SECTION 13400 - DISTRIBUTED CONTROL SYSTEM (DCS)

City of San Diego, CWP Guidelines

PART 1

GENERAL

1.1 WORK OF THIS SECTION

A. The CONTROL SYSTEM PROVIDER (CSP) shall furnish all equipment and provide all needed engineering to accomplish the functional and technical requirements of these contract documents including, but not limited to, project management, design assistance, coordination with on-site area Contractors, detailed system design and integration, conducting graphic development meetings, equipment supply, shipment, storage, job site delivery, programming and configuration, installation oversight, training, calibration, testing, startup, and maintenance. This specification is generic to all Facilities. See Addendums for requirements for specific Facilities. The CSP shall be Westinghouse Process Control Division (WPCD) and the DCS shall be Westinghouse WDPF II.

B. It is the intent of these specifications to assign to the CSP responsibility for system design, installation, testing, configuration, and implementation of a microprocessor-based distributed control system that is offered as a standard system by a nationally recognized manufacturer who is regularly engaged in the manufacture of microprocessor-based distributed control systems (DCS). To ensure that the DCS can be quickly staged, delivered, and configured as a standard system, the entire DCS including peripherals, termination enclosures, field-situated microprocessor-based control modules, operator and engineer interface devices, communication networks, communication processors, and all software must be provided by a CSP who offers all of the above components in their standard product-line in a standard configuration.

C. The CSP shall be responsible for oversight of installation and termination of power and ground utilities for all DCS equipment. The CSP shall review all contract documents to assess space allocations, power allotments and available grounds. If the CSP's power, grounding or spatial requirements differ from that shown within the contract documents, the CSP shall include in the bid price all engineering, design and construction costs associated with the implementation of all of the CSP's power, grounding and spatial requirements.

D. It is the intent of these specifications to have the CSP singularly responsible for the procurement, supply, delivery, installation, implementation and future support of all DCS equipment (i.e., hardware and software). In order to preserve this focused responsibility, the CSP shall be:

1. The manufacturer of the DCS hardware being proposed for this project or offer the hardware in their standard product line.

2. The originator of all data acquisition and control software.

3. The integrator of all Workstation (WS) and communication software.

4. The programmer and integrator of all DCS functions.

5. The source of all DCS documentation.

E. The CSP shall be responsible for providing all equipment, engineering, and services associated with integrating all of the instrumentation and Control devices, and special systems (Fire Detection, Energy Management, and control valve data links), into the DCS in a transparent and seamless manner.

F. The Owner's personnel and representatives shall actively oversee the implementation of all DCS work. It is the intent of these specifications to elevate the Department personnel's DCS familiarity and skill level to such a point wherein, with due time, the Department will be able to perform many if not all DCS configuration functions. This synergy between the staff of the Department and the CSP will be promoted by requiring the CSP to perform all project management, hardware integration, submittal preparation, configuration, training, testing, training, maintenance and warranty work at the Department Headquarters. This synergy between the staff of the CITY and the CSP will be promoted by requiring the CSP to perform hardware integration, configuration, training, system testing, and maintenance/warranty work on-site at the COMC Building using CSP personnel which have been relocated to the COMC Building for the duration of the associated tasks. It is understood that the staff will expand to meet various milestones utilizing CSP personnel which are also relocated to the COMC Building to perform contract work. Adequate office space and system staging areas will be allocated to the CSP by the Department.

G. As a minimum, the CSP shall assume full responsibility for the following:

1. Implementation of the DCS:

a. Provide all engineering, resources, and equipment, required to:

(1) Design and submit DCS hardware, software, and spare part submittals.

(2) Design and submit DCS training submittal for training to be conducted at the Department Headquarters and at the Project Site.

(3) Conduct user meetings at the Department Headquarters dedicated to the development of graphic criteria and design of graphic screens.

(4) Submit all required graphic criteria and graphic design submittals.

(5) Procure all hardware and software required to conform to these specifications.

