

## SECTION 16903

### PROGRAMMABLE CONTROLLERS

#### 1. PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Programmable Controllers.
- B. Input/output Units.
- C. Detention Area Operator Interface Unit.
- D. Programming Software.
- E. Drain Office Computer.

##### 1.2 RELATED SECTIONS

- A. Section 16160 - Cabinets and Enclosures: Cabinets and terminal blocks.
- B. Section 16902 - Electric Controls and Relays.
- C. Section 16930 - Instruments and Accessories.
- D. Section 16940 - Sequence of Operations.

##### 1.3 REFERENCES

- A. NEMA ICS 1 - General Standards for Industrial Control and Systems.
- B. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.
- C. NEMA ICS 3 - Industrial Systems.
- D. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

##### 1.4 SUBMITTALS

- A. Submit shop drawings indicating layout of completed assemblies, interconnecting cabling, dimensions, weights, and external power requirements.
- B. Submit product data for each component specified.
- C. Submit manufacturer's installation instructions.

##### 1.5 OPERATION AND MAINTENANCE DATA

- A. Submit maintenance data.

- B. The Supplier shall provide complete documentation for the system and its constituent parts, including hardware, schematic diagrams, user manuals, troubleshooting procedures, etc.
- C. The Supplier shall provide corrections, modifications, and updates to all documentation as it is released.
- D. The Supplier shall include in their Bid the cost for two complete sets of operation manuals. These manuals shall be bound in hardbacked cover and be indexed in an orderly manner and shall have detailed information about every major system component (I/O cards, processor boards, communication modules etc.) supplied with the system. These manuals will be used primarily for troubleshooting purposes by Owner's personnel. The Supplier shall also include in their Bid the cost for additional manuals on a per set basis.
- E. System hardware drawings shall include as a minimum:
  - 1. Console and rack layouts.
  - 2. Cabinet wiring diagrams and intercabling sketches
  - 3. System power and grounding diagrams.
  - 4. Certified dimensional drawings for all consoles and cabinets including weights.
  - 5. Final overall system schematic and layout drawing showing all major components such as consoles, I/O cabinets, engineer's work station, data highway cabling, etc.
  - 6. Supplier shall include with their Bid a system schematic as described in item 5 above.

#### 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years experience, which maintains service facilities within 100 miles of project.
- B. The Supplier shall provide a complete system that functions in accordance with and fulfills all of the requirements set forth in this Specification. Any omission of details in this Specification shall not relieve the Supplier of furnishing a complete, operating system.
- C. The Supplier shall provide a field proven standard system. Any exceptions must be brought to the attention of the Engineer in the Supplier's Bid.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept products on Site in factory containers and verify damage.
- B. Store products in clean, dry area; maintain temperature to NEMA ICS 1.

#### 1.8 ENVIRONMENTAL REQUIREMENTS

- A. Maintain temperature above 32°F and below 104°F during and after installation of products.
- B. Maintain area free of dirt and dust during and after installation of products.

1.9 MAINTENANCE SERVICE

- A. Provide maintenance services of programmable controllers and modules for one year from date of Substantial Completion.

2. PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Allen-Bradley.
- B. Substitutions: Not permitted.

2.2 I/O REQUIREMENTS

I/O Modules included in PLC needed to meet the following minimum I/O point requirements plus 50 percent:

- A. Detention Area A
  - 1. 4 Analog inputs.
  - 2. 6 Digital inputs
  - 3. 1 Analog output.
  - 4. 7 Digital outputs.
- B. Detention Area B
  - 1. 4 Analog inputs.
  - 2. 12 Digital inputs.
  - 3. 1 Analog output
  - 4. 7 Digital outputs.
  - 5. 1 counting input for +5V Rain gauge.
- C. Detention Area E Inlet Control Structure
  - 1. 4 Analog inputs.
  - 2. 6 Digital inputs.
  - 3. 1 Analog output.
  - 4. 7 Digital outputs.
- D. Detention Area E Outlet Control Structure
  - 1. 4 Analog inputs.
  - 2. 10 Digital inputs.
  - 3. 8 Digital outputs.
- E. Detention Area F
  - 1. 4 Analog inputs.
  - 2. 12 Digital inputs.
  - 3. 1 Analog output.
  - 4. 7 Digital outputs.

2.3 PROGRAMMABLE LOGIC CONTROLLER

- A. The system supplied shall be Allen-Bradley ControlLogix.

