide a hard copy and disk test documentation, including reference power reading, to the Owner prior to installation of the cable.
  3. After all PCS backbone cables are installed and all fibers are connected to the patch panels, install all patch cords between the patch panels in each LCP. Each fiber in the PCS backbone cables shall have patch cords installed.
  4. Conduct an Optical Time Domain Reflecto meter (OTDR) test at 850 nm wavelength on each fiber. Use a stabilized light source and an optical power meter. Submit a completed hard copy of the test documentation to the Engineer. Provide a finalized hard copy and disk of the test documentation, including reference power reading, to the Owner.
  5. OTDR test documentation shall include cable and fiber identification; fiber length; test direction; test wavelength; traces; fiber attenuation; attenuation breakdown for each fiber segment, connector, and coupling, and splice attenuation, if applicable.

END OF SECTION

## SECTION 13481 – FACTORY CONTROL PANELS

### PART 1 – GENERAL

#### 1.01 SCOPE

Factory Control Panels

#### 1.02 RELATED WORK

Division 11 – Equipment

#### 1.03 WORK SPECIFIED ELSEWHERE

Except as noted, equipment specified in this Section is provided under other Divisions. Include, under this Division, receiving, storage and handling; wall or floor mounting of panels (including equipment pads or mounting frames); and wiring.

### PART 2 – PRODUCTS

#### 2.01 CONTROLS

- A. **Control Panels:** Manufacturer shall provide a NEMA 4X control panel. All motor starters, variable frequency drives, relays, timers and other control devices required for control and operation of the equipment shall be mounted in the panel. Where 480 VAC 3 phase power is required, provide a flange mounted main power disconnecting circuit breaker with an interrupting capacity of 42,000 amps symmetrical. All controls shall operate on 120 VAC. Provide a suitably sized control transformer with primary and secondary overcurrent protection. The panel shall have a nameplate engraved with panel name and number FCP-XXX-N.

##### 1. Panel Surface Mounted Devices:

- a. **Manual Operators:** 30.5 mm, heavy duty, oil tight; industrial grade pushbuttons and selector switches with octagonal ring; contacts rated 10 amps continuous, 6 amps break at 120 VAC. Provide flush head for "start" pushbuttons, extended head for "stop" pushbuttons and spring return for "jog" selector switches.
- b. **Pilot Lights:** 30.5 mm, heavy duty, oil tight; industrial grade transformer type pilot light with octagonal ring; 6 volt LED lamp. Acceptable manufacturers: Allen-Bradley, Cutler Hammer, General Electric, or Square D.

Lamp colors:	Green	Run, Open
	Red	Stopped, Off, Closed
	Amber	Alarm

- c. **Digital Panel Indicator:** 3– 1/2 digit, 1/2-inch display height, NEMA 4X rated. 4-20 mA input. Acceptable manufacturers: Newport, Action Instruments, or Red Lion.

- d. Alarm Horn: Electro-mechanical diaphragm type, weatherproof housing for out-of-doors installation, 120 VAC power, 90-110dB at ten feet. Federal Signal Corporation Model 350, or equal.
- e. Alarm Beacon: Heavy duty, corrosion-resistant, high intensity strobe, suitable for outdoor service, 120 VAC power, amber dome. Federal Signal Corporation Model 371 DST, or equal.

2. Panel Internally Mounted Devices.

- a. Motor Starters: NEMA rated starters, circuit breaker combination type, with overcurrent protection in each phase. Interrupting capacity shall be a minimum of 42,000 amps symmetrical.
- b. Relays: For non-motor contactor control, 120 VAC, 10 amp, continuous duty, equal to Potter & Brumfield type KAP or KUP. Contactor control relays, heavy duty, industrial grade, convertible contacts, continuous duty. Acceptable manufacturers: Potter & Brumfield, Allen-Bradley, General Electric, or Square D.
- c. Timers: Solid state, microprocessor based, equal to Eagle Signal type CX100.
- d. Ground Bus: Provide a 14 x 3" x 12" copper ground bus in the rear of the panel. Bond to the metal enclosure, power system ground and signal circuit grounds.
- e. Surge Protection: It is the responsibility of the manufacturer to provide appropriate protection against transients and surges for all field instruments, field wiring, and devices interfacing with control panels.
- f. Space Heater: In all outdoor enclosures, provide a thermostatcontrolled space heater and corrosion inhibitor blocks.
- g. Transformers: Provide a transformer for 120 VAC control and control device power. Transformer shall have sufficient capacity to power panel-supplied external devices such as motor heaters and seal water valves.
- h. Programmable Logic Controller (PLC): At the manufacturer' s option, a PLC may be used to accomplish control logic. Provide two spare I/O points, of each type of I/O used. Provide interposing relays for all external interface discrete signals. Provide isolated analog input/outputs for all external interface analog signals. Provide a copy of the PLC programming software and an electronic copy of the PLC programming software and an electronic copy of the PLC application program that includes annotations. A printout of the application program shall also be provided. PLC logic is to be fully annotated, including point tag descriptors. Acceptable manufacturers are Allen-Bradley.

