SECTION 13600 - COMNET HARDWARE PROCUREMENT

City of San Diego, CWP Guidelines

PART 1 - GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes the general specification and requirements for the procurement of digital hardware associated with the distributed control systems (DCS) and supervisory control and data acquisition (SCADA) components of the Clean Water Operations Management Network (COMNET).

B. The WORK requires that one prequalified System Supplier be given responsibility for furnishing the indicated WORK but without altering the CONTRACTOR'S responsibilities under the Contract Documents.

C. The WORK also includes coordination of design, assembly, testing and installation.

1.2 PREQUALIFICATION

A. System Suppliers shall prequalify for bidding by submitting [five] copies of prequalification applications at least [21] days prior to the bid opening date. The list of prequalified System Suppliers will be limited to those which demonstrate competency to execute the WORK and furnish the services in this Specification by describing proposed system characteristics, functions, and performance together with descriptive information and calculations:

1. Block diagrams for each Distributed Control System (DCS). The content of the block diagrams shall include the following:

a. The number of [Process Control Modules (PCM)] [/] [Programmable Logic Controllers (PLC)] associated with each facility.

b. The quantity and type of process inputs and outputs (I/O) associated with each [PCM] [/] [PLC].

c. The percent utilization for each [PCM] [PLC] (ratio of the number of I/O slots used to the number of I/O slots available).

d. Schematic representation of all communication hardware devices required for on-site DCS communications.

e. Schematic representation of all DCS Man-Machine Interface (MMI) platforms and associated peripherals. All MMIs shall be provided with RAM, hard and floppy drive capacities being proposed.

f. Schedule representation of the DCS historian which defines peripherals associated with the historian and requisite data highway communication devices.

2. A block diagram for the SCADA portion of the COMNET system which defines the manufacturer and model number of all equipment associated with the SCADA component of the COMNET including, but not limited to a clustered host computer system, computer workstations, peripherals and communications systems.

3. A complete set of engineering specifications and technical manuals for each hardware item included in the DCS and SCADA components of COMNET.

4. Evidence which documents that the system supplier is regularly engaged in the manufacturing and supply of equipment of the type described in these Specifications and has adequate plant facilities, organization structure, and technical and managerial expertise to properly perform the WORK in conformance with these Specifications. Satisfactory evidence shall constitute at least five completed projects of similar scope and complexity. Information related to each project shall include:

   a. Brief instrumentation and control system description and functions.

   b. Quantities of signals: input, output analog, and discrete.

   c. Equipment provided.

   d. Facility name and address.

   e. Current operations supervisor name and telephone number.

   f. CONSTRUCTION MANAGER'S name, address and telephone number.

   g. Scope of supply and services.

   h. Dates of contract initiation, hardware installation, and OWNER acceptance.

   i. Project value (instrumentation and control portion).

   j. Size of plant in terms of mgd of sewage treated.

5. Demonstration that the in-house resource of permanent personnel is experienced in the design, manufacturer and hardware integration of equipment and systems as required by these Specifications.

6. Demonstration that the in-house resource of a permanent field service organization is capable of providing training in the operation and maintenance of equipment as described in these Specifications.

7. Each System Supplier shall include in the application a financial prospectus indicative of the corporate financial state. The prospectus shall include:

   a. A copy of current Dunn and Bradstreet report
   b. A letter from a financial institution verifying the capability of securing a bond for this project

B. **Notification**: Each application will be examined, investigated and judged. Each applicant will be notified of his approval or disapproval for prequalification no less than 10 days prior to the bid opening data.

1.3 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. Uniform Fire Code
2. National Electrical Code

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1.	ISA RP55.1	Hardware Testing of Digital Process Computers
2.	ISA S12.4	Instrument Purging for Reduction of Hazardous Area Classification
3.	NEMA ICS6	Enclosures for Industrial Controls and Systems
4.	IEEE 802.2	Logical Link Control
5.	SAMA PMC 33.1	Electromagnetic Susceptibility of Process Control Instrumentation

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in compliance with Section 01300:

1. The System Supplier shall prepare and submit complete and organized shop drawings as indicated. Shop drawings and product data shall be submitted together in complete functional packages. Submittals not organized by functional packages will not be accepted.

2. The System Supplier shall utilize the Instrument and Input/Output Summary (I&IOS) in this Section to submit to the CONSTRUCTION MANAGER two copies of the "as-bid" I&IOS in a floppy disk format using DB3 structure within 90 days of Notice to Proceed. Subsequent data base submittals shall also be augmented with submission of a floppy disk. It is the CONSTRUCTION MANAGER's intent to utilize the floppy disk medium with IBM-AT hardware to facilitate the exchange of information and processing of submittals.

3. The hardware submittal shall include:

a. A complete set of system diagrams which depict:

All PCMs, MMIs, historians, video devices, printers, communication devices, and communication links.

All conduit and wire required to support the power and communication requirements of the system. A separate diagram shall be submitted for each DCS and SCADA component fully annotated with conduit size, number, associated wire size, wire quantity and the panel name, breaker number associated with the power source.

All requisite separation requirements between signal, power and communication conductors shall be clearly shown.

b. Definitive wiring diagrams. These diagrams shall show and identify each component of each system and shall show which components require a nominal 110-volt, 60 Hz power source. Where a voltage regulator is required, it shall be included.

c. Data sheets for each component together with a technical product brochure or bulletin. Data sheets shall show the component name, manufacturer's model number or other identifying product designation, the project tag number, the project system of which it is a part, the project site to which it applies, input and output characteristics, requirements for electric power, requirements for ambient operating conditions, and details on materials of construction.

d. Arrangement and construction drawings for all DCS and SCADA equipment cabinets, including dimensions, identification of all components, preparation and finish data, and nameplates. All drawings shall be accurately scaled and show the position of the equipment in its intended installation location. All drawings must show a scaled representation of the placement of all DCS and SCADA equipment being provided and its spatial relationship to all other equipment (both new and existing) located in the abutting and adjoining areas. All acquired access and clearance associated with the DCS and SCADA equipment and other equipment must be shown with a statement of compliance to manufacturer's recommendation. All drawings must be drawn to a [ ]-inch scale.

e. Installation, mounting and anchoring details for all components and assemblies to be field mounted, including access requirements, conduit connections or entry details. All details must be site specific.

f. Calibration, adjustment and test details for all components and systems.

g. Complete and detailed bill of material.

h. Control room layouts drawn to scale (1-inch to 1-foot, 0-inches).

