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Baker

Baker Environmental, Inc.
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(412) 269-6000
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July 13, 1994

Commander
Atlantic Division
Naval Facilities Engineering Command
1510 Gilbert Street (Building N-26)
Norfolk, Virginia 23511-2699

Attn: Ms. Linda Berry, P.E.
Code 1823

Re: Contract N62470-89-D-4814
Navy CLEAN, District III
Contract Task Order (CTO) 0222
Contaminated Soil and Groundwater
Remedial Design, Operable Unit No. 2
MCB, Camp Lejeune, North Carolina

Dear Ms. Berry:

Baker Environmental, Inc (Baker) is pleased to submit additional electrical drawings and specifications for the Design Package for Soil and Groundwater Remediation for the subject project. This submittal is intended to provide the RAC Contractor, OHM Corporation (OHM), with additional information on the required control and instrumentation systems for the groundwater collection and treatment system. This package includes four sets of full size preliminary drawings and four sets of specification section 16910. Copies of this submittal have been sent to Mr. Neal Paul (MCB Camp Lejeune), the ROICC Office at Camp Lejeune, and to OHM.

The preliminary electrical control loop drawings included in this submittal reflect the groundwater treatment system shown in Baker's Final Design Package, dated May 10, 1994. As you are aware, OHM has revised the treatment process, and is preparing revised process and instrumentation diagrams (i.e., P&ID or "P" drawings) to incorporate these revisions. Baker intends to update the enclosed electrical drawings to reflect the process changes made by OHM. Therefore, the enclosed drawings do not show all the required control loops or control system details, and should not be used for construction.

If you have any questions regarding this submittal, please contact me at (412) 269-2064 or Mr. Ray Wattras (Activity Coordinator) at (412) 269-2016.

Sincerely,

BAKER ENVIRONMENTAL, INC.

Don P. Joiner, P.E.
Project Manager

DPJ/dri

Enclosures

cc: Ms. Susan Gale, Code 1831 (letter only)
Ms. Beth Hacic, Code 02145 (letter only)
Ms. Katherine Lista, P.E., OHM (letter only)
Mr. Neal Paul, AC-S EMD, MCB Camp Lejeune (2 sets)
Ms. Lee Anne Rapp, Code 183 (letter only)
LCDR Steve Shalleen, ROICC, MCB Camp Lejeune (2 sets)
Mr. Tony Winig, OHM (2 sets)

SECTION 16910

PLC SYSTEM AND CONTROL WIRING INTERFACE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

The following are also related documents to this specification:

a. *Process Description and Control Philosophy for Marine Corps Base Camp Lejeune, North Carolina*
Groundwater Treatment System, Operable Unit No.2
Contract Task Order (CTO)-222
Baker Job No. 62470-222-1000-05401

b. ANSI/ISA - 55.1 - Instrumentation Symbols and Identification

c. Related Sections: The following Sections contain requirements that relate to this Section:

Section 16011 - General Requirements

Section 16375 - Underground Electrical Work

Section 16402 - Interior Wiring Systems

Section 16920 - Instrumentation Installation

1.2 SUMMARY

This Section includes a Programmable Logic Controller (PLC) complete with I/O racks, internal and external power supplies, communication modules, isolated analog input and output cards, isolated digital input and output cards, hardware and software. As part of the overall system a PC workstation and interface software will be included. The control wiring interface shall include all necessary conduit, wire, cables etc. to interconnect all devices and control equipment. System installation, start-up and testing including services of trained technicians shall be included in order to make the system function as indicated and intended.

PC Workstation: Personnel Computer to provide English driven menu commands with graphs to interface with relay logic utilized by the PLC.

1.3 SYSTEM DESCRIPTION

The PLC shall be a solid state relay ladder diagram processor unit that performs all of the monitoring and control of the function identified. The PLC shall be connected to a PC workstation that will enable a English language menu interface between an operator and the PLC. The PC

workstation software shall be Windows Version 3.1 based and provide the necessary programming and graphic displays to enable an operator to control, monitor and modify the control system operations. The PLC shall be interfaced with the system instrumentation, process controls, contactors, starters and other controlling/monitoring devices. All external devices shall be interfaced to the respective I/O cards at the PLC or its remote unit. Interface between the PLC and the signal, instrumentation and control devices shall be by instrument cable and wire installed in conduit. The PLC shall be properly programmed to provide the functions as identified by the Process Description and Control Philosophy report.

1.4 SUBMITTAL

Submit Contractor Drawings, diagrams, catalog cuts, etc. in accordance with Section 01010 for the following:

a. Shop drawings shall be provided for the complete system and shall include but not be limited to:

   1. System overview schematic diagram showing signal and power interconnecting wiring.

   2. Scaled panel/enclosure drawings with itemized list of materials.

   3. Schematic and connection diagrams for all input/output devices.

   4. Complete application (ladder diagram) program listing with detailed text annotation to facilitate understanding and debugging of control scheme.

   5. Testing procedures, recommended space parts list, installation instructions for all equipment.

b. Working Drawings shall be provided for the complete system and shall show location of all field devices, conduit sizes, cable/wire sizes and quantities and cable/wire schedules. Simplified logic block diagrams or flow charts shall be provided during the development of the PLC application software.

c. Catalog data shall be provided for all devices and equipment including the PLC and associated hardware.