B. Panel Surface Mounted Devices: The panel shall be furnished with door front mounted devices as called for in the equipment specification.

C. Remote System Interface: The panel shall be provided with 120 VAC Form C contacts for remote status. It shall accept 120 VAC dry contacts for remote control. Analog signals for remote use shall be isolated 4-20 mA. The panel shall accept remote 4-20 mA signals for control. The remote System interface shall include the points as called for in the equipment specification.

PART 3 – EXECUTION (NOT USED)

END OF SECTION



## SECTION 13482 – CONTROL PANELS

### PART 1 - GENERAL

#### 1.01 SCOPE

Control panel.

#### 1.02 SUBMITTALS

- A. The Contractor shall furnish the following items from the System Manufacturer for approval prior to fabrication:
1. Layout drawings of the front of the panel showing mounting dimensions for all instruments and associated hardware.
  2. Assembly drawings shall include:
    - a. Details of panel fabrication including outline dimensions and locations of rear of panel mounted equipment.
    - b. Wiring layout.
    - c. Wiring and tubing interconnection diagrams.
  3. Electrical wiring and termination drawings.
  4. Complete bill of materials describing all panel components, including manufacturer and complete model number for all components.
  5. Catalog cut sheets for all panel components.

#### 1.03 RECORD DRAWINGS

Submit shop drawings as listed under Article 1.02 above plus operation and maintenance information.

#### 1.04 DELIVERY, STORAGE, AND HANDLING

- A. Wrap the completed panel in polyethylene plastic and crate in a wooden shipping crate with sufficient packing to avoid damage in shipment.
- B. Support the base of the shipping crate with the cross members of sufficient strength and clearance to allow movement of the entire crated panel by fork-lift truck.

### PART 2 - PRODUCTS

#### 2.01 ENCLOSURE

- A. Provide wall mounted, stanchion mounted, free-standing, or walk-in enclosures as scheduled.
- B. Provide NEMA 12 enclosures for control panels located indoors inside the control room, NEMA 4X Polycarbonate for chemical areas and NEMA 4X stainless steel for outdoor locations (except walk-in) unless otherwise noted.

- C. In all NEMA 4X enclosures outside, provide a thermostat controlled space heater and corrosion inhibitor blocks. Provide NEMA 4X rated devices on front of enclosure or mount devices on interior panel and provide door mounted tempered glass or polycarbonate viewing window.
- D. Free-standing enclosures are a minimum of 20-inches deep.
- E. NEMA 12 and general purpose enclosures shall be fabricated from a minimum 14 gauge steel, unless noted otherwise, with all seams ground smooth, all corners rounded, and all flat surfaces smooth with no ripples, dimples, or surface imperfections and no screws, bolts, or nuts visible from outside. Provide panel stiffeners as required to provide a rigid, non-bowing surface. Thoroughly clean and degrease the steel shell before painting. Apply one coat of a rust inhibiting primer and two coats of air dry enamel or acrylic with flattening agent to produce a smooth semi-gloss finish. Colors are to be chosen by the Engineer.
- F. Install a continuous hinged front access door. For freestanding enclosures, furnish a three point latch. A single point latch is acceptable for wall-mounted enclosures. Wire door mounted instruments and controls to stationary components with suitable flexible connections and protection where wiring crosses the hinge. Provide double or multiple doors as required for stability and smooth mechanical operation.
- G. Terminate all tubing and electrical connections at the bottom of the panel to bulkhead fittings and terminal strips, with all external connections properly identified for field connections. Space shall be provided at the bottom of the panel for excess wiring to be laid out before landing on the associated field terminal strip. Space shall also be provided at the top and sides of the panel for routing cables entering from the top of the panel.
- H. For panels with 120 VAC power supply, provide appropriately sized circuit breaker, single pole, 22,000 AIC, mounted in the rear of the panel to disconnect power. Mount an engraved nameplate (white letters, red background) to read "WARNING – This panel energized by foreign control power sources. Equipment will be live with panel disconnect in either on or off position".
- I. Internal panel sub-feeds of 120 VAC power shall be divided into separate circuits protected by properly sized circuit breakers or fuses. The following separate circuit divisions shall be provided:
  - 1. Panel light(s) and panel fans (where used).
  - 2. Each receptacle.
  - 3. Power to the panel UPS (where supplied).
  - 4. Thermostatically controlled heaters (where supplied).
  - 5. Each power supply (including 24-volt power supplies, power supplies for PLCs, power supplies for fiber optic transceivers, etc.).
  - 6. 120-volt power to field mounted instruments (each instrument shall be provided with a separate circuit).
- J. Provide 1/4 x 12-inch copper ground bus bar(s) in the rear of the panel. All bus bars shall be bonded together. Ground bus shall be capable of accepting System Ground Grid connection and Power System Ground connection.