4. Standard Software User Manuals: User's manuals for all standard software including all system software and process industry software packages. Manuals shall contain detailed descriptions of the standard software including the features and limitations of the software, how to use the software, and how the software interfaces with the other software. If, in order to meet the Specifications, any changes or additions to this software is required, describe in detail all proposed changes and additions. Topics covered by the user's manuals shall include:

a. Operating System: General characteristics and capabilities including memory management, task scheduling, inter-task communication, and device interface.

b. Development Software: The syntax, execution, and reference capabilities of the compiler, assembler, loader, test editor, debugger, and file management utilities.

c. Peripheral Failover Software: The device failover capabilities including failure detection, actual device failover assignments, and operator procedures or statements for manual reassignment and restoration.

d. Error Messages: Errors detected by each device driver in the system and by the operating system itself. Describe how errors are handled by the application programs and what is presented to the operator.

5 Manufacturer's literature describing the uninterruptible power supply and operational sequences under normal AC power and loss and return of AC power.

6. A block diagram for the UPS showing relationships of major components and interconnecting cable requirements.

7. Wiring diagrams for the UPS identifying factory and field installed wiring.

1.6 OWNER'S MANUAL

A. Information included in the OWNER'S MANUAL shall comply with the requirements of Section 01300 with the following exceptions:

1. The System Supplier shall submit 3 copies of all technical manuals to the CONSTRUCTION MANAGER for review prior to 60 percent completion of the Contract amount as measured by monthly progress payments. The CONSTRUCTION MANAGER shall review and return 2 copies of each submittal within 30 working days following their receipt by the CONSTRUCTION MANAGER. The system supplier shall make all revisions and additions and resubmit to the CONSTRUCTION MANAGER 5 copies of the corrected technical manuals prior to 75 percent completion of the Contract amount.

B. The following shall be included in the OWNER'S MANUAL in addition to the requirements of Section 01300:

1. Processor, peripheral, and data communications equipment instructing reference wiring diagrams and option manuals.

2. System test plans and procedures.

C. The following UPS information shall be included in the OWNER'S MANUAL in compliance with Section 01300:

1. Operation and service instructions.

2. A complete block diagram for the system.

3. A complete circuit diagram for the system.

4. A wiring designation schedule for each amplifier and all major components.

5. A replacement parts list.

6. Manufacturer's guarantee of system efficiency.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. **Delivery of Materials**: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

B. **Storage**: Products shall be carefully stored in a manner recommended by the manufacturer in an area that is protected from the deleterious effects of the elements.

1.8 SPECIAL WARRANTY REQUIREMENT

A. In case of any required repairs or other corrective or remedial work during the warranty period, the warranties on all such corrections, repairs, new equipment, or parts shall be extended for 12 months from the date of completion of any such correction, repairs, new equipment or parts. The extended warranty shall be at no additional cost to the OWNER.

1.9 ENVIRONMENTAL CONDITIONS

A. The complete monitoring and control system and associated input and output wiring will be used in a treatment facilities environment where there will be high energy AC fields, DC control pulses, and varying ground potentials between the transducers or input contact locations and the system components. The system design shall be adequate to provide proper protection against interferences from all such possible situations.

B. All non-control room components shall be suitable for operation under the following environmental conditions:

1. Temperature range: [ ] degrees through [ ] degrees F

2. Thermal shock: [ ] degrees F, per minute maximum

3. Relative humidity: [ ] through [ ] percent

C. Control centers will normally be air conditioned to achieve environmental conditions outlined above. No positive control of relative humidity is provided or contemplated. However, in the event of a failure of the air conditioning system, the entire monitoring and control system, at a relative humidity up to [ ] percent shall be capable of operating continuously with ambient temperature [ ] degrees through [ ] degrees F.

PART 2 - PRODUCTS

2.1 GENERAL

A. Where there is more than one item of similar equipment being furnished under this Contract, all such similar equipment shall be the product of a single manufacturer.

B. Equipment furnished under this Contract shall be standard products furnished by a manufacturer regularly engaged in the manufacture of such products.

2.2 DISTRIBUTED CONTROL SYSTEMS

A. DCS shall be provided for each of the following facilities:

1. North City
2. [Pomerado]
3. Mission Valley
4. Otay Valley
5. [Mission Gorge]

B. Primary hardware components of each DCS shall be:

1. Field situated process control modules which perform scanning, alarming, control and calculation functions in a stand-along manner.

2. Engineering workstations which serve as system configuration and process display and control devices.

3. [ ] colorgraphic printers for alarm documentation and screen copy functions.

4. A redundant fiber optic DCS data highway communications system which supports the maintenance of a global data base.

5. [ ] historian computer[s] for historical trends and report generation.

2.3 SCADA SYSTEM

A. Primary hardware components of the SCADA shall be:

1. [ ] workstations to perform control room, laboratory, engineering, management and administrative functions. Workstations shall be supported by [ ] laser printers.

2. [ ] clustered computer systems which will contain the global data base encompassing DCS and SCADA functions. Each computer system shall be supported by [ ] serial impact printers.

3. [ ] [redundant] [singular] ethernet communication link networking all SCADA components.

2.4 PROCESS CONTROL MODULES AND PROGRAMMABLE LOGIC CONTROLLERS

A. PCMs and PLCs situated in corrosive process environments shall be provided in NEMA [ ] enclosures with integral thermostatically controlled refrigeration units. PCMs and PLCs shall be provided with all required taps, fittings, rotameters, regulation and alarm interlocks and a purge system which is in conformance with ISA-S12.4 Type Z requirements. The PCMs and PLCs shall be complete redundancy (excluding I/O) configured to be fault tolerant. Redundant features shall include controllers, power supplies, and buses. All I/O cards shall be IEEE surge withstand qualified, conform to SAMA - PMC 33.1, have individual A/D and D/A converters on a per point basis with all inputs and outputs being optically or galvanically isolated. All I/O boards shall be removable without powering down any PCM or PLC resource. All printed circuit boards must be industrial grade and able to withstand hostile environments. All volatile memory shall be provided with [ ]-hour battery backup. Isolation transformers and other power normalization devices shall be protected against over voltage and frequency distortion characteristics.

B. PCMs shall perform the following functions:

1. Accept analog input signals [ ] mA DC and dry contact input signals. PCMs shall supply the voltage where required to drive 4-20 mA "two wire" system transmitters. All analog inputs shall have [ ] bit resolution with [ ] percent accuracy. All contact input signals shall be wetted by 110 VAC provided by the PCM.

