



City of Tampa

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ADDENDUM 2

Via E-Mail

DATE: January 27, 2020

Contract 19-C-00051; Howard F. Curren AWTP Methanol Storage Tank Replacement

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

Item 1: The Bid Date for the above referenced project is hereby changed to February 4, 2020.

Item 2: Replace Plan Sheet M-01 MECHANICAL PLAN –METHANOL STORAGE TANKS with the attached Plan Sheet M-01.

Item 3: Replace Plan Sheet M-03 MECHANICAL SECTION –METHANOL STORAGE TANK (TYPICAL) with the attached Plan Sheet M-03.

Item 4: Replace Plan Sheet E-02 ELECTRICAL PLAN –METHANOL STORAGE TANK SYSTEM with the attached Plan Sheet E-02.

Item 5: Replace Specification Workmanship and Materials Section 13500 – Instrumentation and Control System with the attached Section 13500.

Item 6: Replace Specification Workmanship and Materials Section 15091 – Miscellaneous Ball Valves with the attached Section 15091.

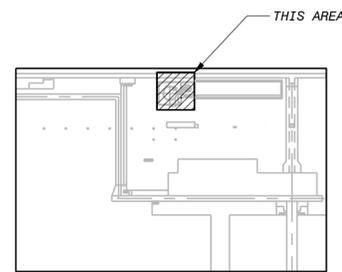
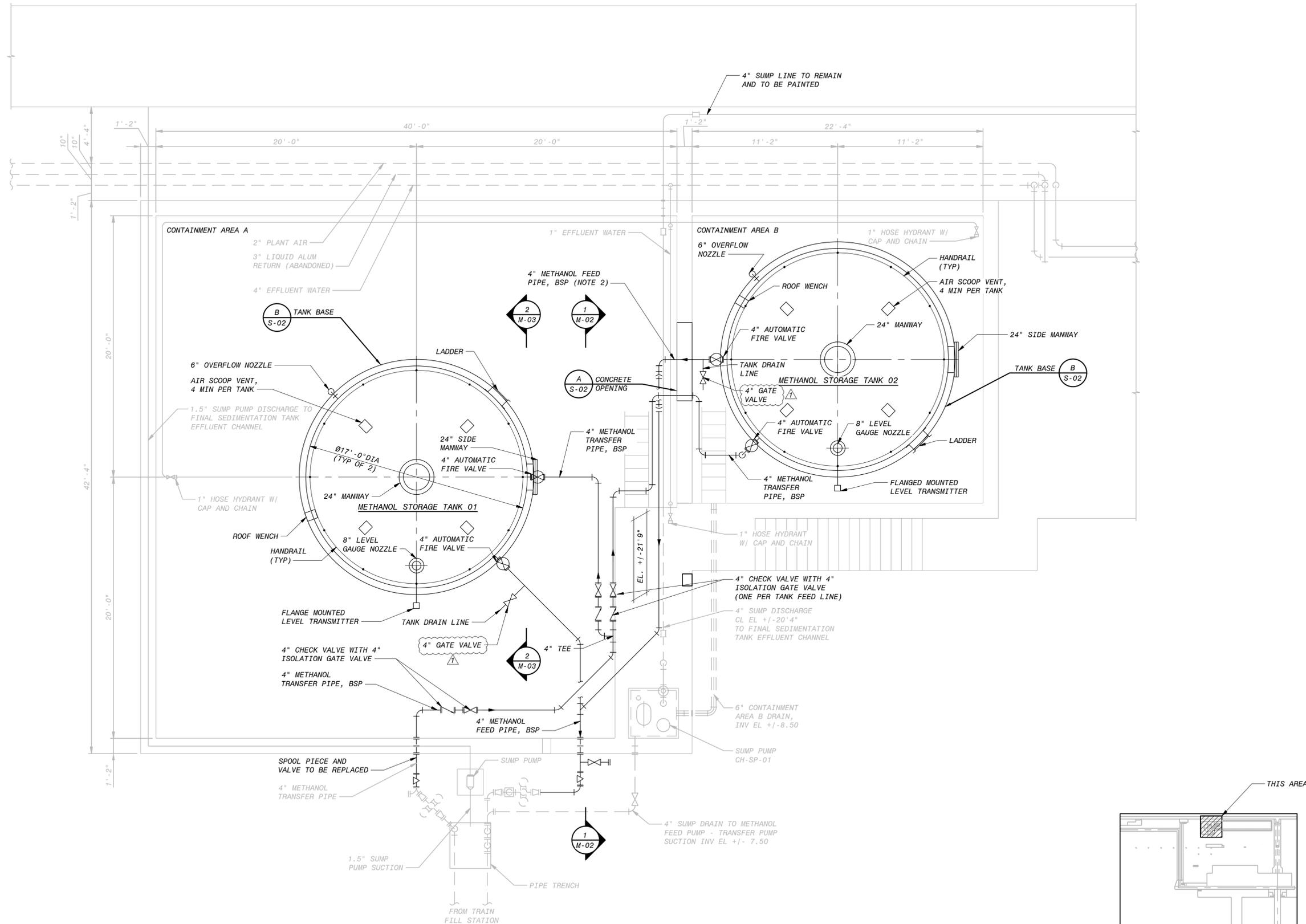
Item 7: Replace Specification Workmanship and Materials Section 15093 – Check Valves with the attached Section 15093.

Item 8: Replace Specification Workmanship and Materials Section 16050 – Electrical with the attached Section 16050.

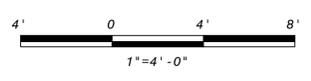
All other provisions of the Contract Documents and Specifications not in conflict with this Addendum shall remain in full force and effect. Questions are to be e-mailed to Contract Administration@tampagov.net.

Jim Greiner

Jim Greiner, P.E., Contract Management Supervisor



KEY PLAN



- NOTES:**
1. NEW METHANOL TANKS SHALL BE CONSTRUCTED OF 316L STAINLESS STEEL.
 2. 4" METHANOL FEED PIPE SHALL BE ROUTED THROUGH THE OPENING CREATED TO COMBINE CONTAINMENT AREAS A AND B. REFER TO DEMOLITION AND STRUCTURAL DRAWINGS FOR DETAILS.
 3. METHANOL TANKS TO BE INSTALLED IN A MANNER THAT WILL NOT INTERRUPT METHANOL SERVICE TO THE FACILITY.
 4. 4" METHANOL TRANSFER PIPE TO BE INSTALLED 6" ABOVE TANK BOTTOM AT POINT OF ENTRY INTO THE TANK.
 5. METHANOL PIPING ROUTING LOCATIONS SHOWN ARE APPROXIMATE. CONTRACTOR TO FIELD VERIFY ALL CHEMICAL TRANSFER AND FEED PIPING LOCATIONS. REFERENCE P&IDS (SHEET I-2) FOR METHANOL PIPING REQUIREMENTS..
 6. TANK AND ANCILLARY EQUIPMENT SHOWING GENERAL LOCATION AND OVERALL TANK SIZE.

SITE PLAN
1" = 4'-0"

JAN 2020	ADDENDUM 1	T	AD	ER	BH
NOV 2019	100% SUBMISSION	E	AD	BV	DH
AUG 2019	90% SUBMITTAL	D	AD	EE	NE
JUNE 2019	60% SUBMISSION	C	AD	EE	DH
DATE	REVISED AND RECORD OF ISSUE	NO.	BY	CHK	APP
	50.3000 - Mechanical Drawings				
	M-01.dwg				
	SAVED: TAM79561_23-Jan-20 2:37:09 PM				
	PLOTTED: TAM79561_23-Jan-20 2:37:15 PM				
	USER: TAM79561				
	50.3000 - Mechanical Drawings				
	50.3000 - Mechanical Drawings				
	50.3000 - Mechanical Drawings				
	50.3000 - Mechanical Drawings				

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CITY OF TAMPA
HOWARD F. CURREN AWWP
METHANOL STORAGE TANK REPLACEMENT

MECHANICAL
PLAN - METHANOL STORAGE TANKS

DESIGNED: NE
DETAILED: HT
CHECKED: EB
APPROVED: DH
DATE: JANUARY 2020
PROJECT NO. 401265
M-01 SHEET 7 OF 22

Section 13500

INSTRUMENTATION AND CONTROL SYSTEM

PART 1 – GENERAL

1-1. **SCOPE.** This section covers the installation of new tank level and combustible gas detection field instruments and modifications to the existing Methanol Pump Control Panel (MPCP) system located at Howard F. Curren AWTP as part of the Methanol Storage Tank Replacement Project.

The system shall be furnished as specified, complete with all software, hardware, instrumentation, and all devices, accessories, appurtenances, testing, and training necessary for proper operation.

The MPCP panel utilizes a GE RX3i PLC controlling the methanol feed pumps and communicating via existing fiber optic communications network to the Curren AWTP Plant Control System (PCS).

The MPCP panel is connected to five existing combustible gas detectors (AIT-101, AIT-102, AIT-103, AIT-104, & AIT-105) each wired to an MPCP front panel mounted process meter and a PLC analog input channel for remote PCS monitoring of combustible gas level. The MPCP front panel mounted digital indicators each provide an alarm contact for MPCP pump motor interlocks and an alarm contact wired to PLC digital input channel for remote PCS monitoring and alarm annunciation.

The MPCP panel is connected to an existing bubbler level transmitter (LIT-101) wired to an MPCP front panel mounted process meter and a PLC analog input channel for remote PCS monitoring of methanol storage tank level. This LIT will be replaced, as described below.

Two additional combustible gas detectors (AIT-106, AIT-107) matching the manufacturer and type of the existing gas detectors shall be provided, installed, wired to the existing MPCP, calibrated, and commissioned.

The existing combustible gas detectors are Det-Tronics Model #PIR9400S3P2AW: Part No. 006300-003 and J-Box Pointwatch Part No. 006414-001. Units are setup and calibrated for Methane, 50% LFL, 2.5% by volume using P/N 006468-001 PointWatch Detector Calibration kit.