- K. Provide 20 percent spare, contiguous panel/sub-panel mounting area to accommodate future panel expansion, unless noted otherwise.
- L. The System Manufacturer shall investigate the space allocated for control panels on the accompanying drawings and inform the Engineer of any potential problems.
- M. If indicated in the control panel schedule, control panels shall be provided with a drip shield or heat shield.
  - 1. A 304 stainless steel drip shield shall be provided to prevent ice buildup on the panel door, door hinges, and front of panel-mounted devices. Minimum overhang shall be one inch on the front and side of the panel.
  - 2. 304 stainless steel heat shields shall be provided to prevent excess heat inside the panel. Shields shall be provided for the top, front, back, and both sides of the panel. Shields shall be mounted to provide one-inch air space between the shield and the panel. Each shield shall have the same height and width as the panel side being protected. Cutouts shall be provided for access to front of panel-mounted devices.
- N. All indicator lights shall be push-to-test. In cases where it is not practical to use push-to-test indicator lights (Engineer's approval required), then a lamp test circuit with a lamp test pushbutton mounted on the front-of-panel shall be provided. Pressing the lamp test pushbutton shall illuminate all indicator lights without interrupting control circuits.

Lamp Colors:	Green	Running, Open
	Red	Stopped, Off, Closed
	Amber	Alarm

- O. Provide one 120 VAC duplex receptacle and fluorescent light(s) as scheduled. Incandescent lights may be used where panel size prohibits the use of fluorescent lights. Provide one standard on/off light switch for the lights. Receptacles and lights shall be provided with a separate circuit breaker and shall be fed from the 120 VAC power supply to the panel. Receptacles and lights shall be fed from uninterruptible power supplies.
- P. All PLC discrete outputs shall have interposing relays installed in the control panel.
- Q. All FRP panels located in direct sunlight shall be provided with at least two coats of UV protective coating to prevent discoloration and cracking.
- R. All control panels shall be either padlockable or have a lock installed in the door handle. All Contractor provided locks shall be keyed alike – consult with the Owner for preferred keying system.
- S. Front of panel devices, such as analog controllers or annunciators, that have rear mounted terminal strips shall be accessible without standing inside the control panel (i.e. mounted on panel door or swing-out panels). Walk-in control panels are excepted.

## 2.02 WIRING

- A. Install a minimum of #16 AWG copper stranded, 600 volt, extra flexible type for all control wiring 50 volts and above, and a minimum of #18 AWG twisted, shielded pair for analog signal conductors. Color code wires as follows:

1. Ground: Green.
  2. Neutral: White.
  3. Line Conductor (150 volts or less to ground): Black.
  4. Control (150 volts AC or less): Red.
  5. Control (150 volts DC or less): Blue.
  6. Interlock control circuits supplied from external power source: Yellow or pink. 7. Signal, Shielded and Special Cables: Identify with wire markers.
- B. Mark all wires with approved wire markers at all terminations, per Section 16195. Clearly mark all terminal blocks with typewritten or ink markings. Label all devices mounted on the steel sub-panel. All instrument and control devices (current switches, MiniCAS II relay modules, etc.) located inside control panels shall have engraved lamacoid nametag affixed on or near the device and shall bear the tag number and service description. Label all devices mounted on the panel front with engraved lamacoid nameplates, fastened with screws. Nameplates shall be threelayer laminated plastic, black letters on a white background. Letter height to be 1/8-inch for individual devices and 1/4-inch for panel designation.
- C. Neatly bundle and secure all wiring with plastic ties. Route back-of-panel wiring in slotted plastic wireways with snap-on covers.
- D. Terminal blocks shall be provided for all field wiring connections to the panel. This includes shield terminals for shielded cables. Terminal blocks may be mounted horizontally or vertically and shall be easily accessed from panel door(s). Terminal blocks shall be DIN rail mounted, screw clamp, feed-through type with 600 volt minimum rating. A minimum of 20 percent extra terminals shall be provided on the terminal blocks. Each terminal shall be clearly and permanently marked. Provide fused terminal blocks for all 120 VAC discrete inputs and outputs. All terminal blocks shall be suitably sized for #12 AWG (minimum) stranded wire. All terminal blocks shall be grouped apart, depending upon type of signal per Paragraph E. below.
- E. AC or DC power wiring shall not run in any raceway with any type of instrument wiring. Wiring is to be divided into categories and shall be carried in separate raceways. The minimum acceptable groupings are:
1. 120 VAC, 60 Hz AC power wiring and chart drive power wiring.
  2. DC power to electronic instruments (does not include loop powered instruments), contact closure input and output wiring.
  3. All wiring carrying pulsed information.
  4. Standard range analog DC signals, thermocouple and up to 200 mV DC signals.
  5. All intrinsic safe wiring.
- F. It is the responsibility of the System Manufacturer to provide appropriate protection against transients and surges for all field wiring, interfacing with the control panels. This protection equipment shall reside in the appropriate control panel. All instrument analog signal wiring, data transmission wiring, and 120 VAC power supply wiring shall be protected against lightning strikes, and other transient surges at all control panel termination points. All control power wiring, AC control power wiring, I/O cabinet discrete input wiring and discrete output wiring which is routed outside of buildings shall be protected against lightning strikes, and other transient surges at all control panel termination points. Lightning and surge devices shall protect the system from induced surges in analog, discrete

and control circuitry and power supply lines. The protective devices shall not interfere with the normal operation of the panel hardware and shall be designed not to have a maximum clamping voltage in excess of what the protected device is capable of withstanding. Protection devices for all internally mounted power supplies shall be installed on individual 120 VAC supply wiring. Each surge/lighting protector shall be independently grounded to the panel ground bus. Protector mounting rail shall not be used to ground the protector.

- G. The System Manufacturer shall provide required hardware and labor for termination of new signals in existing termination cabinets where required. This hardware and workmanship shall match existing work with respect to method, materials, and workmanship.
- H. All control panels furnished under this Section shall carry a UL label which certifies the control panel meets the requirements of UL-508A (latest version).

## 2.03 DRAWINGS

### A. Panel Construction Drawings

1. Shop Drawings and Catalog Cuts: Provide detailed shop drawings and catalog cuts for all panels, instrument racks, and enclosures. Drawings shall show the location of all front panel and internal sub-panel mounted devices to scale and shall include a panel legend and bill of materials. Layout drawings shall show all major dimensions as well as elevations, in inches from the base up, of all rows of components.
2. The panel legend shall list and identify all front of panel devices by their assigned tag numbers, all nameplate inscriptions, service legends, and annunciator inscriptions. Tag number shall be as listed in the Specifications and Drawings.
3. The bill of materials shall include all devices, including those mounted within the panel that are not listed in the panel legend, and shall include the device tag number, description, manufacturer, and complete model number.

### B. Panel Wiring Diagram

1. Provide complete terminal identification of all external primary elements, panels, and junction boxes that interface directly to the panel wiring being shown. Polarity of analog signals shall be shown at each terminal.
2. All external wiring that the electrical contractor must provide and install shall be shown as a dashed line. Special cables that are provided with the instrument shall be clearly identified.
3. Panel wiring diagrams shall identify wire numbers and types, terminal numbers, and tag numbers. Wiring diagrams shall show all circuits individually; no common diagrams will be allowed.
4. Provide panel power wiring diagrams for all panels. The diagrams shall include the grounding requirements.

- C. Interconnecting Wiring Diagrams: Diagrams shall show all component and termination cabinet identification numbers and external wire, fiber, and cable numbers. This diagram shall be coordinated with the electrical supplier and shall bear its mark showing that this has been done.