Submit an Operations and maintenance (O&M) manual in accordance with Section 01730 for the complete system, including all field modifications, PLC system and Remote Terminal Units (RTU). All information included in the O&M manual shall be marked up and modified to properly present the system and components installed including all options etc.

1.5 QUALITY ASSURANCE

The PLC system shall be supplied by a systems manufacturer or systems house experienced in the design, configuration, and programming of process

systems using programable logic controllers for groundwater treatment systems and the waste water industry.

a. The supplier must have a minimum of 3 years experience in the industry and must have at least three completed similar systems successfully operating in the field.

b. The supplier shall have the capability of providing prior to system delivery a complete system factory test and simulation which will include connection and operation of system inputs/outputs and verification of functional and operational requirements.

c. The supplier shall submit evidence of completion and references for at least three similar projects.

d. Comply with the following codes, regulations etc.

1. Components and Installation: NFPA 70 National Electrical Code, 1993 Edition.

2. Listing and Labeling: Provide products specified in this Section that are listed and labeled as defined by article 100 of the National Electrical Code.

3. NEMA Compliance: NEMA ICS2, "Industrial Control Devices, Controllers and Assemblies."

4. UL Compliance: UL508, "Electrical Industrial Control Equipment."

PART 2 PRODUCTS

2.1 MANUFACTURERS

Programmable Logic Controller (PLC): the PLC subject to compliance with requirements provide products by one of the following:

1. Allen-Bradley Company

2. General Electric Company

3. Siemens

4. Gould-Modicon

PC workstation software subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to:

1. ICOM, Inc.
Milwaukee, WI.

2. Wonderware
Irvine, CA.

2.2 GENERAL REQUIREMENTS

1. Instruments furnished for front panel enclosure mounting shall be suitable for flush mounting.

2. Instruments shall return to accurate measurement upon restoration of power after a power failure.

3. Control panels, instruments, meters, and controls, etc., shall be furnished with six spare fuses of each different size used and 12 lamps of each different kind used.

4. Panel-mounted instruments, switches, controls, etc. shall be identified with engraved plastic nameplates.

5. Wiring diagrams shall be furnished for the P.L.C. cabinet and control panels. The diagrams shall be revised to show "as-built" circuitry and equipment and shall show connections from numbered terminal blocks to external equipment. Color coding and relay terminal numbers shall also be indicated.

6. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

7. Field-mounted instruments shall be identified by loop number and function, using engraved plastic tags permanently affixed to each item.

8. Interconnecting cables required for complete system operation shall be provided with the system. These cable shall include signal cables, data highway cables, AC and DC power, and control cables. Accessories, such as special test equipment and tools, shall be provided.

9. A minimum of 10 percent of each type of circuit board or module provided in the system shall be provided as spare (1 board or module for each 10 boards or modules actually used in the system). A minimum of 1 of each type of circuit board or module provided in the system shall be provided as spare. Spares shall be provided for the PLC system. Special maintenance hardware and software required to operate, maintain, test, and troubleshoot the system shall also be provided.

2.2.1 Power Supply Requirements

1. Instruments and devices provided, except as otherwise specified, shall operate on 120-volt plus or minus 10 percent, 60-hertz, plus or minus 1 hertz, single-phase power. A regulator or power supply shall be provided for instruments or devices requiring closer regulation or a different voltage.

2. An integral on-off switch and fuse shall be provided for each instrument requiring electric power connections.

3. Remote-motor-operated or electrically operated equipment shall have a separate 120-volt control circuit.

4. Controls for remote electrically operated or motor-driven equipment shall be complete, including necessary auxiliary relays, so as to require only wiring and connection to the equipment control circuit. Contacts for control of remote motor operation or electrically operated equipment shall be rated not less than 50 percent above the required rating.

2.3 Programmable Logic Controller (PLC)

2.3.1 General

a. A complete microprocessor-based programmable logic controller (PLC) system shall be provided to control and monitor the operation of process equipment as identified in the Process Description and Control Philosophy Report and as shown on the drawings and as specified herein.

b. The programmable logic controller and associated equipment shall be installed in a NEMA enclosure to be located in the control room.

c. The PLC enclosure shall house the PLC, card racks, power supplies, I/O modules, labeled terminal blocks for field wiring terminations, ground bus, fuse blocks, and other associated equipment. Enclosure shall be completely pre-wired by systems manufacturer or systems house in a free standing, two door, 12 gauge steel, NEMA 12 enclosure. Enclosure to be provided with cooling fans, filter intake grille and internally mounted duplex convenience receptacle. Enclosure doors to be provided with ON (Red)/OFF(Green) indicator lights controlled from a door mounted main power ON/OFF key locking pistol grip switch. Doors to be provided with emergency stop push button for control of process, "common" alarm annunciator light, "common" alarm annunciator horn and horn/light reset pushbutton.

d. System hardware shall be of the latest solid-state modular design and shall be surge protected to ensure proper operation on an industrial power system.

e. The programmable logic controller system shall be Model PLC-5/20 manufactured by Allen-Bradley or equal. The drawings and specifications indicate the Allen-Bradley system configuration. Contractor to verify and coordinate voltage, wiring and interface requirements of process equipment furnished by this contractor, or as a part of a vendor supplied package which may alter the system configuration and wiring requirements of the system shown and specified.