The MPCP shall be modified to include the following:

- Two additional combustible gas front panel mounted process indicators
- Wiring of each gas detector analog signal through the panel meter to a spare MPCP PLC analog input channel
- MPCP panel wiring modifications for panel mounted process indicator alarm contacts for pump motor interlocks
- Wiring of process panel meter alarm contact to a spare PLC digital input for remote PCS monitoring and alarm annunciation of 50% LEL gas level.

Two new Yokogawa Model EJA210E-JHS5G-922EN-FF1 level transmitters (LIT-101 and LIT-102) shall be provided for a new methanol storage tank. The new level transmitters shall include



integral field surge protection and all required field mounting hardware and isolation hardware. All transmitter field mounting hardware and isolation hardware shall be constructed of 316 stainless steel. The transmitters shall be flange mounted on a 3" flange.

Both methanol tank level transmitters shall be installed, wired to the existing MPCP, calibrated, and commissioned. The MPCP shall be modified to include the following:

- An additional tank level front panel mounted process indicator
- Wiring of new tank level transmitter analog signal through the panel meter to a spare MPCP PLC analog input channel.
- MPCP panel wiring modifications for panel mounted process indicator alarm contact for methanol transfer pump motor interlock
- Wiring of process panel meter alarm contact to a spare PLC digital input for remote PCS monitoring and alarm annunciation of high tank level.

Each additional field instrument shall include associated stainless-steel field mounting hardware, MPCP signal surge protection, signal isolator / converter and ancillary power supply (if required) wired in the MPCP panel matching the manufacturer and model of existing signal surge protection, signal isolator / converters, and instrument power supplies. The additional MPCP panel instrument nameplates shall match the style and colors of existing panel nameplates.

The existing MPCP Maple Systems Operator Interface Terminal (OIT) and PCS database and Human-Machine Interface (HMI) displays shall be modified to include the additional field instrument signals and alarms for display and annunciation.

The existing Methanol Tank Sump Pump level switches shall be provided for field replacement by CONTRACTOR as shown on E-02.

Replacement float level switches shall consist of a single-pole, double-throw mercury switch, rated not less than 3 amp [A] ac, sealed and housed in a chemical-resistant polypropylene casing. The switch assembly shall be weighted and suspended on a waterproof, three-conductor, synthetic covered flexible cable with 19 AWG [0.5 mm²] conductors and of such length that no splice or junction box is required in the wet well. Switches shall be suitable for operation at up to 150 V ac within an ambient temperature range of 0 to 60°C. Switches shall be suitable for use in a sanitary wastewater wet well. Adjustable mounting hardware shall be provided for supporting each level switch. Switches shall be Ametek B/W Controls "Series 7010", Siemens "LSC", ITT/Flygt "ENM-10", or Gems Sensors & Controls/Warrick Controls "Series M".

Intrinsic safety barriers shall be added and wired by CONTRACTOR at MCC location for both sump control level switch and sump high water level switch.

1-1.02. Associated Sections. This section also includes the equipment and services specified in the following sections.

Section 13500-A FIELD INSTRUMENTS LIST

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings,

Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Drawings. The Drawings indicate locations and arrangements of equipment and may include installation details and block and one-line diagrams showing connections and interfaces with other equipment.

The new Methanol Storage Tank field instruments are listed as an appendix (13500-A) to 13500.

Principal components of the instrumentation systems shall be as indicated on the P&ID drawings.

1-2.03. Codes, Permits and Agency Approvals. All work performed, and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Where mandated by codes, panels, assemblies, materials, and equipment shall be listed by Underwriters' Laboratories. Contractor shall, as part of their work, arrange for and obtain all necessary permits, inspections, and approvals by the authorities having local jurisdiction of such work. This shall include any third-party inspections and testing of panels and equipment.

1-2.04. Supplier's Qualifications. Equipment and software furnished under this section and under other related sections listed in the Scope paragraph above shall be designed, coordinated, and supplied by a single manufacturer or supplier, hereinafter referred to as the System Supplier. The System Supplier shall be regularly engaged in the business of supplying computer-based monitoring, control, and data acquisition systems. The Contractor shall utilize the services of the System Supplier to coordinate all control system related items, to check-out and calibrate instruments, and to perform all testing, training, and startup activities specified to be provided.

The System Supplier shall have the following minimum qualifications:

- The supplier shall maintain a design office staffed with qualified technical design personnel.
- The supplier shall maintain competent and experienced service personnel to service the hardware and software furnished for this project.
- The supplier shall have as a minimum 5 years of experience in the design, coordination and supply of computer-based monitoring, control, and data acquisition systems.

1-2.05. Coordination. Systems supplied under this section shall be designed and coordinated by System Supplier for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications, under other contracts, and, where applicable, with related existing equipment including (but not limited to) existing Owner Plant Control System (PCS) software communicating to the GE RX3i PLC and Maple Systems OIT installed in existing MPCP panel. All equipment shall be designed and installed in full conformity with the Drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, and the manufacturer of the related equipment.

1-2.06. Related Equipment and Materials. Related equipment and materials may include, but will not be limited to, instrumentation, motor controllers, valve actuators, chemical feeders, analytical measuring devices, conduit, cable, and piping as described in other sections or furnished under other contracts.

1-2.07. Device Tag Numbering System. All devices shall be provided with permanent identification tags. The tag numbers shall agree with System Supplier's equipment drawings and shall be as close as practical to the tag numbers used on the Drawings and device schedules. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device. Hand-lettered or tape labels will not be acceptable.

1-3. GENERAL REQUIREMENTS. The drawings and specifications indicate the extent and general arrangement of the systems. If any departures from the Drawings or Specifications are deemed necessary by System Supplier, details of such departures and the reasons shall be submitted to Engineer for review with or before the first stage submittal. No departures shall be made without prior written acceptance.

The specifications describe the minimum requirements for hardware and software. Where System Supplier's standard configuration includes additional items of equipment or software features not specifically described herein, such equipment or features shall be furnished as a part of the system and shall be warranted as specified herein.

1-3.01. Governing Standards. Equipment furnished under this section shall be designed, constructed, and tested in accordance with IEEE 519, ANSI C37.90, FCC Part 15 - Class A, and NEMA ICS-1-109.60.

1-3.02. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The System Supplier shall review the Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications requisite for proper installation subject to acceptance by Engineer. At least three feet of clear access space shall be provided in front of all instrumentation and control system components.

1-3.03. Workmanship and Materials. System Supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except for testing.

1-3.04. Corrosive Fluids. All parts which are exposed to corrosive conditions shall be made from corrosion resistant materials. System Supplier shall submit certification that the instrument

manufacturer approves the selection of materials of primary elements that are in contact with the specified process fluid to be inert to the effects of the process fluid.

1-3.05. Appurtenances. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, and isolation devices shall be furnished as needed for proper performance of the equipment.

1-3.06. Programming Devices. The system supplier shall utilize their own programming or system-configuring devices for modifications to the GE PLC programming and Maple Systems OIT configuration, and calibration of Yokogawa level transmitters. The system supplier's programming devices and tools shall be compatible with OWNER's existing programming software and equipment.

1-4. SUBMITTALS. Complete dimensional, assembly, and installation drawings, wiring and schematic diagrams; and details, specifications, and data covering the materials used and the parts, devices and accessories forming a part of the system furnished, shall be submitted in accordance with the submittals section. Submittal data shall be grouped and submitted in three separate stages. The submittal for each stage shall be substantially complete. Individual drawings and data sheets submitted at random intervals will not be accepted for review. Equipment tag numbers or identifications used on the Drawings shall be referenced where applicable.

1-4.01. First Stage Submittal. The first stage submittal shall include the following items.

- a. A detailed list of any exceptions, functional differences, or discrepancies between the system proposed by System Supplier and this specification.
- b. Product catalog cut sheets on all hardware and software items, clearly marked to show the model number, optional features, and intended service of each device.
- c. A brief, concise description of the proposed system, including major hardware and software components and personnel training.
- d. A block diagram or schematic drawing showing the principal items of equipment furnished, including model numbers, and their interrelationships.
- f. Environmental and power requirements, including heat release information for each equipment item.
- g. Standard field termination drawings for all process input/output equipment, showing typical terminations for each type of point available in the system.

1-4.02. Second Stage Submittal. Before any equipment is released for shipment to the site and before factory testing is scheduled, the following data shall be submitted.

At System Supplier's option, the first and second stage submittals may be combined.

- a. Detailed functional descriptions of all software modules specified and furnished as part of System Supplier's standard system. The descriptions shall be identified with the applicable specification paragraph.
- b. Complete panel fabrication drawings and details of panel wiring, piping, and painting. Panel and subpanel drawings shall be to scale and shall include overall dimensions,

metal thickness, door swing, mounting details, weight, and front of panel arrangement to show general appearance, with spacing and mounting height of instruments and control devices.

- c. Wiring and installation drawings for all interconnecting wiring between components of the system and between related equipment and the equipment furnished under this section. Wiring diagrams shall show complete circuits and indicate all connections. If panel terminal designations, inter-device connections, device features and options, or other features are modified during the fabrication or factory testing, revised drawings shall be submitted before shipment of the equipment to the site.
- e. Review of drawings submitted prior to the final determination of related equipment shall not relieve System Supplier from supplying systems in full compliance with the specific requirements of the related equipment.
- f. Input/output listings showing point names, numbers, and addresses. Input/output identification numbers from the contract documents shall be cross-referenced in this submittal.

1-4.03. Third Stage Submittal. Complete system documentation, in the form of Operation and Maintenance Manuals, shall be submitted before the commencement of field acceptance testing. Operation and Maintenance Manuals shall include complete instruction books for each item of equipment and software furnished. Where instruction booklets cover more than one specific model or range of device, product data sheets shall be included which indicate the device model number and other special features. A complete set of "as-built" wiring, fabrication, and interconnection drawings shall be included with the manuals. If field-wiring modifications are made after these drawings are submitted, the affected drawings shall be revised and resubmitted.