(6) Program, configure, and integrate all software into hardware platforms as required to conform to these specifications.

(7) Prepare all required classroom training materials and conduct all training at the Department Headquarters and at the Project Site.

(8) Perform an Operational Readiness Test (ORT) at the Department Headquarters to verify conformance of the DCS to these specifications.

2. Integration of the DCS with the facility:

a. Provide all engineering, resources, equipment and labor required to:

(1) Attend project review meetings held at the project site, as required by Section 01039, "Coordination and Meetings".

(2) Respond to installation questions relating to the powering, signal termination grounding, environmental requirements and cable requirements of the DCS.

(3) Review all loop drawings generated for all control and instrumentation devices associated with each facility and verify system compatibilities.

(4) Oversee the installation of all equipment specified in these Contract Documents to be installed by others.

(5) Oversee termination of all power and ground conductors performed by others at CSP furnished equipment.

(6) Furnish, oversee installation, and test DCS communications cable (Process Information Network, Facility Information Network, Department Information Network).

(7) Oversee the performance of on-site loop and commissioning tests by others.

(8) Conduct a 90-day DCS performance test.

(9) Update and submit all documentation and previous submittals to reflect "as-built" or record conditions.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 09800 Protective Coating

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

3. Underwriters Laboratory (UL)

B. Where the requirements set forth in the Contract Documents are greater or more rigid than the mandatory requirements referenced herein the applicable portions of the Contract Documents shall govern.

C. In the case of conflict between any mandatory requirements and the Contract Documents, the mandatory requirement shall be followed in each case, but only after submitting such proposed changes to the CONSTRUCTION MANAGER for approval.

D. Nothing contained in the Contract Documents shall be so construed to conflict with any national state, municipal, or local laws or regulations governing the installation of Work specified herein, and all such acts, ordinance, and regulations, including the National Electrical Code, are hereby incorporated and made a part of the Contract Documents. All such requirements shall be satisfied by the CSP at no additional expense to the OWNER.

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-S5.1 Instrument Symbols and Identification

2. ISA-S5.4 Instrument Loop Diagrams

3. ISA-S12.4 Instrument Purging for Reduction of Hazardous Area Classification

4. ISO 9001 Quality systems - Model for Quality Assurance in Design/Development, Production, Installation and Servicing

5. SAMA Scientific Apparatus Makers Association (SAMA) SAMA-PMC-33.1

6. IEEE 812 Standard Definitions of Terms Relating to Fiber Optics

1.5 SHOP DRAWINGS AND SAMPLES

A. It is incumbent upon the CSP to coordinate the work specified in these Sections with on-site area Contractors so that a complete DCS for the entire project will be provided and the installation is supported by accurate shop drawings and record drawings. The CSP shall prepare and submit complete and organized shop drawings, as specified herein. Incomplete or partial submittals are not acceptable. All shop drawings and record drawings shall be submitted in hard and electronic copy. All drawing shall be developed in a CAD environment which utilities INTERGRAPH CAD software.

B Plant-wide loop drawing submittal (PLDS) to verify the DCS interfaces with all instrumentation and devices being provided or installed under this project are to be generated by the Area Construction Contractor (ACC). The PLDS shall also define all interfaces with equipment provided by the CSP. All conflicts between device and DCS requirements shall be immediately brought to the CONSTRUCTION MANAGER's attention. The loop drawing shall be composed of three sections:

1. Page 1: A device shedule with a table showing the following

   a. Device tag number, with Prefix, Unit Process, ISA Tag Prefix, Tag No. and Tag suffix
   b. Equ ipment Service
   c. Device Type
   d. Location
   e. Device Manufacturer
   f. Model No.
   g. Spec. No.
   h. Area Contractor (if applicable
   i. Submittal No.
   j. Remarks
   k. Data Sheet No.
   l. I/O Signal (AI, AO, DI, or DO)
   m. Signal Level
   n. Device Range
   o. Engineering Units
   p. Process Set Point
   q. Loop Diagram No.
   r. Loop Drawing File Name
   s. Interconnect Drawing File Name

2. Page 2: Loop drawing meeting the Requirements of ANSI/ISA S5.4, except that intermediate terminal junction boxes may omitted and be shown on Page 3 for clarity.
3. Page 3: Abbreviated diagram showing instrument, wire and cable numbers, intermediate terminal junction boxes, and PCM terminations.