2. Output regulatory command signals [ ] mA DC and contact output commands as required to meet interface requirements. Contact outputs shall be dry contacts rated for 110 VAC service. Interposing relays and relay enclosures shall be provided and installed by the system supplier for all contact outputs. Relay enclosures shall be installed integral to PCM enclosures.

3. Scan and process all analog and digital inputs for alarm detection and control modification at least once per second.

4. Update all analog and digital outputs at least once per second.

5. Be capable of converting analog inputs to digital.

6. Be capable of converting digital outputs to analog.

7. Scan input signals according to time intervals downloaded from the Engineering Workstation.

8. Condition, filter, and check input signals for instrument limit conditions.

9. Filter, scale and linearize the raw signal into an engineering units based measurement.

10. Originate alarm signals for high, low, and rate-of-change limits and alarm trends.

11. Communicate with the Engineering Workstation and Historian processor via two independent paths with one operating in the on-line mode and the other serving as a dynamic backup. Each PCM shall be equipped to communicate over both data communications networks either in an alternating or a dynamically switched mode.

12. Respond to interrogations from the Historian processor and Engineering Workstation for blocks of data.

13. Receive updated parameters from the Engineering Workstation for all application programs operating in the PCM.

14. Receive downloaded operating system, processing records, and point data base information from the Engineering Workstation.

15. Perform regulatory, logic and sequential control based on configuration data which was written in a high level process oriented control language, compiled, and downloaded to the PCM from the Engineering Workstation.

16. Have an extensive array of self diagnostics which test and report on the integrity of each printed circuit board in the common logic file in addition to I/O failures. Errors and failures shall be indicated locally and reported at the Engineering Workstation.

17. Process [ ] bit minimum.

18. Function as a stand-alone unit which performs all of the functions completely independent from the functioning of the Historian and Engineering Workstation. Failure of the Historian or Engineering Workstation shall not impact data acquisition, control, scaling, alarm checking, or communication functions of any PCM.

19. Monitor temperature in PCM environment. Temperature in each PCM environment shall be hardwired to I/O boards and incorporated into the display hierarchy at each facility.

C. PLCs shall conform to the following:

1. The PLC central processing unit (CPU) shall be of solid-state design. All CPU operating logic shall be contained on plug-in modules for quick replacement. Chassis wired logic is not acceptable. The controller shall be capable of operating in a hostile industrial environment with heat, electrical transients, and vibration, without fans, air conditioning, or electrical filtering. Temperatures and humidities will range up to 60 degrees C and 95 percent humidity, respectively.

2. The PLC shall be furnished with I/O modules suitable to interface with the field devices. The I/Os shall be of the analog input and output type for 4-20 mA signals and on-off input and output I/Os for 24 VDC and 120 VAC. Each PLC shall provide self diagnosis to a board or module level with a fail-safe mode and a dry contact output for remote alarming, and a local indicator on the PLC frame in the event of a fault in the PLC.

3. The central processor shall contain all the relays, timers, counters, number storage registers, shift registers, sequencers, arithmetic capability, and comparators necessary to perform the specified control functions. It shall be capable of interfacing sufficient discrete inputs, analog inputs, discrete outputs, and analog outputs to meet the indicated requirements plus 25 percent installed excess capacity. The power supply shall contain capacitors to provide for orderly shutdown in the event the incoming power does not meet specifications. If this occurs, the processor shall cease operation, forcing all outputs off. The processor shall have a key type memory protect switch to prevent unauthorized program changes.

4. The programmable controller memory shall be CMOS semi-conductor memory with battery backup or EPROM electrically alterable read-only memory. The CMOS memory shall be a minimum of 21K with battery backup to retain the program during power interruptions of up to 1 year. An indicator shall show the status of the batteries and a reference shall be available through the discrete outputs, to alarm the operator that the batteries should be changed.

   The unit shall be supplied with sufficient memory to implement the specified control functions plus a reserve capacity of 25 percent of the total provided. This reserve capacity shall be totally free from any system use. The memory shall be programmed in a multi-node configuration with multiple series or parallel contracts, counters, timers, and arithmetic functions.

5. The controller shall be programmed in "ladder diagram" language. It shall be easily reprogrammed with a Programming Unit or with an Operator or Engineering Workstation. The PLC system shall be programmed by the System Supplier to accomplish the control and monitoring functions indicated. Three documented copies of the operating program shall be furnished which will allow direct, step-by-step, reloading of the system program. Copies of this program shall be furnished in the format used in the contract diagram for conventional relay control systems. These diagrams shall employ equipment name designations used in the PLC as well as the contract diagram equipment name designations (i.e., timer "Q" in the contract drawing may become timer OL in the PLC program).

6. The power supply shall operate at the following:

    a. 120 VAC rms plus or minus 15 percent, continuously.

    b. 120 VAC rms plus or minus 30 percent, maximum 30 seconds.

    c. 120 VAC rms plus or minus 100 percent, maximum 17 milliseconds.

    d. Line spikes at 1000 VAC (5000 micro-seconds duration; 0.05 percent maximum duty cycle).

7. Input/Output Modules: All I/O housings and modules shall be rugged construction with modules in place. Sufficient input and output modules shall be provided with each programmable controller to implement the indicated control functions plus a reserve capacity of 25 percent of the total provided.

    a. Discrete Input Modules: Discrete input modules are defined as contact closure inputs from devices external to the programmable controller module. Input modules shall be shielded from short time constant noise and 60-Hz pickup. Individual inputs shall be optically isolated from low energy common mode transients to 1500 volts peak from users wiring or other I/O modules. The modules shall have LED lights to indicate a discrete input.

    b. Discrete Output Modules: Discrete output modules are defined as contact closure outputs for ON/OFF operation of devices external to the programmable controller module. The output modules shall be fused (typically 5-amp at 115 VAC) with blown fuse indicator lights. The output modules shall be optically isolated from inductively generated, normal mode and low energy, common mode transients to 1500 volts peak. All output modules shall have LED lights to indicate output has been cycled ON by the controller.

    c. Analog Input Modules: Analog input modules are defined as analog inputs or 1 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA DC signals, where an analog to digital conversion is performed and the digital result is entered into the processor. New inputs are provided every scan.

    d. Analog Output Modules: Analog output modules are defined as analog output or 1 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA DC signals, where a digital to analog conversion is performed and the analog result is produced as an output. New outputs are produced on every scan.