1-5. PREPARATION FOR SHIPMENT. All electronic equipment and instruments shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements, shall be kept dry at all times, and shall not be exposed to adverse ambient conditions.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

Each shipment shall include an appropriate shipping list that indicates the contents of the package, including the specific instrument tags. The shipping list shall be accessible without exposing the instruments to the atmosphere. The shipping list shall also contain any cautionary notes regarding storage of the instruments, including requirements to protect the instrument from static discharge, desensitizing chemicals (solvents, paints, etc.), or ambient atmospheric conditions.

Individual instruments shall be appropriately tagged or labeled to positively identify the device. All identification shall be visible without the need to unpack the instrument from its protective packaging.

Instrument shipment and storage requirements shall be coordinated with Engineer or Owner prior to shipment. System Supplier shall provide adequate storage and be ready to accept the

shipment before shipping any equipment to the site. Additional shipping and storage requirements shall be as detailed in the individual instrument specifications.

Components which are shipped loose due to transportation limitations shall be assembled and disassembled by the manufacturer prior to shipment to assure that all components fit together and are adequately supported.

1-6. DELIVERY, STORAGE, AND SHIPPING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1-7. SPARE PARTS. In addition to spare parts and consumable items specified in other sections, the following spares and consumable items shall be provided:

<u>Spare Parts</u>	<u>Quantity</u>
Combustible Gas Detector Transmitter	One (1)
Local Status Panel Digital Panel Display	One (1)
Instrument signal surge protection	Two (2)

1-7.01. Packaging. All spare parts shall be delivered to Owner before final acceptance of the system. Packaging of spare parts shall provide protection against dust and moisture and shall be suitable for storage. Circuit boards and other electronic parts shall be enclosed in anti-static material. All packages shall be clearly marked with the manufacturer's name, part number or other identification, date of manufacture, and approximate shelf life.

1-7.02. Replacement. System Supplier may utilize spare parts and supplies during system installation, de-bugging, startup, or training, but shall restore all such materials and supplies to the specified quantities before final acceptance of the systems.

PART 2 - PRODUCTS

2-1. GENERAL REQUIREMENTS. All equipment furnished under each section referenced in SCOPE is a part of this section and shall be selected by System Supplier for its superior quality and intended performance. Equipment and materials used shall be subject to review.

2-1.01. Standard Products. The systems furnished shall be standard products. Where two or more units of the same type of equipment are supplied, they shall be the products of the same manufacturer; however, all components of the systems furnished hereunder need not be the products of one manufacturer unless specified herein.

To the extent possible, instruments used for similar types of functions and services shall be of the same brand and model line. Similar components of different instruments shall be the products of the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. The design of the systems furnished hereunder shall utilize concepts, techniques and features that provide maximum reliability and ease of maintenance and repair. The systems shall include board-level devices such as light emitting diodes or other indicators to facilitate quick diagnosis and repair. Diagnostic software shall be furnished to facilitate system-level troubleshooting.

2-3. POWER SUPPLY AND INSTRUMENT SIGNAL. Power supply to all control system equipment will be 120 volts, 60 Hz, single phase or powered from existing MPCP panel. System Supplier shall be responsible for distribution of power among new devices installed within the existing MPCP enclosure.

2-4. SERVICE CONDITIONS AND ENVIRONMENTAL REQUIREMENTS. The equipment provided for the instrumentation and control system shall be suitable for the service conditions specified in the attached equipment sections.

All equipment shall be designed and selected to operate without degradation in performance throughout the environmental extremes specified. Equipment shall be designed to prevent the generation of electromagnetic and radio frequency interference and shall be in compliance with FCC Rules and Regulations, Part 15, for Class A computing devices.

2-4.01. Ambient Temperature and Elevation. All system equipment located in air-conditioned rooms shall be suitable for operation in ambient temperatures from 10°C to 35°C and a relative humidity of 10 to 80 percent, noncondensing. All equipment located in non-air-conditioned indoor areas shall be suitable for an ambient temperature range of 0°C to 50°C and a relative humidity of 10 to 95 percent, noncondensing. All equipment located outdoors shall be suitable for operation in an ambient temperature range -20°C to 60°C and a relative humidity of 5 to 100 percent. Heaters and air conditioning/cooling equipment shall be provided where essential to maintain equipment within its manufacturer-recommended operating ranges.

All equipment and instruments shall be designed to operate at the site elevation of 50 feet.

2-4.02. Deleterious Effects. All system equipment will be installed in areas without anti-static floor construction and without any provisions for control of particulates or corrosive gases other than ordinary office-type HVAC filtering. System Supplier shall furnish any additional air cleaning equipment, anti-static chair pads, or other protective measures necessary for proper operation of the system.

All input/output hardware shall meet or exceed, without false operation, all requirements of NEMA ICS-1-109.60, Electrical Noise Tests.

2-4.03. Noise Level. The equivalent "A" weighted sound level for any system equipment located in the control room, except printers, shall not exceed 35 dBA. The sound level for printers shall not exceed 65 dBA. Sound reduction enclosures shall be provided where necessary to comply with these limits.

2-4.04. Lightning Protection. In addition to other environmental protection specified herein, the entire system shall be provided with lightning protection. Lightning protection measures shall include the following.

2-4.04.01. Grounding. All major components of the system shall have a low resistance ground connection. Grounding system provisions indicated on the Drawings shall be modified as recommended by System Supplier.

2-4.04.02. Surge Suppressors. Surge and lightning suppressors shall be non-faulting, non-interrupting, and shall protect against line-to-line and line-to-ground surges. Devices shall be solid-state metal oxide varistor (MOV) or silicon junction type, with a response time of less than 50 nanoseconds. Surge protective devices shall be applied for the following:

- a. All analog signal circuits where any part of the circuit is outside of the building envelope. Circuits shall be protected at both the transmitter and the control system end of the circuit. Surge protection devices shall not impede or interfere with the use of smart transmitter calibration/communication. Protection devices located near the transmitter shall be Telematic "TP48." Protection devices in control panels shall be Transtector "PDS Series or FSP Series", Telematic "SD Series", Phoenix Contact "PipeTrab Series", or Citel "BP1-24."

2-5. SOFTWARE DOCUMENTATION. System Supplier shall furnish complete documentation on all software supplied with the systems specified herein. Operating systems, compilers, assemblers, and utility and diagnostic programs that are standard commercial products of third parties need not be included in the optical media backup. Software documentation shall consist of the following principal items.

- a. One backup set of any integrated circuit or solid-state memory-based plug-in firmware used.
- b. Two complete back-up copies of system and application software in executable format on optical media compatible with the system furnished.
- c. Three sets of user reference manuals for all standard system and application software.
- d. One set of user reference manuals for all operating system software.
- e. Three sets of printed as-built reference documentation for any special software provided specifically for this contract.
- f. For each licensed software product, all documentation provided by the product manufacturer shall be provided. This includes all reference manuals and any other documents that were provided by the manufacturer. One set of this documentation shall be supplied for each and every piece of equipment provided. Multiple pieces of similar equipment or software require multiple copies of this documentation.

2-6. SOFTWARE LICENSE. All software programs supplied as a standard part of System Supplier's products for this project shall be licensed to Owner for use on the system specified herein. Such license shall not restrict Owner from using the software on the system provided hereunder or its replacement. Owner shall have the right to make copies of the software for use on the system provided. Specific requirements of System Supplier's software license are subject to review and approval by Owner and Engineer.

2-7. INSTALLATION TEST EQUIPMENT. All necessary testing equipment for calibration and checking of system components shall be provided by System Supplier. System Supplier shall also furnish calibration and maintenance records for all testing and calibration equipment used on the site if requested by Engineer.

PART 3 – EXECUTION

3-1. INSTALLATION REQUIREMENTS. The installation of equipment furnished hereunder shall be by the Contractor or their assigned subcontractors.

3-1.01. Field Wiring. Field wiring materials and installation shall be in accordance with the electrical section.

3-1.02. Instrument Installation. Instruments shall be mounted so that they can be easily read and serviced and so that all appurtenant devices can be easily operated. Installation details for some instruments are indicated on the Drawings.

All outdoor instrumentation shall be protected from direct sun exposure. Instruments shall be placed in locations to limit south and west sun exposure. Sunshades shall be provided on instruments that are subject to the direct sun exposure. Sunshades shall be located so the opening faces north or east where possible. Sunshades shall be provided as shown on the Drawings.

3-1.03. Salvage of Existing Equipment. Existing equipment and materials removed or replaced under this contract shall be delivered to Owner at a location designated by Owner or shall be properly disposed of at Owner's discretion. Care shall be taken to avoid damage to equipment delivered to Owner.

Any mounting brackets, enclosures, stilling wells, piping, conduits, wiring, or openings that remain after removal of equipment and support hardware shall be removed or repaired in a manner acceptable to Owner and Engineer.

Transmitters or switches containing mercury shall be removed and disposed of by personnel trained in the handling of hazardous materials and using approved procedures.

3-2. SYSTEM SOFTWARE CONFIGURATION. The System Supplier shall modify the existing PCS database and HMI displays to display, log, and annunciate new MPCP field instrument process signals and alarms.

3-3. SYSTEMS CHECK. System Supplier shall provide the services of a trained and experienced field supervisor to assist the installation contractor during installation, and to calibrate, test, and advise others of the procedures for installation, adjustment, and operation.

3-3.01. Field Manager. Not used.

3-3.02. Field Inspection at Delivery. The field supervisor shall inspect major equipment items within five working days of delivery, to assure that the equipment was not damaged during

shipment and shall supervise or assist with unpacking, initial placement, and initial wiring of the system.

3-3.03. Field Calibration of Instruments. After each instrument has been installed, a technical representative of System Supplier shall calibrate each instrument and shall provide a written calibration report for each instrument, indicating the results and final settings. The adjustments of calibrated instruments shall be sealed or marked, insofar as possible, to discourage tampering. Instrument calibration shall be done before checkout of the system operation. A typical instrument calibration report is attached to the end of this section.

3-3.04. Training for Installation Personnel. Not Used.

3-3.05. Field Inspection Prior to Start Up. Not used.