- B. Control strategy implementation shall be via keyboard programming. The programming will be possible without the need for using a high level programming language. Fully integrated ASCII programming shall be possible with no extensions to the base programming language. Programming will be possible through a personal computer (PC) based system.
- C. The control system shall be distributed in the sense that it will be segmented at the process control level and shall be Allen-Bradley CompactLogix. These subsystems shall be capable of local intelligent control to consist of, but not limited to the following:
  - 1. PID Loop Control.
  - 2. Thermocouple linearization.
  - 3. Hi-Low limit monitoring.
  - 4. Average running calculations.
  - 5. Ramping and waveform generation.
  - 6. Counting at up to 20kHz.
  - 7. Latching.
  - 8. Pulse duration and frequency measurement.
  - 9. Generate pulses.
  - 10. Time proportional output.
- D. The microprocessor based system shall be designed to allow required information to be accessible by the other system microprocessors and at the operator control consoles.
- E. The system shall be capable of, but not limited to, performing certain specific tasks, such as:
  - 1. Perform regulatory control functions.
  - 2. Display on the operator consoles control loop status, including process variable input, controller setpoint, controller output, and control mode setting and status.
  - 3. Provide for the capability of the operator to assume manual mode control of a loop and to change controller modes, output values, and tuning setting from the operator console.
  - 4. Trend, record, and log process variables, set-points, and controller outputs, etc.
  - 5. Display and control digital output contacts for control of motor and actuators.
  - 6. Provide dynamic interactive color graphics of sections of the plant process, including relevant control loops and process measurements from which the operator may control the plant.
  - 7. Provide data accumulation of selected measured variable for periodic and event triggered logging. The accumulated data will be stored for historical purposes. The system will be capable of storing information in an hourly, shift, daily, weekly, and monthly format.
  - 8. Allow for analog and digital control strategy manipulation via the operator console keyboard. All operator consoles shall be equipped with key locks which will be used to prevent unauthorized personnel from changing controller tuning parameters, alarm settings, system displays, configuration, etc. This feature will normally be kept in the locked mode. Additionally, the system shall be accessible to the programmer through a PC based system.
  - 9. The system's operator console database shall be capable of storing information for at least 300 tag numbers.
- F. The system shall be designed such that the failure of any portion will have a minimal effect on the control of the process. The system shall be designed to meet the highest level of realistic reliability. The failure of the communication system shall not prevent the micro-processors from functioning. Failure on one console shall not affect the function of another console.

- G. The system shall be designed to allow the programmer to make on-line changes, additions, or deletions to the current executing process control scheme. In this sense, on-line means the system will have the capability to revise the current process control logic without requiring that any portions of the process be interrupted.
- H. All software and all process, status, and alarm information, together with other data stored in the system, shall be protected from loss by inadvertent operator action or by input power failure. Where batteries are required to meet this requirement, they shall be capable of maintaining memory for at least 24 hours.
- I. The system shall continuously monitor itself for failures of its various components.
- J. A system status display shall be available at the operator's console.
- K. The systems shall be flexible and easily expandable. At the time the system ships, it shall contain approximately 20 percent installed spare capacity for expansion. The system shall be designed to have the capability of increasing the overall system capacity in the future by 200 percent with additional hardware.
- L. Any special tools required for system operation or maintenance will be listed in the Bid.
- M. The control system shall be specifically designed for an industrial process control environment. The equipment shall be standard, and have been commercially available for at least 3 years prior to delivery and part of an existing product line. Per component, all hardware, firmware, and software revision levels shall be identical.

#### 2.4 POWER SUPPLY

- A. Input Voltage: 120 volts, 60 Hz.

#### 2.5 STATION OPERATOR INTERFACE

- A. The operator interface equipment shall consist of a LCD/touch screen based, instrument cabinet door mounted operator console. This console shall be an Allen-Bradley VersaView 1700P touch screen industrial computer catalog number (6181p-17TPXPHSS) minimum Pentium IV, 2GHz processor, 512MB or RAM. Contractor to supply 1 USB keyboard to be kept inside control panel.
- B. The Supplier shall provide with their Bid data the screen pixel resolution, the maximum screen call up time, and the maximum number of display screens possible.
- C. Operator consoles shall be NEMA 1/12/4/4x, IP66 rated, designed for mounting in instrument panel door.
- D. The system shall include the capability to copy and store the system configuration data on removable media and to reconfigure the system from the stored media simply and quickly. A minimum of 1 removable media drive shall be provided.
- E. The system shall have full flexibility in specifying or changing the numbers, descriptions, ranges, scale factors, or grouping of various displays on an operator console.
- F. Display data on the operator console shall be updated at a minimum frequency of 1 (one) per second.