2.3.2 Components

a. All hardware components shall be capable of operation in an environment of 0 degrees to 60 degrees.

b. (32 to 140 degrees F) in an atmosphere of 5 to 95-percent relative humidity with no condensation.

c. The programmable controller shall provide a means for mounting the chassis in a standard cabinet or 19 inch rack.

d. The CPU shall have the capacity of addressing a minimum of 512 input and 512 output points. It shall also have the ability to communicate with up to 16 physical locations.

e. Each input and output module shall be a self-contained unit housed within an enclosure. These input/output enclosures with their respective modules shall be field expandable up to 128 unique locations.

f. The programmable controller shall include as a standard feature the capability of addressing remote input and output modules up to 10,000 cable feet from the processor. The communication link between the CPU and any remote input and output distribution chassis shall be either via a 20 AWG tinned copper twinaxil cable with braided and foil sheilds or via fiber optic cable.

g. The communication rate between the CPU and the remote input/output modules shall be user selectable on a per channel basis. At a distance of 10,000 cable feet between the processor and the input and output modules the transmission rate shall be no less than 57.6 Kbaud. If the distance in cable feet is reduced, then this transmission rate may be increased.

h. The programmable controller shall use two independent, asynchronous scans. One scan shall be designated for processing of input and output information only, with the second scan dedicated exclusively to the processing of the logic program. With this criterion it shall be possible to group remote discrete input and output devices to achieve an I/O update time of 7-10 milliseconds per 128 I/O. Input and output devices located in the same backplane (local I/O) as the CPU should be scanned in under 2 milliseconds. Concurrent withe this I/O update time. the processing of a typical logic program shall not exceed 2 milliseconds for 1024 relay type instructions with a maximum overhead of 4 milliseconds.

i. The programmable controller shall have the ability to communicate with a remote I/O rack configured with multiple I/O chassis. Each logical rack of remote I/O can be configured with one or more chassis containing 2, 4, 6, or 8 I/O groups. I/O status and control information indicated rack faults, reset commands, and inhibit commands at the chassis level. Both rack status and control information allowing for indications of rack faults and control including I/O rack reset and inhibit control bits shall be available to the quarter rack level.

2.3.3 Main Frame Hardware

a. The CPU shall be a self-contained unit, and will provide Ladder Rung program execution and support remote or local programming. This device will also supply I/O scanning and inter-processor and peripheral communication functions.

b. The operating system shall be contained in removable programmable devices which allow for easy field replacement.

c. In a single chassis system all system and signal power to the CPU, support modules shall be distributed on a single motherboard or backplane. No interconnecting wiring between there modules via plug-terminated jumpers shall be acceptable.

d. The CPU within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a "green" indicator when no-fault is detected and a "red" indicator when a fault is detected.

e. All modules within the system shall be mechanically interlocked to prevent insertion or removal of modules under power which in turn helps to prevent damage to the modules and/or system.

f. The main CPU shall include a connector that provides inter-processsor communications to peripheral support devices.

g. The main chassis front panel shall include indicators showing the following status information:

1. If power is applied to the CPU
2. Program or Run mode of the CPU
3. The Run/Fault status of the CPU
4. Enabled/Disabled state of outputs
5. State of the I/O adapters
6. If forcing is active
7. If a remote device is talking via the inter-processor communications link

h. Processor mode and status of the I/O shall be selected by a toggle/key switch mounted on the front panel of the CPU.

i. Non-volatile memory shall store the operating system information to protect against loss in the case of power loss or system shut-down. Only at the time of a hardware change or system software program change shall this configuration status be altered or re-entered.

2.3.4 Power Supplies

a. The programmable controller shall operate in compliance with an electrical service of either 120 VAC, single phase, in the frequency range from 47 to 63 Hz, or 24 VDC.

b. The manufacturer shall provide as standard equipment a system power supply capable of converting 120 VAC line power to the DC power

required to operate the programmable controller system.

c. A single main power supply shall have the capability of supplying power to the CPU and local input/output modules. Auxiliary power supplies shall provide power to remotely located racks.

d. The power supply shall automatically shut down the programmable controller system whenever its output current is detected as exceeding 125% of its rated current.

e. The power supply shall monitor the incoming AC line voltage for proper levels. When the power supply is wired to utilize 120 VAC power, the system shall function properly within the range of 97 to 132 VAC. If the voltage level is detected as being out of range for more than one-half line cycle, the power supply shall automatically shut down the system and remain disabled until the proper voltage level returns. In addition, the power supply shall provide surge protection, isolation, and outage carry-over up to 2 cycles of the AC line.

2.3.5 Program Storage

a. The program storage medium shall be of a solid state RAM (volatile) type.

b. The programmable controller system shall be capable of addressing up to 21 K words, where each word is comprised of 16 data bits.

c. Memory shall be available in 6K, 10K, 13K, 14K, 17K, or 21K word segments of RAM. Memory capacity shall be sized to allow for the most economical match to the intended application. As a means of upgrading the system each memory segment shall be field expandable up to the maximum number of memory words addressable by the programmable controller.

d. Memory shall contain battery back-up capable of retaining all stored program data through a continuous power outage for 12 months under worst case conditions. The capability shall exist to remove all batteries from the system without removing system power.

e. The operator shall be able to backup volatile memory, including data and program logic onto either a 3 1/2 inch floppy diskette or winchester hard disk, at their option.

f. A minimum of 6144 16 bit words shall be allocated from main memory for the purpose of data storage. The programmable controller system shall be capable of storing the following data types:

1. External Output Status
2. External Input Status
3. Timer Values
4. Counter Values
5. Signed Integer Numbers (16 bit)
6. Floating Point Numbers
7. Decimal Numbers

8. Binary Numbers
9. Direct and Indexed Addressing
10. Internal Processor Status Information
11. ASCII and Control Structures

g. If contacts or entire rungs are intentionally deleted from an existing logic program, the remaining program shall be automatically repositioned to fill this void. Whenever contacts or entire rungs are intentionally inserted into an existing program, the original program shall automatically be repositioned to accommodate the enlarged program.

h. To reduce the effective scan time in order to detect short pulse duration inputs, it shall be possible to program a select logic rung more than once into memory.

i. The number of times a normally open (N.O.) and/or normally closed (N.C.) contact of an internal output can be programmed shall be limited only by the memory capacity to store these instructions.