3-3.05.01. Analog Signals. Analog input signals shall be simulated at the transmitting source, and verified to be operational within the MPCP PLC, and displayed properly on the MPCP OIT and PCS HMI.

3-3.05.02. Discrete Signals. Discrete input and output signals shall be simulated and verified to be operational within the MPCP PLC and displayed properly on the MPCP OIT and PCS HMI.

3-3.05.03. Devices by Other Suppliers. If interrelated devices furnished by other suppliers, under other contracts, or by Owner, such as valve actuators, motor controls, chemical feeders, and instruments, do not perform properly at the time of system checkout, the field supervisor shall use suitable test equipment to introduce simulated signals to and/or measure signals from these devices to locate the sources of trouble or malfunction.

3-3.05.04. System Check Out Report. The System Supplier shall submit a written report on the results of such tests to Engineer. Additional documentation shall be furnished as requested by Engineer to establish responsibility for corrective measures. System Supplier shall verify, in writing, to Engineer and Owner that System Supplier has successfully completed the external connection check before beginning system startup or field acceptance testing.

3-3.06. Start Up Assistance. After the system supplier has completed the system check and submitted his report, System Supplier shall supply a factory-trained engineer / programmer to provide on-site start up assistance. During the startup period, these personnel shall thoroughly check all equipment, correct any deficiencies, and verify the proper operation of all components. One (1) working days shall be included for this task.

3-4. TESTING. The system shall be acceptance tested on site.

System Supplier shall prepare a testing procedure to be approved by Owner and Engineer that shall demonstrate that the system conforms to the specifications. The testing procedure shall be submitted at least 30 days in advance of testing. The testing shall be conducted by System Supplier and witnessed by Owner and/or Engineer.

System Supplier shall notify Engineer and Owner in writing at least 14 days before the proposed testing date. If the factory acceptance test is concluded unsuccessfully, the test shall be repeated. System Supplier shall reimburse Owner and Engineer for all expenses incurred in connection with attending repeated site testing necessitated by system failure or inadequate preparation.

3-4.01. Factory Acceptance Testing. Not Used.

3-4.02. Site Acceptance Testing. After installation and checkout by System Supplier's personnel, the system shall be subjected to an acceptance test.

Site acceptance testing shall be scheduled after receipt of the System Check Out Report. System Supplier shall verify that all field signal changes are reflected in the proper address locations in the MPCP PLC and MPCP OIT.

System Supplier shall coordinate with Owner on testing requirements to confirm field instruments are functioning and properly communicated and displayed on the PCS HMI.

The site acceptance test shall be conducted on complete system, including all field I/O devices.

The operational demonstration shall confirm that the additional status, alarm, and process variable signals are valid and are present on the MPCP PLC I/O, MPCP panel motor interlocks, MPCP OIT, and PCS HMI. Any errors or abnormal occurrences shall be recorded by System Supplier's field representative. System Supplier's field representative need not be continuously present during the site acceptance testing but shall be available to respond to the site within twenty-four hours of notification.

3-4.02.01. Failure of Redundant Equipment. Not Used.

3-4.02.02. Completion of Test. Successful completion of the site acceptance test, including the operational demonstration, is prerequisite to Substantial Completion as specified in the Supplementary Conditions.

3-5. TRAINING. Not Required.

End of Section

INSTRUMENT NAME & SERVICE:		
BRAND & MODEL NO.:		
TAG OR LOOP NO.:		
INPUT/OUTPUT RANGE:		
INPUT	ACTUAL OUTPUT	DESIRED OUTPUT
PROPORTIONAL BAND:		
RESET:		
POSITION OF SWITCHES, JUMPERS, ETC.		
COMMENTS:		
DATE OF CALIBRATION: CALIBRATED BY:		
Black & Veatch	INSTRUMENT CALIBRATION REPORT	Figure 1-13500

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13500-A
Field Instruments

- Item.** This is an arbitrary sequential number which is for reference only.
- Tag.** This is the ISA (or similar) alpha tag representing the function of the instrument.
- PLC.** This is the PLC location ID where the designated instrument signal is connected.
- Service Description.** This is the description of the instrument service (i.e. Pump Discharge Pressure).
- Device Type & Size.** This is the instrument device type and should match the description as listed in the specification. Where appropriate, the size of the device (such as diameter of flowmeters) will be listed.
- Output Type.** This generally will be '4-20 mA' or "Dry Contact". It could also be a serial output for smart devices (such as HART or FLD-BUS) but only if the serial output is the primary I/O interface.
- Output Range.** This is the calibrated range for analog devices or the trip point(s) for discrete devices.
- Power.** This will typically be either 24 VDC or 115 VAC for dry contact sense voltage, or 115 VAC for AC powered devices. Loop-powered devices will be designated as 2-wire, 24 VDC.
- Inst. Det.** This is a reference to the applicable installation detail on the drawings if applicable.
- Loc. Dwg.** This is the drawing number of the electrical plan or instrument location plan where the device is shown.
- P&I Drawing** This is the drawing number of the P&ID where the device is shown.
- Comments/Notes.** This column may include a cross reference to another specification section where applicable, or to a note which provides additional information. Notes are appended to the end of the device schedule listings.

13500-A

Item	Tag	Connection	Service Description	Device Type & Size	Output Type	Output Range	Device Power	Elec. Dwg.	I&C Dwg.	Comments
1	LIT-102	MPCP PLC	Methanol Tank 02 Level	Pressure Indicating Level Transmitter	4-20ma	Calibrate to Tank	2-wire, 24VDC, MPCP PLC	E-02	I-02	Yokogawa EJA210E-JHS5G-922EN-FF1 - No Exceptions
2	AIT-106	MPCP PLC	Methanol Tank 02 Combustible Gas Detector AIT-106	Combustible Gas Detector	4-20ma	Calibrate to 2.5% methane gas by volume	2-wire, 24VDC, MPCP PLC	E-02	I-02	Det-Tronics Model PIR9400S3P2AW, Part No. 006300-003 and J-Box Pointwatch Part No. 006414-001
3	AIT-107	MPCP PLC	Methanol Tank 02 Combustible Gas Detector AIT-107	Combustible Gas Detector	4-20ma	Calibrate to 2.5% methane gas by volume	2-wire, 24VDC, MPCP PLC	E-02	I-02	Det-Tronics Model PIR9400S3P2AW, Part No. 006300-003 and J-Box Pointwatch Part No. 006414-001
4	LSH-108	MPCP PLC	Methanol Tank Sump High Level Alarm Float Switch	Float Switch	Contact	Field Adjusted in Sump to match existing LS	MPCP PLC 120VAC Digital Input	E-02	-	Ametek B/W Control "Series 7010", Siemens "LSC", ITT/Flyg "ENM-10", or Gems Sensors & Controls "Series M"
5	LS-108	Methanol Tank Sump Pump MCC-59B	Methanol Tank Sump Pump Control Level Float Switch	Float Switch	Contact	Field Adjusted in Sump to match existing LS	MCC-59B Sump Pump Starter 120VAC Control	E-02	-	Ametek B/W Control "Series 7010", Siemens "LSC", ITT/Flyg "ENM-10", or Gems Sensors & Controls "Series M"
6	LIT-101	MPCP PLC	Methanol Tank 01 Level	Pressure Indicating Level Transmitter	4-20ma	Calibrate to Tank	2-wire, 24VDC, MPCP PLC	E-02	I-02	Yokogawa EJA210E-JHS5G-922EN-FF1 - No Exceptions



Section 15091

MISCELLANEOUS BALL VALVES

PART 1 - GENERAL

1-1. **SCOPE.** This section covers the furnishing of manually operated or remote activated two position (open-close) ball valves as specified herein.

Miscellaneous ball valves shall be provided where AWWA type ball valves are not required.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1-2. GENERAL.

1-2.01. **General Equipment Stipulations.** The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If the requirements in this section are different from those in the General Equipment Stipulations, the requirements in the section shall take precedence.

1-2.02. **Identification.** Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1-3. **SUBMITTALS.** Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

2-1. **CONSTRUCTION.** Ball valves shown on the drawing, but not specified herein, shall be selected to match piping material they are installed in.

2-1.01. Valves Type VB-1. Not used.

2-1.02. Valves Type VB-2. Not used.

2-1.03. Valves Type VB-3. Not used.

2-1.04. Valves Type VB-4. Not used.

2-1.05. Valves Type VB-5. Not used.

2-1.06. Valves Type VB-6. Not used.

2-1.07. Valves Type VB-7. Not used.

2-1.08. Valves Type VB-8. Not used.

2-1.09. Valves Type VB-9.

 1	VB-9	Rating	Class 150
	Methanol service	Code	ANSI B16.42
	4 inch	Type	In-line, three-piece, bolted body, firesafe, full port
	Auto Fire Shut-off Valve	Body/Bonnet Trim	Ductile Iron
		Cap/Poppet	Ductile Iron
		Spring	302 Stainless steel
		Stem	PTFE
		Lever arm	Ductile Iron
		Seal Nut/Plug	PTFE
		End Connection	Flanged
	Pres. Limitations	250 psi	
	Valve Operator	Lever	
	Manufacturers	Morrison Bros. Co. "346FDI0400 AV"	

2-1.10. Valves Type VB-10. Not used.

2-1.11. Valves Type VB-11. Not used.

2-1.12. Valves Type VB-12. Not used.

2-1.13. Valves Type VB-13. Not used.

2-1.14. Valves Type VB-14. Not used.

2-1.15. Valves Type VB-15. Not used.

VB-15	Rating	Class 600
Methanol service	Code	ANSI B16.34
4 inch	Type	In-line, three-piece, bolted body, full port Stainless steel
	Body	Teflon
	Trim	Stainless steel
	Seat	Stainless steel
	Ball	Teflon
	Stem	Socket weld
	Stem Seal	



with a lever operator. Ball valves with center lines more than 7'-6" above the floor shall be provided with chain levers.