## 2.04 CONTROL PANEL SCHEDULE

Panel No.	Mounting Type	Enclosure Rating	Light/Receptacle
LCP-PRET	Free-Standing	NEMA 12	Yes/Yes
LCP-410	Wall Mounted	NEMA 4X – Poly	No/No

## PART 3 - EXECUTION

### 3.01 TESTING AND CALIBRATION

- A. Thoroughly shop test the completed panel. Confirm that all lamps burn. Remove, box, and label all parts that may come loose or detached in shipment, so that after installation they may be easily replaced.
- B. Perform preliminary calibrations in the fabricator's shop, and final calibrations at start-up by qualified personnel.
- C. For panel layout, front of panel devices and detailed information regarding the components, refer to the Drawings.

END OF SECTION

## SECTION 13495 – INSTRUMENT INSTALLATION

### PART 1 - GENERAL

#### 1.01 SCOPE

This Section includes details of fabrication and installation for certain instrumentation hardware items.

### PART 2 - PRODUCTS

#### 2.01 INSTRUMENTATION HARDWARE

Refer to Instrument Installation Details.

### PART 3 - EXECUTION

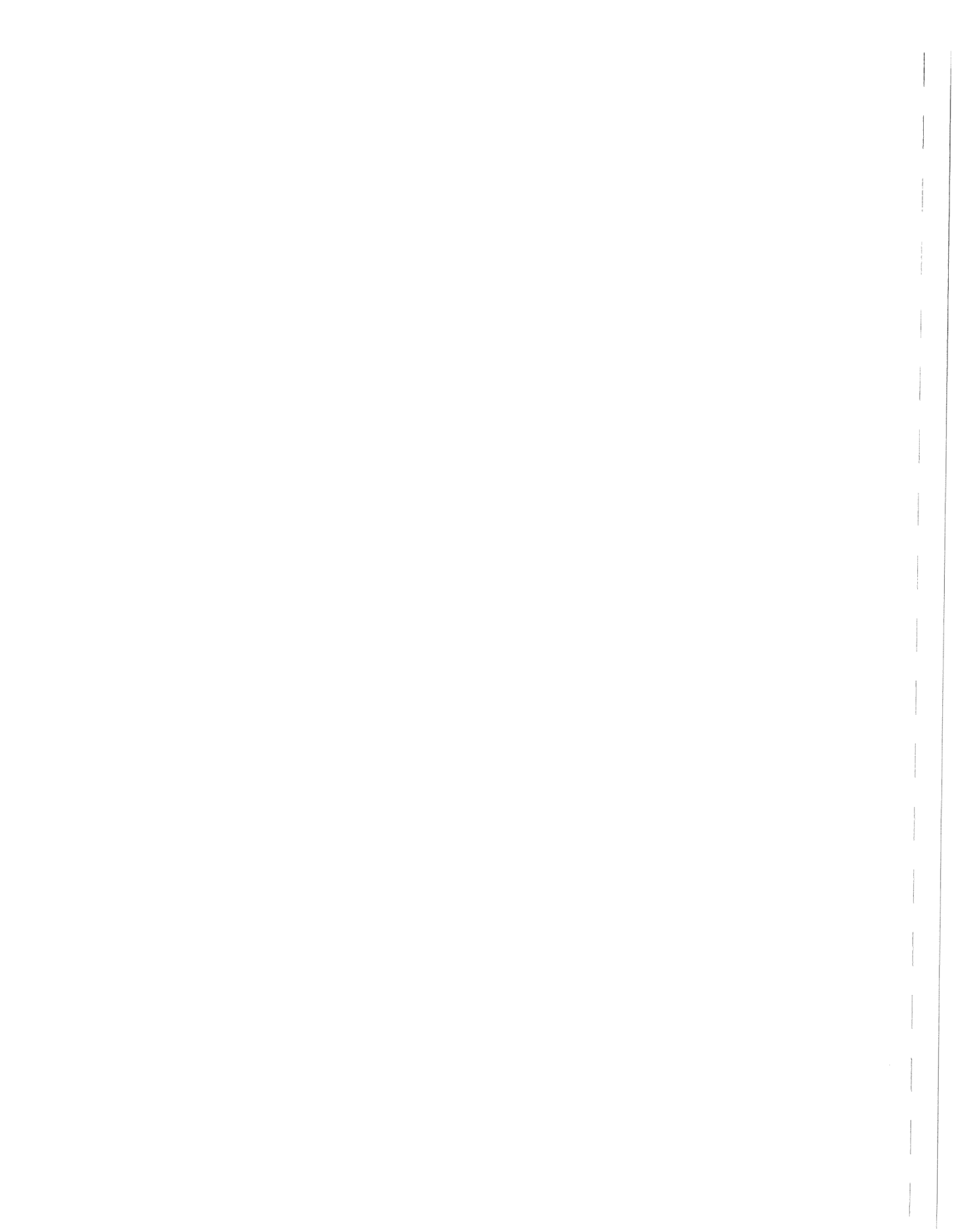
#### 3.01 INSTALLATION

- A. Install and align instruments in accordance with vendor instruction manuals and any details on the Drawings. Locate all field instruments to be accessible for maintenance.
- B. Install all field mounted instruments having indicators or recording charts to make the scale or chart visible from the adjacent operating area. Rotate indicating portions of instrumentation, where necessary, to improve visibility from operating area.
- C. Provide sufficient clearances for access and instrument servicing to include dismantling of the instrument.
- D. Space instruments at least 1-inch off walls using stainless steel channels.
- E. Mount all field instruments securely, using manufacturer mounting yoke, when furnished, on a pipe stand to ensure a rigid, vibrant-free installation.
- F. Locations of instruments shown on the Drawings are approximate. The Contractor may, at the Contractor's discretion, relocate instruments to more appropriate positions within five feet of the location shown on the Drawings. If the Contractor needs to move a particular instrument more than five feet from its designated location, the Contractor shall obtain prior approval from the Owner.
- G. Provide and install any necessary tubing raceways, supports, and tie downs. Tubing raceways and supports shall be of stainless steel construction.
- H. Install tubing and fittings necessary to assure proper instrument operation in a neat, professional manner. Tubing shall be connected to the Field Instrument in such a manner as to prevent stress on the Field Instrument.

END OF SECTION



## **Division 14 - Conveying Systems**





## SECTION 14620 - HOIST AND MONORAIL SYSTEMS

### PART 1 - GENERAL

#### 1.01 SCOPE OF WORK

- A. The Contractor shall furnish, install, and place in satisfactory operation the hoisting equipment and appurtenances as indicated on the Drawings and as herein specified.
- B. Location, capacity, critical dimensions, and other pertinent data shall be as shown on the Drawings and as herein specified.