8. A Data Access Panel with LCD display and keypad shall be furnished to allow the operator to monitor and make changes in set point registers of internal timers and counters in the PLC. A security code or key lock is used to prevent unauthorized program logic or sequence changes. Interconnecting cables between the Data Access Panel and the PLC shall be provided.

9. All programming shall be accomplished with a CRT programmer. The programmer shall be capable of being directly plugged into the system without the requirement of additional hardware. All programming, monitoring, searching and editing shall be accomplished with the programmer. These functions shall be capable of being done both "on line" while the process is scanning or "off line."

The programmer shall display multiple series and parallel contacts, coils, timers, counters, and calculate functions. The programmer shall also be able to monitor the status of all inputs, outputs, timers, counters, and coils. It shall have the capability to disable and force all inputs, outputs, and coils to simulate system operation. It shall also indicate "power flow" through all elements and include a search function to locate any element and its program location. The processor status information, such as error indication and amount of memory remaining, shall be shown on the CRT screen.

The programmer shall be portable and of rugged construction, allowing it to be used in an industrial environment, without special protection. The System Supplier shall furnish one new programmer complete with manuals. The programmer shall be turned over to the OWNER at startup.

D. The I/O summaries at the end of this Section itemize the type and quantity of process I/O associated with each PCM or PLC.

2.5 ENGINEERING WORKSTATIONS

A. Each Engineering Workstation shall consist of [one] [two] high resolution colorgraphic Cathode Ray Tubes (CRT) and computer electronics which communicate over the data highway network. The Engineering Workstation shall permit process monitoring and operator control functions, display of operational reference data and procedures library, system configuration, system documentation, system diagnostic and security monitoring. The Engineering Workstation shall enable the downloading of the following to PCMs, historians, and other Engineering Workstations.

1. Data base configurations
2. Data acquisition parameters and scan rates
3. Control strategies
4. Alarm parameters including limits and priorities
5. Calculations required to monitor and control process
6. Graphic displays
7. Log and report formats

B. Displays shall be generated on high resolution fully solid state, [19]-inch colorgraphic monitors. Video responses shall be essentially flat to [ ] Hz and linearity shall be within [ ] percent based on picture height. All maintenance adjustment and controls shall be readily accessible by the operations personnel. Monitors shall be provided with display generation units which utilize a bit-mapped design to manipulate the individual pixel colors and status of each. All CRTs must have a minimum of [ ] pixel address resolution and an implemented display capability of at least [16] colors. The regeneration rates for the CRTs shall be above the critical frequency of fusion to avoid the perception of flicker. The contrast ratios shall be between [ ] with background levels between [ ]. Display luminances shall be between [ ]-[ ] candles per square meter (cd/m^2). Annotations may come from either the current data base or from display system storage. Each display generation unit shall be capable of writing the entire screen in [ ] second or less. All monitors shall have tilt and swivel bases.

C. Each MMI shall be a workstation platform, based on a reduced instruction set computer (RISC) with integrated mass storage devices to enable operation independent of any other system device. Each workstation shall have a [ ] compiler, [ ] operating system, floating point unit which operates at [ ] double precision floating point operations per second (DP MFLOPS), has a main memory of [ ] megabytes (MB), disk memory capacity of [ ]

gigabytes (GBlks), [ ] bit architecture, [ ] bus slots, and a graphic performance of [ ] 2-D vectors/sec and [ ] 3-D vectors/sec.

2.6 COLORGRAPHIC PRINTERS

A. [ ] colorgraphic printers shall utilize thermal ink jet technology, produce CRT graphics in a minimum of [ ] seconds in a minimum of [ ] colors, with a resolution of [ ] dots per inch.

2.7 HISTORIAN SYSTEMS

A. The DCS historian systems shall consist of [ ] [redundant] [clustered] 32 bit computer[s] complete with Winchester disks, magnetic tapes, printers, [ ] operating system, and a programmer's terminal. All hardware shall be at the current revision level.

B. Each processor shall include a minimum of [ ] general purpose registers, real time clock, floating point hardware, memory protect capability, direct memory access (DMA) channels for auxiliary memory communication, and [ ] MB of CMOS internal random access memory (RAM).

C. Winchester disks shall have a minimum unformatted size of [ ] MB with an access time of [ ] microseconds (MS).

D. Magnetic tapes shall operate at [ ] inches per second tape speed, be [ ] track phase with encoded IBM compatible format, have switch selectable recording density from [ ] bits per inch to [ ] bits per inch, feature electronic deskewing and vertical parity write and read check, and be provided with an integral operator control panel.

E. [ ] streaming tape units shall utilize serial access to acquire data and store data on standard [ ]-inch magnetic tape cartridges, each of which has [ ] MB of formatted capacity and a data transfer rate of [ ] kilobits/sec.

F. [ ] programmer[s] terminal[s] shall consist of a monitor and a keyboard. The monitor shall be [ ]-inch diagonal, have a tilt and swivel base, have a resolution of [ ] by [ ] and have [16] colors. Each keyboard shall be detachable with coil cable, two position tilt, IOS full touch keys with QWERTY layout, numerical pad, cursor control and function keys. Data transmission shall be a minimum of [ ] baud rate.

G. [ ] dot matrix line printers which produce [ ] columns at [ ] lines per minute shall be provided.

H. Ethernet fiber optic cable system complete with requisite repeaters shall be provided to link the DCS historians with the DCS PC-workstations. Communication systems shall comply with IEEE 802.2.

I. [ ] gateway communication devices shall be furnished to enable communications between the DCS data highway networks and the DCS historians. Each gateway shall be highway resident and communicate in a serial manner at a rate of [ ] Kbytes/sec.

2.8 DCS-PC-WORKSTATIONS

A. [ ] PC-XT workstations shall be provided. PC-workstations shall operate at [ ] mega Hertz, have a [16] color monitor, [graphics card], [ ] by [ ] screen resolution, [ ] MB internal

RAM, hard disk with [ ] MB capacity and [ ] MS access time, and be furnished with [ ] serial ports. PC-workstations shall be compatible with the fiber optic LAN.

2.9 LASER PRINTERS

A. [ ] laser-jet printer[s] with [ ] dpi and [ ] page/minute print speed shall be provided. All printers shall be compatible with the fiber optic LAN network.