2.3.6 Input and Output - General

a. Each input or output module shall be a self-contained unit housed within an enclosure.

b. The input/output enclosure (chassis) with its respective modules shall be of universal type and compatible with any, programmable controller manufactured by the supplier.

c. During normal operation, a malfunction in any remote input/output channel shall affect the operation of only that channel and not the operation of the CPU or any other channel.

d. Any remote input/output channel shall be field selectable to shut down the CPU upon failure of that channel.

e. Isolation shall be used between all internal logic and external power circuits. This isolation shall meet the minimum specification of 1500 VRMS.

f. It shall be possible to replace any input or output module without disturbing field wiring.

g. Each I/O module shall contain a visual indicator to display ON/OFF status of individual input or output points.

h. Discrete output modules shall be provided with self-contained fuses for overload and short circuit protection of the module. These cards shall also be capable of having fused swing arms per point so as not to disturb the card and/or wiring while changing a blown fuse.

i. All user wiring to I/O modules shall be through a heavy-duty terminal strip.

j. All input/output modules shall be color coded and titled with a distinctive label.

k. All input modules shall have a specified filter time constant to limit the effects of voltage transients.

2.3.7 Input and Output Modules

a. The programmable controller manufacturer shall offer discrete input/output hardware consisting of the following types:

2.3.7.1 Inputs

1. AC input for devices which operate at 120 VAC, 50/60 Hz.

2. Isolated AC input which provides isolation of 120 VAC input signals.

2.3.7.2 Outputs

1. AC output for devices which operate at 120 VAC, 50/60 Hz.

2. Isolated AC output which provides six (6) isolated outputs capable of switching 120 VAC or 220 VAC power.

3. Contact output which provides four (4) normally open and four (4) normally closed reed relay outputs.

4. Contact output which provides eight (8) normally open/normally closed reed relay outputs.

b. Analog I/O modules of the following types shall be offered by the manufacturer:

Analog input which accepts analog signals and converts them to three digit BCD, four digit BCD or twelve (12) bit binary values. Digital resolution shall be available in 1 part in 256, 1 part in 1000 (BCD), or 1 part in 4096 (binary). Analog inputs shall be available in single-ended, sourcing, differential, and differential isolated versions. Analog inputs shall be available in the following ranges:

1. Voltage range: o to plus 5 VDC, plus 1 to plus 5 VDC, o to plus 10 VDC, minus 5 to plus 5 VDC, minus 10 to plus 10 VDC.

2. Current range: 4 to 20 mA, o to 20 mA, minus 20 to plus 20 mA.

Analog output which converts a three digit BCD number, a four digit BCD number, or a twelve (12) bit binary number into an equivalent single-ended analog output signal. Output isolation shall be available. Analog outputs shall be available in the following ranges:

1. Voltage range: plus 1 to plus 5 VDC, o to plus 10 VDC, minus 10 to plus 10 VDC.

2. Current range: 4 to 20 mA, 0 to 50 mA.

2.4 PC Workstation

The PC workstation shall enable the operator to communicate with the PLC. The workstation shall operate in conjunction with the PLC and shall include an IBM compatible 80486 Dx computer complete with 8 Meg of RAM, 5 1/4" & 3 1/2" dual floppy drive and 40 Meg hard drive, alphanumeric keyboard, mouse, PLC interface card, modem, 19-inch (1024 x 768) VGA color monitor with 256 color driver card, 15-inch wide carriage 20-pin dot matrix printer and necessary cabling.

a. The PC workstation software shall be Windows based using Version 3.1 and/or Workgroups 3.11.

b. The interface software between the PC and the PLC shall be ICOM-WIN telligent Linx for acquiring PLC data for data logging, process monitoring and reporting functions.

c. Provide WIN telligent Logic 5 ladder logic development and maintenance software package to allow mouse-based editing, cut and past, symbolic addressing, import/export functions and I/O monitoring.

d. Provide WIN telligent View software for creation of graphics screens indicating animation of process including visual action/reactions for changes in process set points, alarm conditions and alarm acknowledgements via keyboard or mouse response.

e. Provide interface software to transmit "critical" alarms via modem to the public works center control station, or a location designated by the Government. Interface Software, Modem Tramsmission Rate and Modem Type to be compatable with the receiving equipment at the Public Works Center Control Station.

PART 3 EXECUTION

3.1 Installation

Equipment shall be installed as recommended by the manufacturer to conform to the particular application involved in accordance with the details shown. Installation of equipment and connections to equipment shall be completed in every detail in a first-class workmanlike manner. The electrical control loop drawings and system architecture drawings shown are for purposes of guidance and to show functional requirements only. They do not necessarily contain or show components required to accomplish the desired results or components required to interface equipment. Parts, equipment, devices, etc. necessary to meet the functional and interface requirements shall be provided. Prior to acceptance, the Contractor shall test each piece of equipment and shall furnish written certification that it has been installed in accordance with the manufacturer's requirements, and is calibrated and ready to begin operation.