- C. The Contractor shall furnish and install the tracks and appurtenances necessary for all hoists.
- D. The capacity of each hoist and trolley shall be permanently marked in a conspicuous manner.
- E. All hooks shall be safety type.
- F. All hoists shall be close headroom type.
- G. The Contractor shall verify all dimensions and clearances in the field prior to erection and shall be responsible for the proper fitting and operation of the equipment.
- H. Hoists shall be manufactured by Thern Incorporated, Winona, NH, Cloumbus McKinnon Corp.; Mannesmann Demag Corporation, Cleveland, OH; Harrington Hoists and Cranes; or approved equivalent.

#### 1.02 WORK INCLUDED

One (1) electrically operated hoist and trolley (2-ton) single monorail system.

### PART 2 - PRODUCTS

#### 2.01 MOTORIZED TROLLEY HOIST

- A. The hoist shall be designed for exterior service.
- B. The motorized trolley shall operate at 50 FPM with a pushbutton pendant control.
- C. The minimum lift shall be as shown in schedule with a speed of 18 FPM.

#### 2.02 PAINTING

All parts to be painted shall be in accordance with Division 9. Ferrous surfaces obviously not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating.

2.03 SCHEDULE OF HOISTS AND TROLLEY HOISTS

No.	Area	Line Pull	Wire Rope Length	Steel Chain Length	HP
1	Pump Room	4,000 lbs.	20'	--	3.0

PART 3 - EXECUTION

3.01 FIELD ACCEPTANCE TESTS

- A. The equipment shall be tested at rated load by the Contractor and shall be adjusted to operate smoothly without malfunctions under all load conditions.
- B. Tests shall include a check of the horizontal and vertical alignment of the rails.

END OF SECTION

## **Division 15 - Mechanical**



## SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

### PART 1 - GENERAL

#### 1.01 DESCRIPTION

- A. The Work of this Section consists of providing all labor, materials, and services necessary for the fabrication and installation of all equipment and appurtenances in connection with the plumbing, heating, ventilating and air conditioning work.
- B. It is not the intent of this section to make any Contractor, other than the General Contractor alone, the single responsible party to the Owner. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be done through the General Contractor. No attempt has been made to arbitrarily assign responsibility of work, material, equipment or services to a particular trade or Contractor. Unless stated otherwise, subdivision and assignment of work shall be General Contractor's responsibility.
- C. Work by Others: The following related work will be furnished under other sections of these specifications:
  - 1. All power wiring for motors and equipment.
  - 2. Flashing of all items passing through the roof. See Roofing and Sheet Metal section.
  - 3. All preformed openings in masonry and concrete work for piping and ductwork.
  - 4. All lintels required for openings in walls.
  - 5. Installation of access panels in finished surfaces.

#### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Cutting and patching - Division 1 and 2.
- B. Concrete work - Division 3.
- C. Finishes - Division 9.
- D. Electrical work - Division 16.

#### 1.03 SUBMITTALS

- A. Submit catalog data and shop drawings for all materials and equipment specified under this Section.
- B. Fan submittal data shall include performance curves with the specified operating parameters clearly indicated.

#### 1.04 REFERENCES

The chemical and physical properties of all materials and the design, performance characteristics and methods of construction of all items of equipment shall be in

accordance with the requirements of the latest issue of the various applicable Standard Specifications. These Standard Specifications have been prepared by authorities which are recognized by the Mechanical Trades. The names of these authorities are listed below together with the abbreviation of their names as they may appear in these Specifications.

- A. American National Standard Institute (ANSI).
- B. American Society for Testing and Materials (ASTM).
- C. Air Movement and Control Association (AMCA).
- D. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
- E. American Society of Mechanical Engineers (ASME).
- F. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).

#### 1.05 PERMITS AND CODES

- A. Obtain and pay legally authorized agencies for all permits and inspections necessary for completion of work under this division.
- B. Installation shall be in accordance with applicable State and Local regulations including but not limited to the following:
  - City, State and County Building Inspector
  - National and Local Electrical Codes
  - State Department of Health
  - State Plumbing Code
  - Air Pollution Board
  - Kentucky Standards of Safety
  - Local Insuring Agency
  - National Sanitation Foundation
- C. Furnish three (3) copies of required inspection certificates before requesting final payment.

#### 1.06 EXAMINATION OF SITE

- A. Bidder is advised to visit the site and acquaint himself with the working conditions. Contractor shall accept conditions as they exist on bid date. Claims for labor and material required for difficulties encountered, which could have been foreseen had an examination been made, will not be recognized.
- B. Contractor shall notify the Engineer immediately of any existing field conditions not provided in the Contract Drawings and/or Specifications. Any work not shown on the Contract Drawings which is performed without proper authorization shall make Contractor responsible for correction, addition, and/or deletion as may be later called for by the Engineer.

## PART 2 - PRODUCTS AND EXECUTION

### 2.01 SPECIFICATIONS

- A. Products shall be as identified on the drawings or specified in Division 15 in the following sections for the mechanical products used in the Work.
- B. No products containing asbestos will be used in the Work.

### 2.02 CONTRACT DRAWINGS

- A. Scale of Drawings is approximate. Exact locations, dimensions, and elevations shall be governed by field conditions. Make field measurements of building before fabricating equipment or materials.
- B. Drawings are based on physical dimensions of one or more manufacturer's equipment. Other approved equipment shall be of such dimensions that it can be readily installed in available space with ample clearance for proper maintenance and operation. It shall be the Contractor's responsibility to insure proper operation & installation of equipment installed (other than manufacturer's specified). Approved shop drawings will not relieve the Contractor of this responsibility.
- C. Intent of Drawings is to show systems and sizes. Drawings do not necessarily show all required offsets. Work shall be installed to conform with space limitations. Offset, transformation, fittings, etc., shall be provided where required to attain this objective.
- D. Refer to other drawings for construction of building, work in other sections and floor and ceiling elevations.
- E. Failure to notify the Engineer of any inconsistencies in the Contract Documents shall make the Contractor subject to either method as may be later called for the Engineer.

### 2.03 ORDER OF WORK

Contractor shall organize work to cause least disturbance possible to operation of any building, service or system on site. When necessary to interrupt services, time of interruption shall be approved by Owner. Extras for differences between regular and overtime pay shall be allowed only when work is authorized to be accomplished at a time other than regular working hours. Work shall be scheduled to coincide with and cause the least possible disturbances to other contractor's work and schedules.

### 2.04 COOPERATION

- A. Cooperate with other trades to obtain the most practical arrangement of work. Become familiar with Drawings before starting work.
- B. Make known to other trades intended positioning of materials and intended order of work. Coordinate work with other trades and proceed with the installation to assure no delays to other trades. Determine intended positions of work of other trades and intended order of installation.