2.10 LARGE SCREEN VIDEO PROJECTION SYSTEMS

A. [ ] Large Screen Video Projection System (LSVPS) shall be provided. Each LSVPS shall provide real time graphics linked to the DCS global data base displayed on a high resolution, high-speed large screen that is manipulated by a separate micro-computer with keyboard. The displays shall be manage by [ ] microcomputers fitted with high resolution graphic engines. Displays shall appear with a resolution of [ ] by [ ] pixels with a scanning speed of a minimum of [ ] kilo Hertz (KHz). Screen refresh shall be within [ ] seconds or less. All data accessible to the DCS shall be displayed in a [ ] inch colorgraphic format in the LSVPS. System features shall include ability to define type and character size, ability to define colors and densities, ability to zoom, horizontal and vertical scrolling and windowing.

2.11 FIBER OPTIC COMMUNICATION NETWORKS

A. The System Supplier shall provide standard high speed, fiber optic serial data highway communications networks which shall function as communication links between the Historians, Engineering Workstations, and PCMs. Communications shall be distributed between two completely redundant data communication networks, configured to preclude the possibility of a component failure or cable breakage causing the loss of data, degradation of control or reduction of operator interaction with the process.

B. The data communications networks shall conform with the following:

1. Minimum information transmission rates shall be [ ] megabaud.

2. Networks shall support a minimum of [ ] expansion of I/O and node devices without degradation of performance.

3. Networks shall have a minimum of a [ ] bit cyclic redundancy check code or equivalent.

4. Networks shall monitor total communication time used by any one device and disconnect any device when a preset time limit is exceeded.

5. Networks shall detect cable breakage.

6. Networks shall automatically replace the operating link with the redundant link upon detection of failure without loss of data or deterioration of control.

7. Networks shall be totally redundant.

8. Networks shall be based on industry standards (IEEE).

C. The System Supplier shall provide all data highway cable. The System Supplier shall review the contract documents to determine exact length requirements but in no case shall the System Supplier provide less than [ ] feet of data highway cable.

2.12 NITROGEN GAS PURGE SYSTEM

A. The System Supplier shall provide a nitrogen gas purge system to continuously purge all PCMs with nitrogen gas at the rate of [1] complete volume change per day.

B. The nitrogen gas purge system shall consist of nitrogen cylinders piped to a common manifold with individual branch circuits extending to each enclosure to be purged.

C. The manifold system shall include a discharge pressure regulator, an isolation valve and check valve for each cylinder, isolating and throttling valves on each branch, and all other necessary piping, fittings and accessories. Suitable couplings and flexible pipe sections shall be provided on each branch for quick removal and installation of individual cylinders.

D. All valves, piping, fittings, and accessories shall be 1/4-inch, 316 stainless steel.

E. Temporary rental or leasing agreements of all purge system components, including piping, enclosures, liquid nitrogen cylinders, gauges, fittings and other accessories shall not be acceptable.

F. Two cylinders, each containing the equivalent of 3600 cubic feet of nitrogen gas at atmospheric pressure shall be provided in the system.

G. Each cylinder shall deliver gas reliably and continuously without pressure fall-off.

H. Functions and Capabilities: Each cylinder shall:

1. Allow direct gas flow without auxiliary equipment.

2. Sustain discharge at required pressures.

3. Be capable of withdrawing gas directly up to [25] CFH continuous and [100] CFH intermittent with only regulator and hose (no external heat exchanger operating).

I. Each liquid nitrogen storage cylinder shall also have the following features:

1. A built-in shock absorbing system to resist rough handling and road shock during transport.

2. Self contained controls and piping protected by a stainless steel ring, welded to the top of the cylinder.

3. Valve handles with low thermal conductivity for comfortable operation by hand without the need of gloves.

4. A strong internal support system to provide added protection in all working conditions.

5. Fully insulated cylinder walls to reduce evaporative losses through the pressure relief valve.

6. A built-in automatic pressure building system to allow immediate operation after filling or pressure transfer.

7. A built-in vaporizer to provide direct gas flow without auxiliary equipment.

8. Be designed for unattended service after initial set-up without need for frequent pressure adjustments.

9. A built-in economizer circuit to reduce evaporative pressure build-up during idle time, and provide virtual no-loss operation.

10. Evaporative losses during periods of non-use (zero gas withdrawal) not to exceed 2.5 percent of capacity per day.

J. Each cylinder shall have the following:

1. Gas pressure gauge.

2. Container bursting disc.

3. Safety relief valve.

4. Manual gas vent valve.

5. Economizer regulator.

6. Pressure building regulator.

7. Manual pressure building valve.

8. Liquid level gauge.

9. Casting bursting disc.

10. Manual liquid fill and withdrawal valve.

11. Pressure building coil.

12. Vaporizer.

13. Gas withdrawal check valve.

K. Each cylinder safety relief valve shall be set at 235 psig with a normal container gas operating pressure of 125 psig. A single pressure regulator, adjustable between 0 and 3.0 psig shall be provided on the manifold gas line to maintain a desired positive pressure in each enclosure being purged.

L. The complete nitrogen purge system must be in operation prior to the installation of any PCMs.

M. The System Supplier shall be responsible for providing all required nitrogen until all of its work under this project is accepted.

2.13 SCADA SYSTEM

A. The SCADA Host Computer system shall consist of [ ] [redundant] [clustered] 32 bit computer[s] complete with Winchester disks, magnetic tapes, printers, [ ] operating system and a programmers terminal. All hardware shall be at the current revision level.

B. Each processor shall include a minimum of [ ] general purpose registers, real time clock, floating point hardware, memory protect capability DMA channels for auxiliary memory communication, and [ ] MB of CMOS internal RAM.

C. Winchester disks shall have a minimum unformatted size of [ ] MB with an access time of [ ] MS.

D. Magnetic tapes shall operate at [ ] ips tape speed, be [ ] track phase encoded IBM compatible format, have switch selectable recording density from [ ] bpi and [ ] bpi, feature electronic deskewing and vertical parity write and read check, and be provided with an integral operator control panel.

E. [ ] streaming tape units shall utilize serial access to acquire data and store data on standard [ ]-inch magnetic tape cartridges, each of which has [ ] MB of formatted capacity and a data transfer rate of [ ] kilobits/sec.

F. [ ] programmer[s] terminal[s] shall consist of a monitor and a keyboard. The monitor shall be [ ]-inch diagonal, have a tilt and swivel base, have a resolution of [ ] by [ ] and have [16] colors. Each keyboard shall be detachable with coil cable, two position tilt, IOS full touch keys with QWERTY layout, numerical pad, cursor control and function keys. Data transmission shall be a minimum of [ ] baud rate.