Conduit, power wiring, control and signal wiring, fittings, and related material shall be provided in accordance with Section 16011 and 16402.

3.2 Manufacturer's Start-up Services and Calibration

The services of a factory-trained, qualified service representative of the equipment supplier shall be provided for a minimum of 5 days to inspect the complete equipment installation to ensure that it is installed in accordance with the manufacturer's recommendations, to calibrate all field instruments, to make adjustments necessary to place the system in trouble-free operation, and to instruct the operating personnel in the proper care and operation of the equipment provided. This requirement shall include living expenses and travel to and from the factory or service center and the jobsite.

3.3 Testing

The entire Process control system shall be tested as follows:

3.3.1 Factory Acceptance Testing

The entire programmable logic controller system, including all input/output units, PC-workstation etc. shall be assembled and tested before shipment to the site. This testing shall include a complete system simulation with inputs and outputs connected to simulation test equipment. Test and simulation procedures shall be submitted and approved prior to testing. The tests shall ensure that all hardware and software are operating properly. As a minimum, the factory testing shall include the following:

a. Demonstrate all functions and features of the system described in the specifications.

b. Demonstrate the complete sequence of operation for the facility as described under "Process Description and Control Philosophy for Camp Allen".

c. Simulate all analog and discrete input signals, and demonstrate proper operation of all analog and discrete output signals.

d. Demonstrate all system interlocks and alarm functions.

3.3.2 Preliminary Inspection/Test

a. Repeat all factory tests and simulations to verify that the system is properly interconnected and was not damaged during shipment.

b. Electrical wiring shall be checked for continuity, and instruments shall be checked for proper installation and operation.

c. Contractor shall submit complete procedures for testing and checking instrumentation system as part of the submittal of Contractor's Drawings. Testing procedures shall be approved by the Government prior to testing. Equipment to be used by the Contractor or his subcontractors and/or suppliers during the performance of the testing shall be specified in the procedures by manufacturer and model number.

d. After the complete process control system, including panels and input/output cabinets, field-mounted equipment, wiring, and piping has been installed and checked for proper operation by the appropriate field service engineers, the Contractor shall check the complete system for functions specified and indicated.

e. Verify that each analog and discrete input and output point is connected to the system in accordance with the Contractor's Drawings and operates properly.

f. Start and stop all equipment manually from the PLC by forcing the appropriate output device on and off a minimum of three times for each unit.

g. Demonstrate all system interlocks and alarms.

3.3.3 Prefinal Inspection/Test

Prefinal inspection/test will not be required; however, the system shall be required to operate continuously unattended for a 7 day period with no failures before it will be accepted by the Government.

3.3.4 Test Reports

Complete test procedures, final test reports, and results shall be submitted in accordance with Section 01010.

4.4 Training Requirements

1. The PLC System shall provide on-site training to cover the following topics:

a. System hardware.

b. Operation and programming

c. Maintenance, repair, and troubleshooting

2. A minimum of 5 (8-hour) days of training shall be provided by competent instructors on each topic listed above for a minimum of three personnel. Required training materials, audio-visual aids, and documents shall be provided. The training shall stress hands-on experience and shall be specific to the equipment and software provided and to the system application in particular.

-- End of Section --

SECTION 16910

PLC SYSTEM AND CONTROL WIRING INTERFACE

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3. Control panels, instruments, meters, and controls, etc., shall be furnished with six spare fuses of each different size used and 12 lamps of each different kind used.

4. Panel-mounted instruments, switches, controls, etc. shall be identified with engraved plastic nameplates.

5. Wiring diagrams shall be furnished for the P.L.C. cabinet and control panels. The diagrams shall be revised to show "as-built" circuitry and equipment and shall show connections from numbered terminal blocks to external equipment. Color coding and relay terminal numbers shall also be indicated.

6. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

7. Field-mounted instruments shall be identified by loop number and function, using engraved plastic tags permanently affixed to each item.

8. Interconnecting cables required for complete system operation shall be provided with the system. These cable shall include signal cables, data highway cables, AC and DC power, and control cables. Accessories, such as special test equipment and tools, shall be provided.

9. A minimum of 10 percent of each type of circuit board or module provided in the system shall be provided as spare (1 board or module for each 10 boards or modules actually used in the system). A minimum of 1 of each type of circuit board or module provided in the system shall be provided as spare. Spares shall be provided for the PLC system. Special maintenance hardware and software required to operate, maintain, test, and troubleshoot the system shall also be provided.

2.2.1 Power Supply Requirements

1. Instruments and devices provided, except as otherwise specified, shall operate on 120-volt plus or minus 10 percent, 60-hertz, plus or minus 1 hertz, single-phase power. A regulator or power supply shall be provided for instruments or devices requiring closer regulation or a different voltage.

2. An integral on-off switch and fuse shall be provided for each instrument requiring electric power connections.

3. Remote-motor-operated or electrically operated equipment shall have a separate 120-volt control circuit.

4. Controls for remote electrically operated or motor-driven equipment shall be complete, including necessary auxiliary relays, so as to require only wiring and connection to the equipment control circuit. Contacts for control of remote motor operation or electrically operated equipment shall be rated not less than 50 percent above the required rating.