Valves indicated to be electric motor operated on the drawings shall have reversible electric motor operators designed for 120-volt ac, single phase operation. Actuators shall include integral thermal overload protection and a declutchable manual override. Actuators shall be equipped with motor operation limit switches and two additional single-pole, double-throw limit switches for auxiliary open and closed indication. An internal heater and thermostat shall be provided in each actuator housing to prevent condensation. Actuators in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the drawings shall have NEMA Type 7 housings. Actuators in other areas shall have NEMA Type 4X housings.

2-3. ACCESSORIES. If the drawings indicate the need for extension stems, stem guides; position indicator; floor boxes; valve boxes; or operating stands, refer to the Valve and Gate Actuator section.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section shall be installed in accordance with the Valve Installation section.

End of Section

Section 15093

CHECK VALVES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of check valves as specified herein and as indicated in the swing Check Valve Schedule.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Temporary Number Plates. Not used.

1-2.03. Identification. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 – PRODUCTS

2-1. CONSTRUCTION.

2-1.01. Valves VC-15.





VC-15	Rating Type	Class 150 Integral seat, swing type, bolted cover
Chemical feed service	Body/Bonnet Rubber Flapper	Cast Iron Reinforced NBR, Acrylonitrile-Butadiene, Carbon Steel ASTM A36 or Reinforced CR, Chloroprene, Carbon Steel ASTM A36
4 inch and smaller carbon steel pipe	Hinge End Connection Temp. Limitations Manufacturers	Carbon Steel A216 Flanged 0 to 150°F APCO Series 100

2-1.02. Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Surfaces To Be Coated

Unfinished Surfaces

Interior Surfaces

Liquid Service

Epoxy enamel.

Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults

Asphalt varnish or coal tar epoxy.

Exterior Surfaces of All Other Valves

Universal primer.

Polished or Machined Surfaces

Rust-preventive compound.

Actuators and Accessories

Universal primer.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section shall be installed in accordance with Valve Installation section.

End of Section

Section 16050

ELECTRICAL

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of all equipment and materials needed for the electrical requirements of this Contract. It also covers conduit, wiring, and terminations for electrical equipment installed under Electrical Equipment Installation section.

This section covers the installation and interconnection of electrical equipment furnished under other sections, except electrical items designated to be installed under those sections.

Electrical scope consists of installation of field devices, conduits and cabling associated with new combustible gas detectors and methanol storage tank level transmitters to existing Methanol Pump Control Panel as shown on plans. Scope of supply also includes replacement of existing area lighting fixture and fixture mounting conduits and replacement of conduits, field operator station, and sump pump float switches as indicated on plans.

City of Tampa's standard electrical specifications are included under appendix 16050-A. Any conflicts between 16050 and City of Tampa standard electrical specifications W-76 shall be construed and reconciled to the more stringent requirement.

1-2. GENERAL. Electrical apparatus on all equipment shall be installed complete and placed in readiness for proper operation.

Electrical materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment provided under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Coordination. Electrical work shall conform to the construction schedule and the progress of other trades.

1-2.04. Anchor Bolts and Expansion Anchors. All anchor bolts, nuts, washers, and expansion anchors shall comply with Anchorage in Concrete and Masonry section, except smaller than 3/4 inch [19 mm] will be permitted to match NEMA standard size bolt holes on motors and electrical equipment.

1-2.05. Drawings. Supplementing this section, the Drawings indicate locations of equipment and enclosures and provide one-line and schematic diagrams regarding the connection and interaction with other equipment.

1-3. CODES AND PERMITS. All work shall be performed, and materials shall be furnished in accordance with the NEC - National Electrical Code, the NESC - National Electrical Safety Code, and the following standards where applicable:

AEIC	The Association of Edison Illuminating Companies
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
Fed Spec	Federal Specification
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
NEIS	National Electrical Installation Standards
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
UL	Underwriters' Laboratories

Equipment covered by this section shall be listed by UL, or by a nationally recognized third-party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. If no third-party testing laboratory provides the required listing, an independent test shall be performed at Contractor's expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure to be used.

1-4. SEISMIC DESIGN REQUIREMENT.

1-4.01. Seismic Design Requirements. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-5. IDENTIFICATION.

1-5.01. Conduit. Conduits in manholes, handholes, building entrance pull boxes, junction boxes, and equipment shall be provided with identification tags. Identification tags shall be 19 gauge [1 mm thick] stainless steel, with 1/2 inch [13 mm] stamped letters and numbers as indicated on the Drawings. Identification tags shall be attached to conduits with nylon tie wraps and shall be positioned to be readily visible.

1-5.02. Conductors. All conductors in power, control, and instrumentation circuits shall be identified and color coded as described herein.

1-5.02.01. Conductor Identification Number. Except for lighting and receptacle circuits, each individual conductor in power, control, and instrumentation circuits shall be provided with wire identification markers at the point of termination.

The wire markers shall be of the heat-shrinkable tube type, with custom typed identification numbers.

The wire numbers shall be as indicated on the equipment manufacturer's drawings.

The wire markers shall be positioned to be readily visible for inspection.

1-5.02.02. Conductor Color Coding. Power conductors shall be color coded as indicated below. For conductors 6 AWG and smaller, the color coding shall be the insulation finish color. For sizes larger than 6 AWG, the color coding may be by marking tape. The equipment grounding conductor shall be green or green with one or more yellow stripes if the conductor is insulated.

The following color-coding system shall be used:

120/240V single-phase — black, red, and white
120/208V, three-phase — black, red, blue, and white
120/240V, three-phase — black, orange, blue, and white
277/480V, three-phase — brown, orange, yellow, and gray
2400/4160V, three-phase — black, red, blue, and white
7200/12470V, three-phase — black, red, blue, and white

Where 120/240- and 120/208-volt systems share the same conduit or enclosure, the neutral for either the 120/240 volt system or the 208 volt system shall be white with a permanent identifiable violet stripe.

Control and instrumentation circuit conductors shall be color coded as indicated in the Cable Data Figures at the end of this section.

1-5.03. Motor Starters. Not used.

1-5.04. Control Stations. Not used.

1-5.05. Circuit Breakers. Not used.

1-5.06.
Disconnect
Switches. Not
used.

1-5.07. Arc Flash Hazard Labels. Not Used.

1-6. SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the work performed by the Contractor, shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:

Drawings and data.
Operating manuals.
Samples.
Test reports
Studies

1-6.01. Submittal Identification. Information covering all materials and equipment shall be submitted for review in accordance with the Submittal Procedures section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment as follows:

- a. Lamp fixture descriptive sheets shall show the fixture schedule letter, number, or symbol for which the sheet applies.
- b. Equipment and materials descriptive literature and drawings shall show the specification paragraph for which the equipment applies.
- c. Sheets or drawings covering more than the item being considered shall have all inapplicable information crossed out.
- d. A suitable notation shall identify equipment and materials descriptive literature not readily cross-referenced with the Drawings or Specifications.
- e. Schematics and connection diagrams for all electrical equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections.
- f. Surge protective device submittals shall include drawings (including unit dimensions, weights, component and connection locations, mounting provisions, and wiring diagrams), equipment manuals that detail the installation, operation and maintenance instructions for the specified unit(s), and manufacturer's descriptive bulletins and product sheets.

Contractor shall submit the name and qualifications of the Engineering and Testing Services firm proposed to perform the protective device study and the on-site testing.

Within 90 days after the Notice to Proceed, Contractor shall furnish a submittal for all types of cable and conduit to be provided. The submittal shall include the cable manufacturer and type, and sufficient data to indicate that the cable and conduit meet the specified requirements.

In addition to the complete specifications and descriptive literature, a sample of the largest size of each type of cable shall be submitted for review before installation. Each sample shall include legible and complete surface printing of the cable identification.

1-6.02. Seismic Design Requirements. Submitted confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-7. **PROTECTION AND STORAGE**. During construction, the insulation on all electrical equipment shall be protected against absorption of moisture, and metallic components shall be protected against corrosion by strip heaters, lamps, or other suitable means. This protection shall be provided immediately upon receipt of the equipment and shall be maintained continuously.

PART 2 - PRODUCTS

2-1. POWER SERVICE ENTRANCE. Not Used.

2-2. TELEPHONE SERVICE ENTRANCE. Not used.

2-3. CABLE. All cables of each type (such as lighting cable or 600-volt power cable) shall be from the same manufacturer.

All types of cable shall conform to the Cable Data Figures at the end of this section and as described herein.

2-3.01. Lighting Cable. Lighting and receptacle circuits, shall be as specified for 600 volt (Figure 2-16050 XHHW-2) power cable.

2-3.02. 600 Volt Power Cable. Not Used.

2-3.03. Instrument Cable. Cable for electronic circuits to instrumentation, metering, and other signalling and control equipment shall be two- or three-conductor instrument cable twisted for magnetic noise rejection and protected from electrostatic noise by a total coverage shield. Types of instrument cables shall be (Figure 4-16050 single pair).

2.3.04. Multiconductor Control Cable. Not used.

2-3.05. Medium Voltage Power Cable. Not used.

2-3.06. Tray Cable. Not used.

2-4. RACEWAY. Conduit and cable tray shall be as described in the following paragraphs:

2-4.01. Rigid Steel Conduit. Not Used.

2-4.02. Intermediate Metal Conduit (IMC). Not used.

2-4.03. Liquid-tight Flexible Non-Metallic Conduit. Liquidtight flexible non-metallic conduit shall have a moisture-proof polyvinyl chloride jacket and shall be UL labelled. Rated for continuous use at 140°F. The conduit shall be resistant to oil, water, heat, sunlight, corrosion, most acids, ozone, alkali, strains, abrasions, and crushing. Compatible liquid-tight fittings shall be used for conduit installation.

All flexible conduits size 2 inch or less in non-classified areas shall be non-metallic, liquid-tight, and have a circular cross section. The flexible conduit and fittings shall be as manufactured by Carlon, Kellems, K-Flex, or equal.

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

2-4.04. Utility (PVC) Duct. Not used.

2-4.05. Rigid Nonmetallic (PVC) Conduit. PVC conduit shall be heavy wall, Schedule 80 UL labelled for aboveground and underground uses, and shall conform to NEMA TC-2 and UL 651 as manufactured by Carlon, Triangle, Allied Tube, or equal.