G. [ ] dot matrix line printers which produce [ ] columns at [ ] lpm shall be provided.

H. Ethernet fiber optic cable system complete with requisite repeaters shall be provided to link the DCS historians with the DCS PC-workstations. Communication systems shall comply with IEEE 802.2.

I. [ ] gateway communication devices shall be furnished to enable communications between the DCS data highway networks and the DCS historians. Each gateway shall be highway resident and communicate in a serial manner at a rate of [ ] Kbytes/sec.

2.14 SCADA PC-WORKSTATIONS

A. [ ] SCADA PC-XT workstations shall be provided. PC-workstations shall operate at [ ] mega Hertz, have a [16] colors monitor, [graphics card], [ ] by [ ] screen resolution, [ ] MB internal RAM, hard disk with [ ] MB capacity and [ ] MS access time, and be furnished with [ ] serial ports. PC-workstations shall be compatible with the fiber optic LAN.

2.15 SCADA PRINTERS

A. [ ] SCADA colorgraphic printers shall utilize thermal ink jet technology, produce CRT graphics in a minimum of [ ] colors, with a resolution of [ ] dpi.

B. [ ] SCADA laser-jet printer[s] with [ ] dpi and [ ] page/minute print speed shall be provided. All printers shall be compatible with the fiber optic LAN.

2.16 SCADA COMMUNICATIONS NETWORK

A. The SCADA communications networks shall link the SCADA host with SCADA workstations. The network shall be [fiber optic] [thin wire] and comply with IEEE 802.[ ].

2.17 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. [ ] distinct completely static uninterruptible AC power supplies shall be provided at:

1. [ ]
2. [ ]
3. [ ]

Each UPS shall be sized to provide for 100 percent expansion. The System Supplier shall submit the required size of external circuit breakers required for anticipated UPS inrush current and battery cable protection. Each UPS shall consist of a static inverter, rectifier charger, static transfer switch, manual bypass switch, and storage battery. The inverter, bypass switch, and static transfer switch shall be installed in a single, floor-standing NEMA 12 gasketed lockable enclosure; batteries shall be installed in separate racks.

B. **Operation**: The system shall operate as follows:

1. Normal AC Power: Critical load shall be supplied from the AC power line through the static inverter and the rectifier charger which also shall maintain the battery in fully charged "float" condition.

2. Abnormal AC Power: Critical load shall be continuously supplied from the battery through the static inverter whenever the AC line voltage dips or fails.

3. Return of Normal AC Power: The rectifier charger shall supply power from AC line to critical loads without disturbance and at the same time shall recharge battery in preparation for future AC power line failure.

4. Loss of Rectifier Charger, Battery or Inverter: The static switch shall pass critical load to normal AC power upon deviation of inverter voltage beyond preset under and over voltage limits. Sensing shall be accomplished at the input terminals of the static bypass to prevent disturbance in excess of 1/4 cycle for any failures up to these terminals. Upon restoration of normal inverter operation, the static switch shall return critical load back to inverter without disturbance. A synchronizing check shall prevent return if the inverter and line voltage are not in phase.

C. **Input/Output Rating**: The continuous output capacity of the UPS shall be sufficient to supply the computer, interface, and peripherals with regulated AC power [15] minutes from the battery only. Input shall be 115 volts plus or minus 10 percent, 60 Hertz plus or minus 1 Hertz for units rated under 5 KV. The alternate AC power supply to the UPS shall be 120 V single phase for all UPSs. Output shall be 115 volts plus or minus 2 percent, 60 Hertz plus 0.5 percent when not synchronized to line, i.e., during AC line failure. Frequency shall be synchronized to AC line during normal operation.

D. **Overload Capacity**: It shall be the responsibility of the System Supplier to supply a UPS with sufficient output capacity to supply the inrush current requirements of the COMNET system including peripherals when starting up. Automatic switchover to the AC line during high current inrush with automatic switchback to the inverter when current returns to normal

are acceptable. The inverter shall have the ability to supply [150] percent of the normal computer system requirements for [30] seconds and [125] percent of the computer system requirements continuously for [10] minutes without degradation of service life.

E. **Frequency Stability**: It shall be the responsibility of the System Supplier to supply a UPS with frequency stability matched to the requirements of the computer system. Rate of frequency change (Hz/SEC) of the UPS system during switchover shall be held to a limit which will not cause malfunction of the computer system including disk and peripherals.

F. **Protection**: Circuit breakers shall be provided on input to rectifier battery charger and to static switch, on DC output of charger and on AC input and AC output inverter. Short circuit on system output under any condition including transfer to the AC line shall not cause UPS damage.

G. **Battery Charger**: The battery charger shall be the unfiltered type, automatic, self-regulated, and self-protected; components shall be all solid state. The charger shall have sufficient capacity to simultaneously recharge the battery and supply full load direct current to the inverter; under these conditions, the charger shall be able to fully recharge the battery in [4] hours after the battery has supplied the full load for [15] minutes. The charger shall have input and output magnetic circuit breakers, silicon diode rectifiers, and SCR controls and devices to protect the unit from voltage and current surges. The charger shall be fitted with the following control devices with meters mounted on the enclosure exterior.

1. Output DC voltmeter.

2. Output DC ammeter.

3. Float charger adjustment.

4. Equalizing voltage adjustment.

5. DC low voltage alarm relay for sensing battery voltage, with contact closure, for remote alarm.

H. **Battery Cells**: The sealed battery cells shall be of the gel type. The battery shall be mounted on a step-type battery rack. Rack shall be steel framed, firmly braced and protected by two coats of acid-resistant paint. Rack and its mounting shall provide a seismic zone [4] earthquake-resistant support for the batteries where the battery rack is in excess of [1000] pounds. Battery shall have the capacity required to supply the inverter at rated capacity of [15] minutes. Battery rack shall be enclosed in metal cabinet with hinged access doors.

I. The battery shall be provided with intercell connectors, stainless steel terminals, lugs, cell lifter, lug wrenches, portable hydrometer and portable thermometer.