2.3 Programmable Logic Controller (PLC)

2.3.1 General

a. A complete microprocessor-based programmable logic controller (PLC) system shall be provided to control and monitor the operation of process equipment as identified in the Process Description and Control Philosophy Report and as shown on the drawings and as specified herein.

b. The programmable logic controller and associated equipment shall be installed in a NEMA enclosure to be located in the control room.

c. The PLC enclosure shall house the PLC, card racks, power supplies, I/O modules, labeled terminal blocks for field wiring terminations, ground bus, fuse blocks, and other associated equipment. Enclosure shall be completely pre-wired by systems manufacturer or systems house in a free standing, two door, 12 gauge steel, NEMA 12 enclosure. Enclosure to be provided with cooling fans, filter intake grille and internally mounted duplex convenience receptacle. Enclosure doors to be provided with ON (Red)/OFF(Green) indicator lights controlled from a door mounted main power ON/OFF key locking pistol grip switch. Doors to be provided with emergency stop push button for control of process, "common" alarm annunciator light, "common" alarm annunciator horn and horn/light reset pushbutton.

d. System hardware shall be of the latest solid-state modular design and shall be surge protected to ensure proper operation on an industrial power system.

e. The programmable logic controller system shall be Model PLC-5/20 manufactured by Allen-Bradley or equal. The drawings and specifications indicate the Allen-Bradley system configuration. Contractor to verify and coordinate voltage, wiring and interface requirements of process equipment furnished by this contractor, or as a part of a vendor supplied package which may alter the system configuration and wiring requirements of the system shown and specified.

2.3.2 Components

a. All hardware components shall be capable of operation in an environment of 0 degrees to 60 degrees.

b. (32 to 140 degrees F) in an atmosphere of 5 to 95-percent relative humidity with no condensation.

c. The programmable controller shall provide a means for mounting the chassis in a standard cabinet or 19 inch rack.

d. The CPU shall have the capacity of addressing a minimum of 512 input and 512 output points. It shall also have the ability to communicate with up to 16 physical locations.

e. Each input and output module shall be a self-contained unit housed within an enclosure. These input/output enclosures with their respective modules shall be field expandable up to 128 unique locations.

f. The programmable controller shall include as a standard feature the capability of addressing remote input and output modules up to 10,000 cable feet from the processor. The communication link between the CPU and any remote input and output distribution chassis shall be either via a 20 AWG tinned copper twinaxil cable with braided and foil sheilds or via fiber optic cable.

g. The communication rate between the CPU and the remote input/output modules shall be user selectable on a per channel basis. At a distance of 10,000 cable feet between the processor and the input and output modules the transmission rate shall be no less than 57.6 Kbaud. If the distance in cable feet is reduced, then this transmission rate may be increased.

h. The programmable controller shall use two independent, asynchronous scans. One scan shall be designated for processing of input and output information only, with the second scan dedicated exclusively to the processing of the logic program. With this criterion it shall be possible to group remote discrete input and output devices to achieve an I/O update time of 7-10 milliseconds per 128 I/O. Input and output devices located in the same backplane (local I/O) as the CPU should be scanned in under 2 milliseconds. Concurrent withe this I/O update time. the processing of a typical logic program shall not exceed 2 milliseconds for 1024 relay type instructions with a maximum overhead of 4 milliseconds.

i. The programmable controller shall have the ability to communicate with a remote I/O rack configured with multiple I/O chassis. Each logical rack of remote I/O can be configured with one or more chassis containing 2, 4, 6, or 8 I/O groups. I/O status and control information indicated rack faults, reset commands, and inhibit commands at the chassis level. Both rack status and control information allowing for indications of rack faults and control including I/O rack reset and inhibit control bits shall be available to the quarter rack level.

2.3.3 Main Frame Hardware

a. The CPU shall be a self-contained unit, and will provide Ladder Rung program execution and support remote or local programming. This device will also supply I/O scanning and inter-processor and peripheral communication functions.

b. The operating system shall be contained in removable programmable devices which allow for easy field replacement.

c. In a single chassis system all system and signal power to the CPU, support modules shall be distributed on a single motherboard or backplane. No interconnecting wiring between there modules via plug-terminated jumpers shall be acceptable.

d. The CPU within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a "green" indicator when no-fault is detected and a "red" indicator when a fault is detected.

e. All modules within the system shall be mechanically interlocked to prevent insertion or removal of modules under power which in turn helps to prevent damage to the modules and/or system.

f. The main CPU shall include a connector that provides inter-processsor communications to peripheral support devices.

g. The main chassis front panel shall include indicators showing the following status information:

1. If power is applied to the CPU
2. Program or Run mode of the CPU
3. The Run/Fault status of the CPU
4. Enabled/Disabled state of outputs
5. State of the I/O adapters
6. If forcing is active
7. If a remote device is talking via the inter-processor communications link

h. Processor mode and status of the I/O shall be selected by a toggle/key switch mounted on the front panel of the CPU.

i. Non-volatile memory shall store the operating system information to protect against loss in the case of power loss or system shut-down. Only at the time of a hardware change or system software program change shall this configuration status be altered or re-entered.