- G. The operator consoles shall be capable of generating the following types of displays:
  - 1. Control system process overview displays.
  - 2. Group displays.
  - 3. Individual loop displays.
  - 4. Process and system malfunction alarm displays.
  - 5. Trend displays.
  - 6. Process graphics displays.
  - 7. Diagnostics displays.
  
- H. The monitor console touch screen shall be the operator's direct interface to control the process. It shall be designed to allow the user to perform operating, tuning, and configuring functions. Process parameter modifications such as controller setpoint or output changes shall be via either a typed data value or a variable ramping technique. The operator interface monitor shall also be able, with the addition of a standard keyboard to function as an engineer's work station with all necessary hardware and software to configure, monitor and control the system. An interface link shall be provided between the Engineer's work station and the system so that the work station can be utilized to upload and download system configuration from and to the system microprocessors.
  
- I. The Supplier shall provide the hardware and associated software required for storing process related data onto a media such as a hard drive for historical data collection. A means of downloading the data to a compact disc or other long term storage media shall also be included. The Supplier shall provide with their Bid data the storage capabilities of this system, and any other pertinent information.
  
- J. Operators shall be able to access all MMI information available at any location from any other location on the control network.

## 2.6 INSTRUMENT & CONTROL

- A. The system control will be executed via Allen-Bradley ControlLogix located in the control cabinet. Control system functionality shall be distributed on a modular basis. Control functions will not depend on a centrally based device or communication link. Process controllers shall continue to function if communication with the operator's console fails.
  
- B. All control algorithms in an I/O level microprocessor shall execute at a minimum of once every 100 milliseconds.
  
- C. The system shall be designed to allow the processors to be placed in service without the assistance of any other device. The processors shall be capable of communicating with each other and be unaffected by failure of other devices connected to the system.
  
- D. In the event of a power supply failure or incoming power system failure, the processor shall retain all control configuration memory for a period of time. Supplier shall state this time period in the Bid.
  
- E. The Supplier shall Bid the I/O modules to interface to the quantity and type of process signals as shown on the plans.
  
- F. Digital inputs and outputs shall be optically isolated from electrical ground.
  
- G. Digital input and output modules shall have an integral on-off-auto test switch.

- H. Digital input circuits shall be designed such that an inadvertent grounding of the interrogation source, or return field wiring will produce an open circuit. The Supplier shall state their belief if external fusing of the digital inputs is necessary to meet this requirement.
- I. Analog modules shall source current loop power and be isolated from analog common.

## 2.7 COMMUNICATIONS NETWORK

- A. The communication modules and Ethernet network, cable modems and fiber optic cables shall provide the means for the operator console, controllers, and the Engineer's workstation to operate as a system network.
- B. The Supplier shall provide all Ethernet switches and network interfaces required to insure communication between system components. The network shall be capable of normal operation at distances of up to 7000 feet; however, contractor to verify distances between I/O racks and the operator consoles for Bid purposes.
- C. Ethernet Switches shall be located near each PLC in accordance with Section 16902 – Electrical Controls and Relays and Drawings.
- D. The network shall be capable of having operator consoles, computer interfaces, process interface units, etc., placed anywhere along its length.
- E. The network wiring shall consist of cable modems cabling between buildings, optical fiber to remote I/O station I-496, from building B to building A, and from building Detention Area E Outlet Control Structure to Detention Area E Inlet Control Structure, and category 5 cabling between components in a single building.
- F. The Supplier shall provide with their Bid the maximum permissible network length between active devices, the normal data transmission rate, the modulation method, and the communication technique utilized (i.e. token ring, exception reporting, etc.).
- G. System Architecture: See plans.

## 2.8 SOFTWARE REQUIREMENTS

- A. Control system software shall be provided by Owner.
- B. Contractor shall provided the following software for each computer:
  - 1. Windows XP Professional.
  - 2. Internet Explorer 6.0 or higher, OR Netscape 6.0 or higher.
  - 3. Roxio Easy Media Creator 7 (Contractor to confirm compatibility and most recent version) DVD and CD archiving software.
- C. Contractor shall supply the Owner with all software licenses and original software.