2.05 WORKMANSHIP

Work shall be performed only by mechanics and tradesmen skilled and working within their respective trades and shall present appearance typical of the best trade practices. Work not installed in this manner shall be repaired, removed or replaced, or otherwise remedied at Contractor's expense as directed by Engineer.

2.06 GUARANTEE

- A. Labor and materials entering into this Contract shall be guaranteed for a period of one year from date of acceptance. Date of acceptance shall be date of voucher for final payment. Owner reserves right to use equipment installed prior to date of final acceptance. Use of equipment by Owner shall in not way invalidate guarantee except Owner shall be liable for damage to equipment during this period due to negligence of his operator or other employees.
- B. This guarantee shall further provide that, in the event of a failure of any system or its component equipment items or the improper functioning thereof, during the period of this guarantee. This Contractor shall have available an "on call" competent service personnel for the restoration of all systems and equipment for complete operation. Should the nature of the failure be such as to present an emergency in the opinion of the Owner, such personnel shall be promptly available, regardless of the hours of the day or day of the week. Should the failure be such as to fall under the guarantee, the cost of the service shall be borne by this Contractor, otherwise the Owner will pay therefor at the prevailing rate for such service.
- C. Should this Contractor fail to make such service personnel promptly available "on call" the Owner may employ such personnel as are available to him at the expense of this Contractor.

2.07 DEBRIS

Before final acceptance of Work, clean and restore all road surfaces, sidewalks, and other areas leaving them in a neat, clean and usable condition as originally found. Remove all machinery, tools, surplus materials, dirt, sand, temporary building, and other structures from the site. All manholes and other appurtenance structures shall be cleared of all scaffolding, rubbish and dirt. Existing road and walks cut or damaged shall be restored and repaired to the satisfaction of the Engineer.

2.08 CUTTING AND PATCHING

- A. Unless otherwise indicated do all cutting and patching required for installation of work. All openings, not requiring lintels, shall be cut and patched by mechanical contractor. Openings requiring lintels for ductwork, grilles, louvers, etc. in vertical walls both new and existing shall be coordinate with General Contractor. Patching of these openings shall be by this Contractor.
- B. Do no more cutting than necessary. Cutting of structural members or exposed surface of concrete block shall not be permitted without written approval of Engineer.



- C. Cut pipe openings in floor slabs with core drill. Scribe cut edges of trenches or openings in slabs with masonry saws.
- D. Where necessary to remove exterior walks, paving, or lawns, they shall be returned to their original surfaces.
- E. Only skilled mechanics and tradesman shall do patching and finishing required to match surrounding surfaces.

## 2.09 SUBMITTALS

- A. Generally shop drawings submittals will be required for all plumbing fixtures and mechanical equipment as specified in the following specification sections.
- B. All shop drawings shall be checked and noted accordingly by the Contractor before submitting same to the Engineer for his review.
- C. No equipment shall be ordered or fabricated without formal approval of submitted shop drawings.

## 2.10 RECORD DRAWINGS

The Contractor will maintain one (1) set of prints which will be on file in the field office. These prints shall be kept and maintained in good condition at the site of the project and a qualified representative of the Contractor shall record on these prints from day to day as the Work progresses, all changes, alterations and deviations from the Contract Drawings with special emphasis on the exact final location of all underground utilities by offset distances to surface improvements such as building corners, curbs, etc. Entries and notations shall be neat, legible and permanent. Those prints shall be delivered to the Engineer upon completion of the project. Approval of final payment will be contingent upon compliance with these provisions.

## 2.11 ACCESS TO EQUIPMENT

- A. Wherever any mechanical device, or items of equipment is concealed, or enclosed above or behind walls, ceiling, floors, bulkheads, etc., conceivably require service in the future, the Contractor shall provide access, with approved access panels (where required).
- B. Access shall be provided for all concealed valves, cocks, cleanouts, expansion joints, air vents, strainers, traps, unions, dampers, splitters, extractors, etc.

## 2.12 CONCRETE PADS

Where specified and detailed, pads and curbs will be provided by this Contractor. The mechanical contractor will bear full responsibility for the furnishing of sizes and location of these pads. Mechanical contractor shall see that the concrete pads are large enough to allow a four inch margin on all four sides of the equipment on the pad.

END OF SECTION 15050