2-4.06. PVC-Coated Rigid Aluminum Conduit. The conduit shall be rigid aluminium. Before the PVC coating is applied, the aluminium surfaces shall be coated with a primer to obtain a bond between the aluminium substrate and the coating. The PVC coating shall be bonded to the primed outer surface of the conduit. The bond on conduit and fittings shall be stronger than the tensile strength of the PVC coating. The thickness of the PVC coating shall be at least 40 mils [1000 µm]. The PVC material shall conform to the applicable ASTM standards and UL 6A.

A chemically cured two-part urethane coating, at a nominal 2 mil [50 µm] thickness, shall be applied to the interior of all conduit and fittings. The coating shall be sufficiently flexible to permit field bending the conduit without cracking or flaking of the coating.

Every female conduit opening shall have a PVC sleeve extending one conduit diameter or 2 inches [50 mm], whichever is less, beyond the opening. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit before coating. The wall thickness of the sleeve shall be at least 40 mils [1000 µm].

All fittings, condulets, mounting hardware, and accessories shall be PVC-coated. All hollow conduit fittings shall be coated with the interior urethane coating described above. The screw heads on condulets shall be encapsulated by the manufacturer with a corrosion-resistant material.

PVC coated rigid aluminium conduit shall be manufactured by Plasti-Bond, Perma-Coate, KorKap, Calbond, Ocal, or Robroy Industries.

2-4.08. Rigid Aluminum Conduit (RAC). Rigid aluminum conduit and fittings shall be manufactured of 6063-T1 alloy, shall conform to ANSI C80.5 and Fed. Spec. WW-C-540, and shall be manufactured in accordance with UL 6A.

2-4.09. Cable Tray. Not used.

2-5. WIRING DEVICES, BOXES, AND FITTINGS. Concealed conduit systems shall have flush-mounted switches and convenience outlets. Exposed conduit systems shall have surface-mounted switches and convenience outlets.

2-5.01. Conduit Boxes and Fittings.

- a. Stainless steel boxes and fittings shall be manufactured by Crouse-Hinds, Appleton, or O Z Gedney. In applications utilizing aluminum conduit systems, aluminum boxes and fittings manufactured by Crouse-Hinds, Appleton, or O Z Gedney shall be installed.
- b. Rigid PVC device boxes and fittings shall be manufactured by Carlon or Cantex.
- c. Stainless steel device boxes shall be manufactured by Appleton, Raco, or Steel City.
- d. PVC coated device boxes shall be manufactured by Calbond, Ocal, or Robroy Industries.
- e. Hub arrangements on threaded fittings shall be the most appropriate for the conduit arrangement to avoid unnecessary bends and fittings.

2-5.02. Device Plates. Not Used.

2-5.03. Wall Switches. Not Used.

2-5.04. Receptacles. Not Used.

2-5.05. Special Outlets. Not used.

2-6. JUNCTION BOXES, PULL BOXES, AND WIRING GUTTERS.

Outdoor boxes and gutters shall be NEMA Type 4X, ABS or stainless steel and shall be rigidly supported by PVC-coated or stainless-steel framing materials. Mounting hardware, which includes nuts, bolts, and anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.

Bolt-on junction box covers 3 feet [900 mm] square or larger, or heavier than 25 lbs [11 kg], shall have rigid handles. Covers larger than 3 by 4 feet [900 by 1200 mm] shall be split.

Where indicated on the Drawings, junction and pull boxes with a removable side opposite the underground conduits shall be provided over building ends of underground conduit banks. Boxes shall be sized in accordance with the National Electrical Code, including space for full size continuations of all underground conduits not originally continued. Conduit arrangement shall leave maximum space for future conduits.

2-7. LIGHTING FIXTURES. Not Used.

2-7.01. Electronic Drivers. Not Used.

2-8. LIGHTING PANELS. Not Used.

2-9. POWER PANELS. Not Used.

2-11. SEPARATELY ENCLOSED MOTOR STARTERS. Not used.

2-12. SEPARATELY ENCLOSED MANUAL STARTERS. Not used.

2-13. CONTROL STATIONS. Not used.

2-14. SEPARATELY ENCLOSED CIRCUIT BREAKERS. Not used.

2-15. DISCONNECT SWITCHES. Not used.

2-16. LIGHTING AND AUXILIARY POWER TRANSFORMERS. Not Used.

2-17. POWER CENTERS. Not used.

2-18. POWER FACTOR CORRECTION CAPACITORS. Not used.

2-19. LIGHTING CONTACTORS. Not used.

2-20. PHOTOELECTRIC CONTROLS. Not used.

2-21. RELAY ENCLOSURES. Not used.

2-22. ALARM HORN AND BEACON. Not used.

2-23. HEAT-TRACED PIPING. Not used.

PART 3 - EXECUTION

3-1. INSTALLATION, TESTING, AND COMMISSIONING. All material, equipment, and components specified herein shall be installed, tested, and commissioned for operation in compliance with NECA 1000 – NEIS Specification System. Where required in NECA 1000, testing and commissioning procedures shall be followed prior to energizing equipment.

3-2. ARC FLASH HAZARD ANALYSIS. Not Used.

3-3. PROTECTIVE DEVICE STUDY. Not Used.

3-4. POWER AND SERVICE ENTRANCE INSTALLATION. Not Used.

3-5. TELECOMMUNICATIONS SERVICE ENTRANCE INSTALLATION. Not used.

3-6. CABLE INSTALLATION.

3-6.01. General. Except as otherwise specified or indicated on the Drawings, cable shall be installed according to the following procedures, taking care to protect the cable and to avoid kinking the conductors, cutting or puncturing the jacket, contamination by oil or grease, or any other damage. Circuits to supply electric power and control to equipment and devices, communication and signal circuits as indicated on the one-line diagrams shall be installed continuous and may not be spliced unless approved by the Engineer.

- a. Stranded conductor cable shall be terminated by lugs or pressure type connectors. Wrapping stranded cables around screw type terminals is not acceptable.
- b. Stranded conductor cable shall be spliced by crimp type connectors. Twist-on wire connectors may only be used for splicing solid cable and for terminations at lighting fixtures.
- c. Splices may be made only at junction boxes.
- d. Cable terminations and splices shall be made as recommended by the cable manufacturer for the particular cable and service conditions.
- e. All 5,000-volt rated cable and above shielded cable stress cone terminations shall be IEEE Class 1 molded rubber type. Shielded cable splices shall be tape or molded rubber type as required. Shielded cable splices and stress cone terminations shall be made by qualified splicers. Materials shall be by 3M Company, Plymouth/Bishop, or Raychem Electric Power Products.
- f. Cable shall not be pulled tight against bushings nor pressed heavily against enclosures.
- g. Cable-pulling lubricant shall be compatible with all cable jackets; shall not contain wax, grease, or silicone; and shall be Polywater "Type J".

- h. Cables operating at more than 2000 volts shall be fireproofed in all cable vaults, manholes, and handholes. Fireproofing shall be applied with a half-lapped layer of 3M "Scotch 77 Arc-Proofing Tape", anchored at each end with a double wrap of 3M "Scotch 69 Glass Cloth Tape" or with equivalent tape by Anixter or Plymouth/Bishop.
- i. Where necessary to prevent heavy loading on cable connections, in vertical risers, the cable shall be supported by Kellems, or equal, woven grips.
- j. Spare cable ends shall be taped, coiled, and identified.
- k. Cables shall not be bent to a radius less than the minimum recommended by the manufacturer. For cables rated higher than 600 volts, the minimum radius shall be 8 diameters for nonshielded cable and 12 diameters for shielded cable.
- l. All cables in one conduit, over 1 foot [305 mm] long, or with any bends, shall be pulled in or out simultaneously.
- m. Circuits to supply electric power and control to equipment and devices are indicated on the one-line diagrams. Conductors in designated numbers and sizes shall be installed in conduit of designated size. Circuits shall not be combined to reduce conduit requirements unless acceptable to Engineer.
- n. Instrument cable shields and drain wires shall be continuous over the entire length of the circuit and grounded at one end only. In general, the field end of the shield shall be ungrounded. At the ungrounded termination of the circuit, the shield and drain wire shall be insulated by taping to prevent grounding.
- o. Cables operating at more than 2,000 volts which terminate at medium-voltage padmounted equipment bushings shall include a metal oxide varistor surge protective elbow terminator conforming to IEEE Standard 386. Elbows shall provide a weatherproof, dead-front, hot-stick operable separable connection. Surge protector rating shall be as recommended by the terminator supplier.

3-6.02. Underground Cable Pulling Procedure. Not used.

3-6.03. Medium-Voltage Cable Insulation Test. Not used.

3-7. RACEWAY INSTALLATION. Contractor shall be responsible for routing all raceway. This shall include all conduits indicated on the one-lines, riser diagrams, and home-runs shown on the plan Drawings. Conduits shall be routed as defined in these Specifications. Where conduit routing is shown on plans, it shall be considered a general guideline and shall be field verified to avoid interferences.

Except as otherwise specified or indicated on the Drawings, conduit installation and identification shall be completed according to the following procedures.

3-7.01. Installation of Interior and Exposed Exterior Conduit. This section covers the installation of conduit inside structures, above and below grade, and in exposed outdoor locations. In general, conduit inside structures shall be concealed. Large conduit and conduit stubs may be exposed unless otherwise specified or indicated on the Drawings. No conduit shall be exposed in water chambers unless so indicated on the Drawings.