## 2.9 ELECTRICAL REQUIREMENTS

- A. The Supplier shall provide all wiring internal to their system, including that required for interposing relays, if provided.
- B. The Supplier shall provide all power supplies required and internal power wiring.

- C. All I/O and microprocessor control units shall be furnished with power supplies at the component utilization voltage required. Any additional equipment required to convert power to the level required by the Supplier shall also be provided.
- D. All power supplies shall be 110 percent capacity designed to maintain continuous service from the Buyer's sources while subject to the source regulation specified.
- E. Power source furnished as specified in other Sections for the control equipment will be as follows or equivalent for the Site location:
  - 1. Uninterruptible AC source, single phase, two wire, grounded, 120 VA nominal, plus or minus 10 percent probable fluctuation, 60 HZ, plus or minus 1.0, voltage sine wave function with harmonic distortion not to exceed 5 percent, very infrequent, short duration interruptions or extreme voltage regulation drop due to system faults or inverter failure.
  - 2. Unregulated commercial grade AC source, single phase, two wire grounded, 60 HZ, 120 volts nominal, plus or minus 10 percent normal fluctuation, approximately one minute duration dips to 80 percent of nominal voltage infrequently.
- F. The Supplier shall state source voltage and frequency variation that will still allow for proper operation of the control system.
- G. All power supplies shall be designed to eliminate any potentially detrimental effects due to source voltage harmonic distortion, ripple, or high voltage spikes. The Supplier shall state maximum variations permitted that will still allow proper operation of the control system.
- H. All transformers, inverters, regulators, rectifiers, etc., required to convert the source voltage to that required by the system shall be furnished by the Supplier.
- I. The Supplier shall clearly specify all signal and power grounding requirements for each system, including ground separation distances.
- J. The Supplier shall supply suitable ground bus bars in all equipment cabinets.
- K. Separate isolated ground systems shall be provided for both signal ground and equipment ground.
- L. All electrical enclosures shall be grounded in accordance with NFPA No. 70-1981 and IEEE No-142 recommended practices for grounding of industrial commercial power systems.
- M. All equipment above shall be protected from power line surges.
- N. All equipment shall be protected against surges in the control and sensor wiring.
- O. The system shall have adequate shielding to prevent failure or mis-operation due to radio frequency interference (RFI). RFI sources in the area will include hand held receivers, airplane flyover, and amateur radio. Supplier shall state distance requirements of normal radio equipment from the system equipment.
- P. All communication electronics shall be protected against surges induced on the data highway.
- Q. Communication link overvoltage protection is required to protect all equipment against overvoltage of any communications link. The system must be IEEE No. 472 (Surge Withstand Capacity Test).

- R. All field wiring shall terminate on Supplier furnished terminal strips in the I/O cabinets. Wiring from the I/O cards to these terminal strips is the responsibility of the system Supplier. The Engineer will assist in the layout and arrangement of these terminal strips to ensure proper interface with the field wiring. All terminal strips and blocks shall be adequately identified. Terminal blocks shall be provided for terminating shields for analog signals. Terminal blocks for field wiring shall be suitable for terminating #12-#16 stranded AWG copper wire and shall be of high density design rail mounted and approximately .25 inches in height.
- S. The Supplier shall provide a suitable wireway for all field wiring entering the I/O cabinets. Wireways shall be Panduit, or equal and shall not be filled any more than 60 percent capacity.
- T. A maximum of two (2) conductors per terminal shall be permitted. This includes all wiring plus terminal allowance for external wire normally required.
- U. All internal wiring shall be permanently tagged with sleeve type markers. Markers shall be black letters on white sleeves.
- V. All 120 VAC power series shall be #14 AWG stranded, 600 volt PVC insulated copper wire or equivalent. Color coding shall be black for the phase leg, white for the neutral leg, and green for the instrument case ground. All powered instruments shall have their cases grounded.
- W. The Supplier shall provide with their Bid data the maximum and minimum allowable room temperature and humidity for the operation of the system components.

#### 2.10 ENCLOSURE

- A. Enclosure: NEMA ICS 6; Type 3R OR 4x sized for PC system and associated instrumentation. Touch screen computer listed above shall be installed in door.

#### 2.11 Drain Office Computer

- A. Provided by Owner.