J. **Static Inverter**: The static inverter shall be solid state construction using modular plug-in components. Output shall be a sine wave with less than 5 percent harmonic distortion from zero output to full load. Output of inverter shall be in phase plus or minus 5 degrees of normal utility current if utility frequency is between 59.5 and 60.5 Hz. Automatic current limiting shall be provided to prevent damage to the inverter. The inverter shall have panel mounted AC output ammeter and volt-meter. Inverter shall have an AC low voltage alarm contact in parallel with the battery charger alarm contact indicated above.

K. **Static Transfer Switch**: The static transfer switch shall use thyristors to switch the load from the inverter to normal utility power upon inverter failure, and do such with zero-break providing full continuity of voltage output throughout the transfer cycle. The switch operation level shall be adjustable from 60 to 100 percent of normal voltage. Transfer back to the inverter shall be prevented for 15 seconds after utility power has returned to normal frequency and voltage parameters. The switch shall have the same overload capacity with those above to indicate the switch malfunction. The switch shall incorporate circuitry to prevent nuisance transfers while supplying loads exhibiting crest factors up to [3]. The switch shall have the following panel-mounted controls:

1. Position indicating lamps.

2. Switch to manually initiate transfer in either direction.

L. **Bypass Switch**: The bypass switch shall have overlapping contacts to permit isolation of the static transfer switch without load current interruption.

M. The UPS shall not generate noise levels exceeding 55 DB within [3] feet of the enclosure.

2.18 SOFTWARE REQUIREMENTS

A. **General**:

1. The DCS/SCADA system software shall be capable of controlling system level activities and allow the operator to monitor and control the process through an interactive human interface. The software shall allow concurrent execution of more than one program in a background, foreground or multi-tasking mode.

2. The operator interface for all process control activities shall be through the use of fully interactive software modules. Such modules shall be target oriented using easily recognized icons or custom symbols or they shall be entirely menu driven using pulldown menus. Selection choices shall be through the use of a cursor-positioning mouse and shall not require the use of an alphanumeric keyboard. The use of typed commands to move from module to module or from display to display is not acceptable.

3. Through the execution of all software modules, the operator shall be presented with all of the command or operation choices available at that point in the program using words or symbols to make the choices self-explanatory and unambiguous. Question and answer or fill-in-the-blank format shall only be accepted where file names, tag names, or other unique text or numerical information is required.

4. System software shall include a real time operating system, a calendar and time program, a file management program and a system of diagnostic routines in addition to any compilers, editors, loaders, or assemblers required to support the process control software language.

5. Changes to the system database, report formats, and display formats shall be made from the engineering or operator workstation by interactive modules and shall not require direct modification at the source code level.

6. All programs shall be self-configuring, such that they obtain the size and configuration of the system from parameters contained in the various files created during system

generation. No parameters related to the hardware configuration shall be hard coded into any of the software.

B. **System Software:** System software shall include a complete and unmodified operating system furnished by the System Supplier that enables the indicated system functions. Operating system software shall function fully automatically without operator intervention, except as required to establish file names and similar information.

1. Operating System Software: The operating system software shall be the standard uncorrupted product of the central computer manufacturer and shall support the following functions:

    a. Response to a program request or an operator demand.

    b. Dynamic allocation of main memory usage, computation time, peripheral usage, and I/O channel usage in the system.

    c. Allotment of system resources on the basis of task priority levels such that a logical allocation of resources and suitable response times are assured.

    d. Queuing of requests in order of priority if one or more requested resources are unavailable.

    e. Resolution of contending requests for the same resource based on priority.

    f. Servicing requests for execution of one program by another.

    g. Transferring data between programs as requested.

    h. Management of all information transfers to and from peripheral devices.

    i. Control and recovery from all program fault conditions.

    j. Diagnosing and reporting real-time hardware device errors.

2. Software Execution: Program execution shall be based on a multilevel priority interrupt structure. A program interrupted by a higher priority program shall be entered into a list of pending programs and its execution shall be resumed once it becomes the currently highest priority program. Initiation of programs shall be activated by all of the following:

    a. In response to external interrupts.

    b. At a scheduled time of the day.

    c. On an elapsed time interval basis.

    d. On request by another program.

    e. On request from the operator interface.

The system shall allow periodic programs to be scheduled. The allocation of resources to a time scheduled program shall be based on its relative priority and the availability of computer system resources.

3. System Startup and Restart:

   a. Software shall initialize and bring a computer or any microprocessor based hardware unit from an inactive condition to a state of operational readiness.

   b. Initialization shall include determining computer system status prior to initializing operating system software and initializing application software. Initialization shall also include the loading of all memory resident software, initializing timers, counters, and queues, and initializing all dynamic database values.

   c. No less frequently than every 15 minutes the system shall save on disk a complete copy of all main memory resident data base and system parameters required to completely characterize the current status of the computer system hardware and software. In the event that a system restart is required, a special Restart program shall be activated to read these data and initialize the main memory resident parameters. The Restart program shall use a battery operated real-time clock to automatically set the time and date. The Restart program shall also perform any other "housekeeping" functions required to restore the system to normal operation.

4. System Shutdown: The software shall initiate orderly shutdowns for equipment failure, including computer processor failure, primary power failure, or a manually entered shutdown command. When a loss of primary power is sensed, a high- priority hardware interrupt shall initiate software for an immediate, orderly shutdown. When a shutdown occurs in response to a command or malfunction, the software shall bring the affected hardware quickly and automatically to a secure state.

5. System Failover: The software system shall support fully automatic failover to redundant hardware for all indicated systems.

   During normal operation, two hardware units shall be in an operational state with one unit in the primary mode performing all on-line and real-time functions and the other unit operating in a backup mode. The backup unit may be performing parallel off-line functions. Periodic checkpointing or other methods shall be utilized to ensure that files used by the backup processor are current. When a malfunction of the primary unit is detected, an orderly transfer of function shall take place from the failed unit to the backup unit. Operator intervention shall not be required. Neither unit shall be favored as primary.

   After restoration of the failed processor, retransfer to the restored unit shall not be required.

6. Diagnostics: The software shall contain diagnostic programs to detect and isolate hardware problems and assist maintenance personnel in discovering the causes for system failures. The system manufacturer's standard diagnostic routines shall be used as much as possible. Diagnostic software and test programs shall be included for each indicated component in the system.

Diagnostic routines shall test for power supply, central processing unit, memory, and I/O bus failures

7. Alarm Handling:

a. Diagnostic alarms shall result from hardware and software errors detected by online diagnostics which might affect operation of the software.

b. The alarm handling sequence shall be:

When an alarm condition has been detected, log an alarm message on the system printer, display the alarm message on the alarm window of each operator display screen and actuate an audible alarm at the operator display screen.