2.3.4 Power Supplies

a. The programmable controller shall operate in compliance with an electrical service of either 120 VAC, single phase, in the frequency range from 47 to 63 Hz, or 24 VDC.

b. The manufacturer shall provide as standard equipment a system power supply capable of converting 120 VAC line power to the DC power

required to operate the programmable controller system.

c. A single main power supply shall have the capability of supplying power to the CPU and local input/output modules. Auxiliary power supplies shall provide power to remotely located racks.

d. The power supply shall automatically shut down the programmable controller system whenever its output current is detected as exceeding 125% of its rated current.

e. The power supply shall monitor the incoming AC line voltage for proper levels. When the power supply is wired to utilize 120 VAC power, the system shall function properly within the range of 97 to 132 VAC. If the voltage level is detected as being out of range for more than one-half line cycle, the power supply shall automatically shut down the system and remain disabled until the proper voltage level returns. In addition, the power supply shall provide surge protection, isolation, and outage carry-over up to 2 cycles of the AC line.

2.3.5 Program Storage

a. The program storage medium shall be of a solid state RAM (volatile) type.

b. The programmable controller system shall be capable of addressing up to 21 K words, where each word is comprised of 16 data bits.

c. Memory shall be available in 6K, 10K, 13K, 14K, 17K, or 21K word segments of RAM. Memory capacity shall be sized to allow for the most economical match to the intended application. As a means of upgrading the system each memory segment shall be field expandable up to the maximum number of memory words addressable by the programmable controller.

d. Memory shall contain battery back-up capable of retaining all stored program data through a continuous power outage for 12 months under worst case conditions. The capability shall exist to remove all batteries from the system without removing system power.

e. The operator shall be able to backup volatile memory, including data and program logic onto either a 3 1/2 inch floppy diskette or winchester hard disk, at their option.

f. A minimum of 6144 16 bit words shall be allocated from main memory for the purpose of data storage. The programmable controller system shall be capable of storing the following data types:

1. External Output Status
2. External Input Status
3. Timer Values
4. Counter Values
5. Signed Integer Numbers (16 bit)
6. Floating Point Numbers
7. Decimal Numbers

8. Binary Numbers
9. Direct and Indexed Addressing
10. Internal Processor Status Information
11. ASCII and Control Structures

g. If contacts or entire rungs are intentionally deleted from an existing logic program, the remaining program shall be automatically repositioned to fill this void. Whenever contacts or entire rungs are intentionally inserted into an existing program, the original program shall automatically be repositioned to accommodate the enlarged program.

h. To reduce the effective scan time in order to detect short pulse duration inputs, it shall be possible to program a select logic rung more than once into memory.

i. The number of times a normally open (N.O.) and/or normally closed (N.C.) contact of an internal output can be programmed shall be limited only by the memory capacity to store these instructions.

2.3.6 Input and Output - General

a. Each input or output module shall be a self-contained unit housed within an enclosure.

b. The input/output enclosure (chassis) with its respective modules shall be of universal type and compatible with any, programmable controller manufactured by the supplier.

c. During normal operation, a malfunction in any remote input/output channel shall affect the operation of only that channel and not the operation of the CPU or any other channel.

d. Any remote input/output channel shall be field selectable to shut down the CPU upon failure of that channel.

e. Isolation shall be used between all internal logic and external power circuits. This isolation shall meet the minimum specification of 1500 VRMS.

f. It shall be possible to replace any input or output module without disturbing field wiring.

g. Each I/O module shall contain a visual indicator to display ON/OFF status of individual input or output points.

h. Discrete output modules shall be provided with self-contained fuses for overload and short circuit protection of the module. These cards shall also be capable of having fused swing arms per point so as not to disturb the card and/or wiring while changing a blown fuse.

i. All user wiring to I/O modules shall be through a heavy-duty terminal strip.

j. All input/output modules shall be color coded and titled with a distinctive label.

k. All input modules shall have a specified filter time constant to limit the effects of voltage transients.

2.3.7 Input and Output Modules

a. The programmable controller manufacturer shall offer discrete input/output hardware consisting of the following types:

2.3.7.1 Inputs

1. AC input for devices which operate at 120 VAC, 50/60 Hz.

2. Isolated AC input which provides isolation of 120 VAC input signals.

2.3.7.2 Outputs

1. AC output for devices which operate at 120 VAC, 50/60 Hz.

2. Isolated AC output which provides six (6) isolated outputs capable of switching 120 VAC or 220 VAC power.

3. Contact output which provides four (4) normally open and four (4) normally closed reed relay outputs.

4. Contact output which provides eight (8) normally open/normally closed reed relay outputs.

b. Analog I/O modules of the following types shall be offered by the manufacturer:

Analog input which accepts analog signals and converts them to three digit BCD, four digit BCD or twelve (12) bit binary values. Digital resolution shall be available in 1 part in 256, 1 part in 1000 (BCD), or 1 part in 4096 (binary). Analog inputs shall be available in single-ended, sourcing, differential, and differential isolated versions. Analog inputs shall be available in the following ranges:

1. Voltage range: o to plus 5 VDC, plus 1 to plus 5 VDC, o to plus 10 VDC, minus 5 to plus 5 VDC, minus 10 to plus 10 VDC.