C. The CSP shall augment the content of the PLDS by providing all of the requisite data relating to the DCS. For each DCS input/output, the CSP shall note on the PLDS the following information:

1. PCM number, and physical location.

2. Type of input.

3. I/O card location and address.

4. All DCS-dependent displayed functions using ISA symbology.

5. Drawing reference for DCS software content.

D. During the period of preparation of these submittal, the CSP shall maintain a direct, informal liaison with the CONSTRUCTION MANAGER for exchange of technical information. As a result of this liaison, certain minor refinements and revisions in the system as specified may be authorized informally by the CONSTRUCTION MANAGER, but these shall not alter the scope of work or cause increase or decrease in the contract price. During this informal exchange, no oral statement by the CONSTRUCTION MANAGER shall be construed to give formal approval of any component or method, nor shall any statement be construed to grant formal exception to, or variation from these Contract Documents.

E. In these Contract Documents all systems, all meters, all instruments, and all other elements are represented schematically, and are designated by symbology as derived from Instrument Society of America Standard ISA S5.1 (latest revision). The nomenclature and numbers designated herein and on the Drawings shall be employed exclusively throughout shop drawings, and similar materials. Any other symbols, designations, and nomenclature unique to any manufacturer's standard methods shall not replace those prescribed above, used herein, and on the Drawings.

F. All shop drawings shall include the letter head and/or title block of the CSP. The title block shall include, as a minimum, the CSP's registered business name and address, project name, drawing name, revision level, and personnel responsible for the content of the drawing. The quantity of submittal sets required shall be as specified in Section 01300, "Contractor Submittal".

G. The DCS hardware submittal (DCSHS) shall be a singular all inclusive submittal which shall include, but not be limited to:

1. A complete set of system diagrams which depict:

   a. All Process Control Modules (PCMs), Workstations (WSs), Historian System (HS) devices, video devices, printers, UPS, telemetry devices, communication devices, and communication links.

   b. All conduit and wire required to support the power, ground, Input/Output, and communication requirements of the system. A separate diagram shall be submitted for each DCS component fully annotated with conduit size, number, associated with the power source. All conduit and wire numbers shall be consistent with the numbering system shown in these Contract Documents.

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

2. Comprehensive power diagrams which 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.

3. Technical data sheets for each component together with a technical projects brochure or bulletin which show:

ions, identification of all components, preparation and finish data, nameplates, and the like. 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 equipment being provided under this contract and its spatial relationship to all other equipment (both new and existing) located in the abutting and adjoining areas. All acquired access and clearances associated with the DCS equipment and other equipment must be shown with a statement of compliance to manufacturers recommendation, NEC and other applicable codes. All drawings must be drawn to a 1/2-inch = 1 foot scale.

5. 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.

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

7. Complete and detailed bill of material.

8. Calculations shall be submitted to verify each network's optical power budget. Calculations shall include the PMD being used, transmitter output power level (dbm), receiver input power level (dbm), losses generated by splices, connectors, and repeaters. The resulting calculations shall represent the allowable end-to-end optical link budgets for use in designing the network.

9. The hardware submittal copies shall be numbered, with controlled distribution. Updates for the DCS Hardware submittal shall be issued whenever the hardware configuration or equipment supplied changes as a result of change orders, requests for substitution or any other procedure. Updates shall be clearly marked as to the pages to be removed and replaced. Updates shall be issued to all holders of controlled distribution copies.