Unless otherwise indicated on the Drawings, Contractor shall be responsible for routing the conduit to meet the following installation requirements:

- a. Conduit installed in all exposed indoor locations, except corrosive areas indicated on the Drawings, and in floor slabs, walls, and ceilings of hazardous

- (classified) locations, shall be rigid aluminium. Exposed conduit shall be rigidly supported by stainless steel hardware and framing materials, including nuts and bolts.
- b. Conduit installed in floor slabs and walls in non-hazardous locations shall be rigid Schedule 80 PVC.
 - c. Conduit installed in all exposed outdoor locations shall be PVC-coated rigid aluminium, rigidly supported by PVC-coated framing materials. Mounting hardware, which includes nuts, bolts, and anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.
 - d. Final connections to dry type transformers, to motors without flexible cords, and to other equipment with rotating or moving parts shall be liquid-tight flexible non-metallic conduit with watertight connectors installed without sharp bends and in the minimum lengths required for the application, but not longer than 6 feet [1.8 m] unless otherwise acceptable to Engineer.
 - e. Terminations and connections of rigid aluminum conduit shall be taper threaded. Conduits shall be reamed free of burrs and shall be terminated with conduit bushings.
 - f. Exposed conduit shall be installed either parallel or perpendicular to structural members and surfaces.
 - g. Two or more conduits in the same general routing shall be parallel, with symmetrical bends.
 - h. Conduits shall be at least 6 inches [150 mm] from high temperature piping, ducts, and flues.
 - i. Conduit installed in corrosive chemical feed and storage areas as indicated by Area Type on the Drawings shall be rigid Schedule 80 PVC. Exposed conduit in corrosive areas shall be supported by FRP framing materials with stainless steel hardware, including nuts and bolts.
 - j. Rigid Schedule 80 PVC conduit shall have supports and provisions for expansion as required by NEC Article 352.
 - k. Metallic conduit connections to metal enclosures shall be securely fastened by locknuts inside and outside.
 - l. Rigid Schedule 80 PVC conduit shall be secured to metal device boxes using a male terminal adapter with a locknut inside or by using a box adapter inserted through the knockout and cemented into a coupling.
 - m. Conduits in walls or slabs, which have reinforcement in both faces, shall be installed between the reinforcing steel. In slabs with only a single layer of reinforcing steel, conduits shall be placed under the reinforcement. Conduits larger than 1/3 of the slab thickness shall be concrete encased under the slab.
 - n. Conduits that cross structural joints where structural movement is allowed shall be fitted with concrete-tight and watertight expansion/deflection couplings, suitable for use with metallic conduits and rigid Schedule 80 PVC conduits. The couplings shall be Appleton Type DF, Crouse-Hinds Type XD, or O-Z Type DX.
 - o. Conduit shall be clear of structural openings and indicated future openings.
 - p. Conduits through roofs or metal walls shall be flashed and sealed watertight.
 - q. Conduit installed through any openings cut into non-fire rated concrete or masonry structure elements shall be neatly grouted. Conduit penetrations of fire rated structure elements shall be sealed in a manner that maintains the fire rating as indicated on the Architectural Drawings.
 - r. Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.
 - s. Exposed conduit stubs for future use shall be terminated with pipe caps.
 - t. Concealed conduit for future use shall be terminated in equipment or fitted with couplings plugged flush with structural surfaces.

- u. Where the Drawings indicate future duplication of equipment wired hereunder, concealed portions of conduits for future equipment shall be provided.
- v. Horizontal conduit shall be installed to allow at least 7 feet [2.1 m] of headroom, except along structures, piping, and equipment or in other areas where headroom cannot be maintained.
- w. Conduit shall not be routed across the surface of a floor, roof, or walkway unless approved by Engineer.
- x. PVC-coated rigid aluminum conduit shall be threaded and installed as recommended by the conduit manufacturer's installation procedure using appropriate tools.
- y. All conduits that enter enclosures shall be terminated with acceptable fittings that will not affect the NEMA rating of the enclosure.
- z. Conduit which turns out of concrete slabs or walls, shall be connected to a 90-degree elbow of PVC-coated rigid aluminum conduit before it emerges. Conduits shall have PVC-coated rigid aluminum coupling embedded a minimum of 3 inches when emerging from slabs or walls and the coupling shall extend 2 inches from the wall.
- aa. Power conductors to and from adjustable frequency drives shall be installed in steel conduit.

3-7.02. Underground Conduit Installation. All excavation, backfilling, and concrete work shall conform to the respective sections of these Specifications. Underground conduit shall conform to the following requirements:

- a. All underground conduits shall be concrete encased unless indicated otherwise on the Drawings. Concrete encasement within 15 feet of building entrances, under and within 5 feet of roadways, and within 10 feet of indicated future excavations shall be reinforced as detailed on the Drawings.
- b. Concrete encased conduit shall be schedule 40 PVC. Conduits shall have PVC-coated aluminum coupling embedded a minimum of 3 inches when emerging from walls and the coupling shall extend 2 inches from the wall. All PVC joints shall be solvent welded in accordance with the recommendations of the manufacturer.
- c. Concrete encasement on exposed outdoor conduit risers shall continue to 6 inches [150 mm] above grade, with top crowned and edges chamfered.
- d. Conduit and concrete encasement installed underground for future extension shall be terminated flush at the bulkhead with a coupling and a screw plug. The termination of the duct bank shall be reinforced with bars 100 diameters long that shall be terminated 2 inches [50 mm] from the bulkhead. Matching splice bars shall be 50 bar diameters long. Each longitudinal bar shall be provided with a Lenton "Form Saver" coupler and plate or a Dayton "Superior DBR" coupler at the bulkhead. The coupler shall be threaded to accept a dowel of like diameter in the future. Threads shall be protected with screw-in plastic caps. A 1-3/4 by 3/4 inch [45 by 20 mm] deep horizontal shear key shall be formed in the concrete encasement above and below the embedded conduits. After concrete placement, conduit and bar connector ends shall be cleaned and coated with two coats of thixotropic coal tar.
- e. Underground conduits indicated not to be concrete encased shall be rigid Schedule 80 PVC.

- f. Underground conduit bend radius shall be at least 2 feet [600 mm] at vertical risers and at least 3 feet [900 mm] elsewhere.
- g. Underground conduits and conduit banks shall have at least 2 feet [600 mm] of earth cover, except where indicated otherwise.
- h. Underground conduit banks through building walls shall be cast in place, or concreted into boxouts, with water stops on all sides of the boxout. Water stops are specified in the Cast-In-Place Concrete section.
- i. Underground nonmetallic conduits, which turn out of concrete or earth in outdoor locations, shall be connected to 90-degree elbows of PVC-coated rigid aluminium conduit before they emerge.
- j. Conduits not encased in concrete and passing through walls, which have one side in contact with earth, shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.
- k. Underground conduits shall be sloped to drain from buildings to manholes.
- l. Each 5 kV or higher voltage cable, each 250 kcmil [120 mm²] or larger cable, and each conduit group of smaller cables shall be supported from manhole walls by Kindorf "D-990" or Unistrut "P-3259" inserts, with Kindorf "F-721-24" or Unistrut "P-2544" brackets and Unistrut "P1753" or "P1754" fiberglass reinforced polyester cable saddles.
- m. Telephone cables shall not be installed in raceways, conduits, boxes, manholes, or handholes containing other types of circuits.
- n. Intercommunication and instrument cables shall be separated the maximum possible distance from all power wiring in pull-boxes, manholes, and handholes.
- o. Each duct shall be carefully cleaned before and after installation. All inside surfaces shall be free from imperfections likely to injure the cable. After installation of complete duct runs in sizes 2 inches and larger, ducts shall be snaked with an approved tube cleaner equipped with an approved cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the duct. Ducts through which the mandrel will not pass shall not be incorporated in the work. After snaking, the ends of dead-ended ducts shall be protected with standard conduit caps to prevent the entrance of water or other foreign matter.

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

Transitions from above-grade rigid aluminium conduit to non-metallic conduit shall be accomplished with a threaded adapter. Rigid aluminium conduit installed above grade and extending below grade shall include the first 90° elbow. All rigid aluminium conduits extending below grade shall be coated with two coats of an asphaltum-type paint along its entire length below grade and extending 6" above grade or above the top of the finished slab. The asphaltum-type paint shall conform to Fed. Spec. TT-V_51 and equivalent to Koppers Bitumatic Super Service Black.

3-7.03. Sealing of Conduits. After cable has been installed and connected, conduit ends shall be sealed by forcing nonhardening sealing compound into the conduits to a depth at least equal to the conduit diameter. This method shall be used for sealing all conduits at handholes, manholes, and building entrance junction boxes, and for 1 inch [25 mm] and larger conduit connections to equipment.

Conduits entering chlorine feed and storage rooms shall be sealed in a junction box or conduit body adjacent to the point of entrance.

Conduits entering hazardous (classified) areas and submersible or explosion proof enclosures shall have Appleton "Type ESU" or Crouse-Hinds "EYS" sealing fittings with sealing compound.

3-7.04. Reuse of Existing Conduits. Existing conduits may be reused subject to the concurrence of Engineer and compliance with the following requirements:

- a. A wire brush shall be pulled through the conduit to remove any loose debris.
- b. A mandrel shall be pulled through the conduit to remove sharp edges and burrs.

3-8. WIRING DEVICES, BOXES, AND FITTINGS INSTALLATION. Metallic and nonmetallic conduit boxes and fittings shall be installed in the following locations:

3-8.01. Conduit Boxes and Fittings.

- a. Stainless steel or aluminum boxes and fittings shall be installed in concrete walls, ceilings, and floors; in the outdoor faces of masonry walls; and in all locations where weatherproof device covers are required. These boxes and fittings shall also be installed in exposed rigid steel and intermediate metal conduit systems.
- b. Aluminum or stainless-steel boxes shall be installed in the indoor faces of masonry walls, in interior partition walls, and in joist supported ceilings.
- c. Rigid PVC device boxes shall be installed in exposed nonmetallic conduit systems.
- d. PVC coated boxes and fittings shall be installed in PVC coated conduit systems.
- e. Telephone conduit shall be provided with separate junction boxes and pull fittings.

3-9. EQUIPMENT INSTALLATION. Except as otherwise specified or indicated on the Drawings, the following procedures shall be used in performing electrical work.

3-9.01. Setting of Equipment. All equipment, boxes, and gutters shall be installed level and plumb. Boxes, equipment enclosures, metal raceways, and similar items mounted on water- or earth-bearing walls shall be separated from the wall by at least 1/4 inch [6 mm] thick

corrosion-resistant spacers. Where boxes, enclosures, and raceways are installed at locations where walls are not suitable or available for mounting, concrete equipment pads, framing material, and associated hardware shall be provided.