2. Current range: 4 to 20 mA, o to 20 mA, minus 20 to plus 20 mA.

Analog output which converts a three digit BCD number, a four digit BCD number, or a twelve (12) bit binary number into an equivalent single-ended analog output signal. Output isolation shall be available. Analog outputs shall be available in the following ranges:

1. Voltage range: plus 1 to plus 5 VDC, o to plus 10 VDC, minus 10 to plus 10 VDC.

2. Current range: 4 to 20 mA, 0 to 50 mA.

2.4 PC Workstation

The PC workstation shall enable the operator to communicate with the PLC. The workstation shall operate in conjunction with the PLC and shall include an IBM compatible 80486 Dx computer complete with 8 Meg of RAM, 5 1/4" & 3 1/2" dual floppy drive and 40 Meg hard drive, alphanumeric keyboard, mouse, PLC interface card, modem, 19-inch (1024 x 768) VGA color monitor with 256 color driver card, 15-inch wide carriage 20-pin dot matrix printer and necessary cabling.

a. The PC workstation software shall be Windows based using Version 3.1 and/or Workgroups 3.11.

b. The interface software between the PC and the PLC shall be ICOM-WIN telligent Linx for acquiring PLC data for data logging, process monitoring and reporting functions.

c. Provide WIN telligent Logic 5 ladder logic development and maintenance software package to allow mouse-based editing, cut and past, symbolic addressing, import/export functions and I/O monitoring.

d. Provide WIN telligent View software for creation of graphics screens indicating animation of process including visual action/reactions for changes in process set points, alarm conditions and alarm acknowledgements via keyboard or mouse response.

e. Provide interface software to transmit "critical" alarms via modem to the public works center control station, or a location designated by the Government. Interface Software, Modem Tramsmission Rate and Modem Type to be compatable with the receiving equipment at the Public Works Center Control Station.

PART 3 EXECUTION

3.1 Installation

Equipment shall be installed as recommended by the manufacturer to conform to the particular application involved in accordance with the details shown. Installation of equipment and connections to equipment shall be completed in every detail in a first-class workmanlike manner. The electrical control loop drawings and system architecture drawings shown are for purposes of guidance and to show functional requirements only. They do not necessarily contain or show components required to accomplish the desired results or components required to interface equipment. Parts, equipment, devices, etc. necessary to meet the functional and interface requirements shall be provided. Prior to acceptance, the Contractor shall test each piece of equipment and shall furnish written certification that it has been installed in accordance with the manufacturer's requirements, and is calibrated and ready to begin operation.

Conduit, power wiring, control and signal wiring, fittings, and related material shall be provided in accordance with Section 16011 and 16402.

3.2 Manufacturer's Start-up Services and Calibration

The services of a factory-trained, qualified service representative of the equipment supplier shall be provided for a minimum of 5 days to inspect the complete equipment installation to ensure that it is installed in accordance with the manufacturer's recommendations, to calibrate all field instruments, to make adjustments necessary to place the system in trouble-free operation, and to instruct the operating personnel in the proper care and operation of the equipment provided. This requirement shall include living expenses and travel to and from the factory or service center and the jobsite.

3.3 Testing

The entire Process control system shall be tested as follows:

3.3.1 Factory Acceptance Testing

The entire programmable logic controller system, including all input/output units, PC-workstation etc. shall be assembled and tested before shipment to the site. This testing shall include a complete system simulation with inputs and outputs connected to simulation test equipment. Test and simulation procedures shall be submitted and approved prior to testing. The tests shall ensure that all hardware and software are operating properly. As a minimum, the factory testing shall include the following:

a. Demonstrate all functions and features of the system described in the specifications.

b. Demonstrate the complete sequence of operation for the facility as described under "Process Description and Control Philosophy for Camp Allen".

c. Simulate all analog and discrete input signals, and demonstrate proper operation of all analog and discrete output signals.

d. Demonstrate all system interlocks and alarm functions.

3.3.2 Preliminary Inspection/Test

a. Repeat all factory tests and simulations to verify that the system is properly interconnected and was not damaged during shipment.

b. Electrical wiring shall be checked for continuity, and instruments shall be checked for proper installation and operation.

c. Contractor shall submit complete procedures for testing and checking instrumentation system as part of the submittal of Contractor's Drawings. Testing procedures shall be approved by the Government prior to testing. Equipment to be used by the Contractor or his subcontractors and/or suppliers during the performance of the testing shall be specified in the procedures by manufacturer and model number.

d. After the complete process control system, including panels and input/output cabinets, field-mounted equipment, wiring, and piping has been installed and checked for proper operation by the appropriate field service engineers, the Contractor shall check the complete system for functions specified and indicated.

e. Verify that each analog and discrete input and output point is connected to the system in accordance with the Contractor's Drawings and operates properly.

f. Start and stop all equipment manually from the PLC by forcing the appropriate output device on and off a minimum of three times for each unit.

g. Demonstrate all system interlocks and alarms.

3.3.3 Prefinal Inspection/Test

Prefinal inspection/test will not be required; however, the system shall be required to operate continuously unattended for a 7 day period with no failures before it will be accepted by the Government.

3.3.4 Test Reports

Complete test procedures, final test reports, and results shall be submitted in accordance with Section 01010.

4.4 Training Requirements

1. The PLC System shall provide on-site training to cover the following topics:

a. System hardware.

b. Operation and programming

c. Maintenance, repair, and troubleshooting

2. A minimum of 5 (8-hour) days of training shall be provided by competent instructors on each topic listed above for a minimum of three personnel. Required training materials, audio-visual aids, and documents shall be provided. The training shall stress hands-on experience and shall be specific to the equipment and software provided and to the system application in particular.

-- End of Section --