I. The DCS Software Submittal (DCSSS) shall be included in a singular all inclusive submittal which shall include but not be limited to:

1. A complete set of all available software algorithms.

2. A complete set of control strategies which depict all monitoring and control functions on a loop by loop basis, in a modified SAMA-type format.

3. An English narrative of each data acquisition or control loop mission and anticipated action. Narratives shall enumerate the signal point name, signal descriptor, associated PCM number, associated system template displays, system functions activated by signal (i.e., interlocks, alarms, logs, etc.).

4. A complete set of module configuration sheets depicting each loop linkage. Each loop shall be on its own 8 1/2" x 11" sheet.

5. A complete listing of the DCS data base listing for each data points relevant parameters such as range, contact orientation, limits, incremental limits, I/O card type, I/O hardware address and assignment.

6. Detailed descriptions of procedures used to implement and modify control strategies and data base construction.

7. The software submittal copies shall be numbered, with controlled distribution. Updates for the DCS Software submittal shall be issued periodically or upon major software configuration changes occur as a result of change orders, requests for substitution or any other procedure. Updates shall be clearly marked as to the pages to be removed and replaced. Updates shall be issued to all holders of controlled distribution copies.

K. The DCS Graphic Submittal (DCSGS) shall reflect the results of process graphics meetings held for the facility. These meetings shall be chaired by the CSP and attended by a user group participants and the CONSTRUCTION MANAGER. The DCSGS copies shall be numbered, with controlled distribution. Updates for the DCSGS shall be issued after each meeting or upon major graphics configuration changes. Updates shall be clearly marked as to the pages to be removed and replaced. Updates shall be issued to all holders of controlled distribution copies.

Subsequent to the successful review of the CSP shall submit for each facility:

1. One complete set of all WS accessible displays which are unique to this project (i.e., process global, system global, process regional, systems regional, process group, process loop, process component, integrated tutorials, integrated process tutorials, integrated documentation, user assistance). These displays shall be in full size color graphic format and replicate the proposed screen contents. All background colors shall be identical to that of the screen content. All displays shall be arranged in a hierarchial order with references to associated WSs.

2. A system display linkage diagram which defines the hierarchial order and the linkages via page, down, left, right commands.

3. A definition of each displays data fields by tag numbers.

4. A definition of each displays dynamic elements which shall blink, change color, rotate or change shape in response to process changes.

5. A listing of all "help" text associated with each display screen.

6. The software submittal copies shall be numbered, with controlled distribution. Updates for the DCS Software submittal shall be issued periodically or upon major software configuration changes occur as a result of change orders, requests for substitution or any other procedure. Updates shall be clearly marked as to the pages to be removed and replaced. Updates shall be issued to all holders of controlled distribution copies.

L. The CSP shall submit the procedures proposed to be followed during the tests required under this project. Procedures shall include statement indicating test objectives, test descriptions, forms, and checklists to be used to control and document the required tests. Prior to the preparation of the detailed test procedures, the CSP shall submit outlines of the specific proposed tests. Submittal shall include examples of the proposed forms and checklists. Once the Preliminary Test Procedure Submittal have been reviewed by the CONSTRUCTION MANAGER and returned stamped either "no exceptions noted" or "make corrections noted", the CSP shall submit the proposed detailed test procedures, forms, and checklists. Once the detailed Test Procedures Submittal have been reviewed by the CONSTRUCTION MANAGER and returned stamped either "no exceptions noted" or "make corrections noted", the tests may be scheduled. Upon completion of each required test, document the test by submitting a copy of the signed-off test procedures shall be submitted as test documentation. These requirements shall apply to the factory testing of all panels, and all on-site tests.

M. Subsequent to the receipt of the OWNER's and CONSTRUCTION MANAGER's inputs made at the pre-submittal conference, the CSP shall submit a training plan to cover all training required under this contract. All material shall be in compliance with the requirements of paragraph 3.8. The training shall include:

1. A resubmittal of the material submitted under the proposed training plan with the incorporation of all modifications agreed to at the pre-submittal conference.