3-9.02. Sealing of Equipment. All outdoor substation, switchgear, motor control center, and similar equipment shall be permanently sealed at the base, and all openings into equipment shall be screened or sealed with concrete grout to keep out rodents and insects the size of wasps and mud daubers. Small cracks and openings shall be sealed from inside with silicone sealant, Dow-Corning "795" or General Electric "SCS1200".

3-10. GROUNDING.

3-10.01. General. The electrical system and equipment shall be grounded in compliance with the National Electrical Code and the following requirements:

- a. All ground conductors shall be at least 12 AWG [4 mm²] soft drawn copper cable or bar, bare or green-insulated in accordance with the National Electrical Code.
- b. Ground cable splices and joints, ground rod connections, and equipment bonding connections shall meet the requirements of IEEE 837, and shall be exothermic weld connections or irreversible high-compression connections, Cadweld "Exothermic" or Burndy "Hyground". Mechanical connectors will not be acceptable. Cable connections to bus bars shall be made with high-compression two-hole lugs.
- c. Ground cable through exterior building walls shall enter within 3 feet [900 mm] below finished grade and shall be provided with a water stop. Unless otherwise indicated, installation of the water stop shall include filling the space between the strands with solder and soldering a 12 inch [300 mm] copper disc over the cable.
- d. Ground cable near the base of a structure shall be installed in earth and as far from the structure as the excavation permits, but not closer than 24 inches [600 mm]. The tops of ground rods and ground cable interconnecting ground rods shall be buried a minimum of 30 inches [750 mm] below grade, or below the frost line, whichever is deeper.
- e. All powered equipment, including lighting fixtures and receptacles, shall be grounded by a copper ground conductor in addition to the conduit connection.
- f. Ground connections to equipment and ground buses shall be made with copper or high conductivity copper alloy ground lugs or clamps. Connections to enclosures not provided with ground buses or ground terminals shall be made with irreversible high-compression type lugs inserted under permanent assembly bolts or under new bolts drilled and inserted through enclosures, other than explosion proof enclosures, or by grounding locknuts or bushings. Ground cable connections to anchor bolts; against gaskets, paint, or varnish; or on bolts holding removable access covers will not be acceptable.
- g. The grounding system shall be bonded to the station piping by connecting to the first flange inside the building, on either a suction or discharge pipe, with a copper bar or strap. The flange shall be drilled and tapped to provide a bolted connection.

- h. Ground conductors shall be routed as directly as possible, avoiding unnecessary bends. Ground conductor installations for equipment ground connections to the grounding system shall have turns with minimum bend radii of 12 inches [300 mm].
- i. Ground rods not described elsewhere shall be a minimum of 5/8 inch in diameter by 10 feet [3 m] long, with a copper jacket bonded to a steel core.
- j. Test wells and covers for non-traffic areas shall be molded high density polyethylene. Test wells for traffic areas shall be precast concrete construction rated for traffic duty with concrete or cast-iron covers.

3-10.02. Grounding System Resistance. The ground system resistance shall comply with National Electrical Code.

3-10.03. Grounding System Testing. The grounding system of each new building or structure and each existing building or structure indicated below, shall be tested to determine the resistance to earth. Testing shall be performed by an independent electrical or grounding system testing organization. Testing shall be completed after not less than three full days without precipitation and without any other moistening or chemical treatment of the soil.

3-10.03.01. New Grounding Systems. Not used.

3.10.03.02. Existing Grounding Systems. Grounding systems of each existing building or structure indicated shall be tested for resistance to earth.

Existing building(s) or structure(s) to be tested	Methanol Storage Tank Area and Methanol Pump Control Panel
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Where existing grounding systems can be isolated from the building power service or utility power service a three-point fall of potential test shall be completed as indicated above. Where isolation of the building grounding system is not practical, a clamp-on resistance test will be an acceptable alternative. Clamp-on resistance testing shall be completed utilizing a ground resistance tester specifically designed for clamp on resistance testing, such as the AEMC "Model 3711". Clamp-on resistance measurements shall be taken at the service side of the service entrance neutral, upstream of the neutral to ground bonding connection to ensure a single path between the grounding system and the utility reference.

3.10.03.03. Grounding System Test Report. A report certified by the testing organization shall be prepared and submitted in accordance with the Submittal Procedures section. The final report shall include complete testing results for each building or structure, graphical representation of the test point results for the three-point fall of potential method, and complete observations of all site weather conditions and other environmental conditions that may affect the test results. Final acceptance of the results reported shall be subject to the review and approval of Engineer.

3-11. LIGHTING FIXTURE INSTALLATION. The Drawings indicate the general locations and arrangements of the lighting fixtures. Fixtures in rows shall be aligned both vertically and horizontally unless otherwise specified. Fixtures shall be clear of pipes, mechanical equipment, structural openings, indicated future equipment and structural openings, and other obstructions.

Conduit and wire for lighting fixture installation is not shown on the Drawings and shall be sized, furnished and installed by Contractor. Circuits to emergency lighting units, exit signs, and fixtures indicated to be night lights shall not be switched. Circuits to lighting fixtures indicated to have emergency battery packs shall include an additional un-switched hot conductor. Conductors shall be minimum 12 AWG and conduit shall be minimum 3/4 inch for lighting fixture installation.

3-12. POWER FACTOR CORRECTION CAPACITOR INSTALLATION. Not used.

3-13. HEAT-TRACED PIPING INSTALLATION. Not used.

3-14. MODIFICATIONS TO EXISTING EQUIPMENT. Modifications to existing equipment shall be completed as specified herein and indicated on the Drawings. All existing facilities shall be kept in service during construction. Temporary power or relocation of existing power and control wiring, equipment, and devices shall be provided as required during construction. Coordination and timing of outages shall be as specified in other sections of these Specifications. Electrical power interruptions will only be allowed where agreed upon in advance with Owner, and scheduling at times of low demand may be required.

3-14.01. Demolition. Unless otherwise specified or indicated on the Drawings, all cable and all exposed conduit for power and control signals of equipment indicated to be removed shall be demolished. Conduit supports and electrical equipment mounting hardware shall be removed, and holes or damage remaining shall be grouted or sealed flush. Conduit partially concealed shall be removed where exposed and plugged with expanding grout flush with the floor or wall. Repairs shall be refinished to match the existing surrounding surfaces. Demolished equipment shall be discarded or salvaged as indicated on the Drawings and as specified in other sections of these Specifications.

STANDARD SPECIFICATIONS						
REFERENCE: ICEA S-95-658 (NEMA WC 70).						
CONDUCTOR: Concentric-lay, uncoated copper; strand Class B. Wet/dry maximum operating temperature 90°C.						
INSULATION: Cross-linked thermosetting polyethylene, ICEA S-95-658, Paragraph 3.6.						
SHIELD: None.						
JACKET: None.						
FACTORY TESTS: Cable shall meet the requirements of ICEA S-95-658.						
Cable Details						
Size		Number of Strands	Conductor Insulation Thickness*		Maximum Outside Diameter	
AWG or kcmil	mm ²		in.	µm	in.	mm
14	2.5	7	0.030	760	0.17	4.32
12	4.0	7	0.030	760	0.19	4.83
10	6.0	7	0.030	760	0.21	5.33
8	10.0	7	0.045	1140	0.27	6.86
6	16.0	7	0.045	1140	0.31	7.87
4	25.0	7	0.045	1140	0.36	9.14

2	35.0	7	0.045	1140	0.42	10.67
1	40.0	19	0.055	1400	0.48	12.19
1/0	50.0	19	0.055	1400	0.52	13.21
2/0	70.0	19	0.055	1400	0.57	14.48
4/0	95.0	19	0.055	1400	0.68	17.27
250	120.0	37	0.065	1650	0.75	19.05
350	185.0	37	0.065	1650	0.85	21.59
500	300.0	37	0.065	1650	0.98	24.89
750	400.0	61	0.080	2030	1.22	31.00
1,000	500.0	61	0.080	2030	1.37	34.80

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 90 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, XLP, XHHW-2, conductor size, and voltage class.

600 Volt, Single Conductor Lighting/Power Cable (600-1-XLP-NONE-XHHW-2)

BLACK & VEATCH

Cable Data

Figure 2-16050

STANDARD SPECIFICATIONS

REFERENCE: UL 66, UL 1277.

CONDUCTOR: 16 AWG (1.5 mm²), 7-strand, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

INSULATION: Polyvinyl chloride, not less than 15 mils (380 μm) average thickness; 13 mils (330 μm) minimum thickness, UL 66, Type TFN.

LAY: Twisted pair with 1-1/2 inch to 3 inch (38.10 mm - 63.5 mm) lay.

SHIELD: Cable assembly, combination aluminum-polyester tape and 7-strand, 20 AWG (0.5 mm²) minimum size, tinned copper drain wire, shield applied to achieve 100 percent cover over insulated conductors.

JACKET: Conductor: Nylon, 4 mils (100 μm) minimum thickness, UL 66.

Cable assembly: Black, flame-retardant polyvinyl chloride, UL 1277, applied over tape-wrapped cable core.

CONDUCTOR IDENTIFICATION: One conductor black, one conductor white.

FACTORY TESTS: Insulated conductors shall meet the requirements of UL 66 for Type TFN. Assembly jacket shall meet the requirements of UL 1277. Cable shall meet the vertical-tray flame test requirements of UL 1277.

Cable Details

	Assembly Jacket Thickness*		Maximum Outside Diameter	
	in.	μm	in.	mm
Single Pair	0.045	1140	0.34	8.64

<p>*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the value indicated above.</p> <p>A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, Type TC, Type TFN, conductor size, single pair, and voltage class.</p>				
600 Volt, Single Pair, Shielded Instrument Cable (600-SINGLE-PAIR-SH-INSTR)				
BLACK & VEATCH	Cable Data		Figure 4-16050	

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