Continue the audible alarm until the alarm condition is acknowledged by an entry from the operator display screen.

When an alarm is acknowledged log an Alarm Acknowledge message on the system printer.

When an alarm condition clears, log a "Clear" message on the system printer.

2.19 NAMEPLATES, TOOLS, SPARE PARTS

A. **Tools**: The System Supplier shall furnish all tools and test equipment required to repair and calibrate the COMNET hardware and maintain it in good operating condition. The test equipment shall include signal generating and signal tracing equipment.

B. **Spare Parts**: The System Supplier shall provide the following spare parts:

1. [ ] of each type of input/output board
2. [ ] of each type of power supply
3. [ ] box of ribbon for each printer
4. [ ] floppy disks if used in system
5. [ ] spare extension boards or modules for each type provided

PART 3 - EXECUTION

3.1 GENERAL

A. **Installation**: All work, including calibration, testing, adjustment, and maintenance shall be done by the System Supplier's qualified, experienced personnel who are technically skilled in their trades, are thoroughly instructed, and are competently supervised. The resulting completed hardware installation shall reflect professional quality work, employing the highest industrial standards and methods.

3.2 FACTORY TESTING

A. The complete system, including all equipment, peripheral devices and interconnecting cables shall be assembled at the factory and shall be completely tested under simulated operating conditions using completely operational programs. Field I/O shall be simulated into the PCMs. PCM function compliance shall be demonstrated. All

PCM data shall be conveyed to workstation screens for display/control functions. All data shall be transmitted to the historian and host to verify functionality.

B. The following ISA-RP 55.1 test procedures shall be used, as applicable, to ascertain compliance with requirements of these Specifications.

1. Section 3: in its entirety
2. Section 4: applicable portions
3. Section 5: in its entirety
4. Section 6: in its entirety
5. Section 7: in its entirety
6. Section 8: in its entirety
7. Glossary - CMR test configuration
8. Glossary - NMR test configuration
9. Glossary - Noise measurement configuration
10. Appendix A - Analog Input Subsystem Accuracy

C. All test documentation and results shall comply with ISA-RP55.1 Type 2 and Type 3 documentation.

D. The system supplier shall submit a detailed factory test plan to the CONSTRUCTION MANAGER at least 45 days in advance of commencement of the factory test. The CONSTRUCTION MANAGER shall be notified at least 30 days in advance of any factory tests. The CONSTRUCTION MANAGER and the OWNER (at the option of either) reserve the right to observe.

E. Before testing, each item of equipment shall be fully factory inspected, calibrated and tested for function, operation and continuity of circuits as applicable.

F. The system supplier shall carry out a 100-hour full system test during which the entire system shall operate continuously without failure, all in accordance with the indicated requirements. If a system component fails during the test, the 100-hour test period shall be restarted after its operation is restored. In the event that the system does not function as required, it shall be modified at the factory to meet the requirements and shall be retested without additional cost to the OWNER.

G. After successful completion of the factory test, four certified copies of all test results shall be furnished to the CONSTRUCTION MANAGER together with a clear and unequivocal statement that all factory test requirements have been met. The CONSTRUCTION MANAGER will give written notice of the acceptability of the factory tests within 30 days of receipt of the factory test results.

3.3 INSTRUCTION

A. **General**: The System Supplier shall train the OWNER'S personnel on the operation and maintenance of hardware and software provided.

B. All tuition costs shall be included in the System Supplier's bid.

C. None of the courses shall overlap in material or in schedule. Courses shall be scheduled in series so that individuals can attend multiple courses.

D. Training courses shall be scheduled a minimum of [ ] days in advance of when they are to be given.

E. Training shall be performed by authorized representatives of the equipment manufacturer and shall be specific to the equipment provided. Instructors shall have at least 2 years of training experience.

F. Within 60 days of receipt of Notice to Proceed, the system supplier shall submit a training plan which contains, as a minimum, course outlines and schedules for training to be provided at the system supplier's facilities.

G. Proposed training material, including resumes for the proposed instructors and a detailed outline of each lesson, shall be submitted to the CONSTRUCTION MANAGER at least 30 days in advance of when the lesson is to be given. The CONSTRUCTION MANAGER shall review the submitted data for suitability and furnish comments which shall be incorporated into the course.

H. All training materials shall be of text book quality, fully integrated and annotated with graphics and be bound in 3-ring binders, bearing the project name and course content.

I. **Preparatory Training at System Supplier's Facility**: A series of preparatory training courses will be conducted at the system suppliers facility prior to factory testing. A [ ] day hardware familiarization course shall be conducted for [ ] persons each. The course content shall include a description of all major hardware components utilized in the system.

3.4 INSTRUMENT AND I/O SUMMARY

A. **General**: The Instrument and I/O Summary (I&IOS) contained herein itemizes the I/O associated with the hardware provided under this Contract.

B. Each column on the I&IOS is defined as follows:

1. Tag Number: The identifier assigned to a device which performs a function in the control system. The System Supplier shall use the identifier in tagging devices in the field.

2. Loop Title: The name of the control loop in which the device functions.

3. Description: A process-oriented functional assignment made to a device which puts the device in the context of the loop in which it functions.

4. P&ID Dwg: The Process and Instrumentation drawing upon which the device appears.

5. Spec. No.: The number of the Specification Section which describes the device.

6. I/O Type: The itemization of input or output by type.

7. Control Panel No.: The designation of the control panel with which the device is associated.

8. Panel Face Dwg. No.: The instrumentation drawing upon which the control panel face is shown.

9. CSI No.: The designation of the Computer System Interface Cabinet associated with the control panel.

10. Install. Detail: The designation of the detail indicating how the device shall be installed.

11. Mech. Dwg.: The mechanical drawing upon which the device appears.

12. Elect. Dwg.: The electrical drawing upon which the device appears.

13. Remarks: A "scratch pad" area which may contain information relating to the device.

C. [ ] pages I&IOS follow this Section

** END OF SECTION **

INSTRUMENT AND I/O SUMMARY

Tag No.	Loop Title	Description	P&ID Dwg.	Spec. No.	I/O Type	Control Panel No.	Panel Face Dwg. No.	CSI No.	Install. Detail	Mech. Dwg.	Elect. Dwg.	Remarks
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

I/O Total: DI = [ ] DO = [ ] AI = [ ] AO = [ ]