2. Schedule of training courses including dates, durations, and locations of each class.

3. Resumes of the instructors who will actually implement the plan.

1.6 OWNERS MANUAL

A. The organization of the preceding shop drawing submittal shall be compatible to eventual inclusion with the Operations & Maintenance Manual submittals for this facility and shall include final alterations reflecting "record" conditions. Submittal not organized as described herein and incomplete submittals for a given Loop shall not be accepted. Accordingly, the initial multiple-copy shop drawing submittal shall be separately bound in a standard size, 3-ring, looseleaf, vinyl plastic, hard cover, binder suitable for bookshelf storage. Binder ring size shall not exceed 3-inches. 5 final sets of technical manuals shall be supplied for the OWNER in accordance with Section 01300, "Contractor Submittal", and one final set shall be supplied for the CONSTRUCTION MANAGER, as a condition of acceptance of the project.

1. Initially, 2 sets of these manuals shall be submitted to the CONSTRUCTION MANAGER for review after return of favorably reviewed shop drawings and data required herein. Following the CONSTRUCTION MANAGER's review, one set will be returned to the CSP with comments. The sets shall be revised and/or amended as required and the requisite final sets shall be submitted to the CONSTRUCTION MANAGER 15 days prior to start-up of systems. The CONSTRUCTION MANAGER will distribute the copies.

2. In addition to updated shop drawing information reflecting actual existing conditions, each set of technical manuals shall include installation, connection, operation, troubleshooting, maintenance and overhaul instructions in complete detail. This shall provide the OWNER with comprehensive information on all systems and all components to enable operation, service, maintenance and repair. Exploded or other detailed views of instruments, assemblies and accessory components shall be included together with complete parts lists and ordering instructions.

3. Repair parts list for each item (as applicable); such lists shall contain the name of each item, purchase order number, model/serial number, and the recommended repair parts to stock, along with the catalog, part, or piece number of each such repair part.

4. Outline dimensional drawings and assembly drawings and the names of the parts.

5. Copies of maintenance specifications, schedules, and instructions.

6. Copies of operation and adjustment instructions for all equipment and components.

7. Processor, peripheral, and data communications equipment instruction, reference, wiring, and option manuals.

8. Software manuals and program source and object listings, annotated in clear English, technically correct flow charts, narrative descriptions, diagnostics, and user's guides. Permanent copies of all programs on magnetic tape/CD shall be provided for the OWNER's use. Software documentation shall include full instructions on how a program is used, including execution procedures and system software dependency.

9. System test plans and procedures.

10. Simple, English language instructions on how to operate the system through the Workstation (WS).

11. All Operations and Maintenance materials, including shop drawings and the CSP’s standard DCS manuals and documentation, shall also be submitted in an electronic format. This material shall be resident in the FIN file server associated with the specific facility for which the operation and maintenance manual has been prepared, i.e., the FS-HQ will not be required to store the material. In addition, this material shall support the functionality of the Operations and Maintenance Manual features associated with the Process Control Training

Simulator specified in Section 13450. All text files shall be in both the latest revision level of Wordperfect and in HTML. Electronic data shall be submitted on 3-1/2 floppy disks and on CD mediums.

1.7 AS-BUILT DRAWINGS

A. As-built drawings shall be prepared in accordance with Section 01300 with the following exceptions and changes:

1. The CONTRACTOR shall keep current an approved set of complete DCS loop drawings, PIDs, control descriptions, Input/Output termination lists, control schematics, DCS installation drawings, UPS installation drawings, network conduit and cable routing drawings, and test reports. These drawings shall include all devices furnished under this specification and interfaces with all other devices furnished under this specification and interfaces with all other devices which communicate with the DCS.

2. One set of original drawings and two copies of each as-built drawing under this Section shall be submitted to the CONSTRUCTION MANAGER after completion of field checkout, but before placing the systems in service for the OWNER'S use.