#### 2.12 Auto dialer

- A. Manufacturer: Phonetics, Inc., Sensaphone Express II.
- B. Shall have minimum of 6 alarm inputs.

#### 2.13 SPARE PARTS

- A. At contract closeout provide the Owner with the following spare parts (all parts shall adhere to this specification):
  1. PLC with the Detention Area E Outlet Control Structure configuration for I/O.
  2. 2 spare PLC power supplies.
  3. 1 spare UPS.
  4. 1 spare cable modem.
  5. 1 spare Ethernet switch.
  6. 10 spare of each size and type fuse used.
  7. MMI (touch screen) Computer.
  8. Auto dialer.

### 3. PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify field measurements.
- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Beginning of installation means installer accepts conditions.

#### 3.2 TESTING AND INSPECTION

- A. Owner and/or their Engineer shall have the right to inspect the system equipment during the manufacturing and assembly period prior to system testing.
- B. The system shall be fully tested prior to shipment. The testing will include the surveillance system. This will include verification of hardware integrity and system software program functionality. The components will be tested as a complete system with cable modems, VPN routers, fiber optic, and all other cables connected to link the entire system together as it will be installed at the job Site.
- C. Test stands and all measuring equipment shall be provided by the Supplier and wired to the system inputs and outputs in the following manner:
  - 1. All digital inputs shall be wired to test board switches.
  - 2. All digital outputs shall be wired to test board indicating lights.
  - 3. All analog inputs shall be wired to the test boards to devices which will generate the appropriate variable analog input signal.
  - 4. Analog outputs will be read at the MSCS output terminal strip with a meter capable of reading in the 4-20 milliamperes range.
- D. All test board switches and lamps shall be marked clearly for easy identification of the input and output. This may be done with either a brief description of the I/O point or by use of the item tag number.
- E. Prior to Owner designated personnel arriving at the Site for system testing, the Suppliers shall verify that all inputs and outputs wired to the test stands read into the software to the appropriate associated input or output address point.
- F. Prior to Owner designated personnel arriving at the Site for system testing, the Supplier will function test the entire system to ensure that all components are operational and communicating properly with other components of the system, such as operator consoles to I/O racks, I/O cards to microprocessors, etc.
- G. The Supplier shall notify Owner and engineer at least two weeks in advance of the date when system testing will commence.

#### 3.3 SHIPPING

- A. Following the acceptance, test the Supplier shall disconnect all test stand wiring and prepare the system for shipping.

- B. I & C cabinet shall be shipped intact. Circuit boards shall not be removed for shipping. Supplier shall pack or crate cabinets and operator consoles so as to avoid any damage during shipment.
- C. Each crate shall be clearly marked as to content and reference made to the purchase order number.
- D. Land shipment shall be by air ride van, which shall include heavy shock mounts.
- E. Owner and Engineer shall be advised of the scheduled shipping date at least two weeks in advance.
- F. The Supplier shall check all transportation limitations such as height, width, or load limits to meet requirements in all areas through which materials will pass to the job Site. The Supplier shall have sole responsibility for the proper shipment of all materials and equipment.
- G. The Supplier shall be responsible for ensuring that no hardware associated with the system is subject to any detrimental temperature or humidity conditions during transit to the job Site.
- H. The Supplier shall be responsible for any and all damage to, or losses of, materials, equipment occurring during delivery of the system to the job Site. Should equipment be damaged during shipment, the Supplier shall repair or replace any damaged equipment or materials immediately. The Supplier shall pay all additional shipping costs incurred to assure arrival of the replacement components in the quickest time possible.

#### 3.4 CONSTRUCTION

- A. Construct instrumentation and control cabinets in accordance with equipment manufacturer's instructions and drawings.

#### 3.5 MANUFACTURER'S FIELD SERVICES

- A. The Supplier shall state in their Bid the availability and cost of field service personnel at the job Site on a callout basis stating the response time.
- B. The Supplier shall state in their Bid the rate structure for contract maintenance.

#### 3.6 DEMONSTRATION AND TRAINING

- A. Provide systems demonstration.
- B. Demonstrate operation of controller. Provide 8 hours of field instruction for Owner's personnel, to be conducted at project Site with manufacturer's representative.
- C. Instruct Owner's personnel in a classroom environment for a minimum of 16 hours. Time may only be accrued toward training after the date of substantial completion.
  - 1. Training program shall be conducted at the Owner's Site and shall include instruction on all system hardware and the system network.

END OF SECTION