1.8 SERVICES OF MANUFACTURER

A. The CSP shall provide job site visits and services of a manufacturer's technical field representatives for all equipment which is furnished by others. Job site visits shall occur during the calibration, testing and start-up phase of the project.

B. The CSP shall provide the services of competent field technicians to oversee the installation, testing, calibration, start-up, operation and maintenance of the equipment provided under this Section.

C. Provide all necessary assistance to instruct the OWNER's representative in regard to the operation of the equipment supplied. This assistance shall be provided during the start-up phase of the project and the first year of the facility operation following project completion and OWNER acceptance.

1.9 GUARANTEE

A. The CSP shall guarantee the WORK of this section and all applicable Sections in conformance with the requirements of Section 00800-Supplementary General Conditions.

1.10 PRODUCT DELIVERY, STORAGE AND HANDLING

A. After the successful completion the Operational Readiness Testing, and subsequent to the site construction progressing to a point where the intended locations for DCS equipment are complete and free from exposure to on-going construction, all equipment, cabinets, panels, and consoles

a. The component name as used on project drawings and in these specifications.

b. Manufacturer's model number or other identifying product designation.

c. The project tag number.

d. The project system of which it is a part of.

e. The project site to which it applies.

f. Input and output characteristics.

g. Requirements for electric power.

h. Specifications for ambient operating condition.

i. Details on materials of construction for those components to be field mounted.

4. Site-specific arrangement and construction drawings for all DCS equipment cabinets, including dimens shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

B. Special instructions for proper field handling, storage, and installation required by the manufacturer for proper protection, shall be securely attached to each piece of equipment prior to packaging and shipment.

C. Each component shall be tagged to identify its location, tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment under this Section. Identification shall be prominently displayed on the outside of the package.

D. Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged,such damage shall be repaired by the CSP at their own cost and expense. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through such test such as directed by the CONSTRUCTION MANAGER. This shall be at the cost and expense of the CSP, or the apparatus shall be replaced by the CSP at their own expense.

1.11 QUALITY ASSURANCE

A. The CSP shall have instituted a quality assurance program which utilizes organized methodologies and industry standards. All manufacturing, design, development, production, installation, and field service resources of the CSP shall be certified as conforming with all of the requirements of international quality standard ISO 9001. The certification shall be submitted to the CONSTRUCTION MANAGER. This certification shall be a "Certification of Quality", from an internationally recognized certification agency. The program shall include the following aspects at a minimum:

1. System of traceability of manufactured unit and system software throughout development, production and testing.

2. System of "burn-in" for all components and available supportive documents.

3. Demonstrated record of prompt positive response to field failures.

4. Record of prompt shipments in accordance with contract obligations.

5. Documented program of failure analysis.

6. Quality assurance organization which complies with ISO 9001 guidelines.

7. Documented product safety policy relevant to all products intended to be furnished under this Contract.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Current Technology:** All hardware and software shall be the most recent field-proven models and revision levels marketed by their manufacturers at the time of proposal submission. It is the intent of the Department to obtain a DCS which utilizes state-of-the-art products in the CSP's product line, such as RISC-based devices. Products within the CSP's product line which have been superseded by newer, more advanced devices shall not be acceptable.

B. **Hardware and Software Commonality:** Where there is more than one item of similar equipment, being furnished under this contract, all such equipment shall be the product of a single manufacturer and feature the interchangeability of parts. All equipment shall be of modular design to facilitate interchangeability of parts and to assure ease of servicing. This interchangeability shall apply to the following components, as a minimum, of the DCS.

1. Processor Modules
2. Bulk Memory Modules
3. Communication Interface Modules
4. Analog and Discrete Signal Modules
5. Power Supply Modules

C. **Fault Tolerant:** Where a system processor is indicated to be redundant, that unit shall function as a fault tolerant device. Fault tolerant processing shall consist of two parallel-operation processors (electronics) with separate connections to the system communication network. Both processors shall receive and process information simultaneously, with faults detected by the processors themselves. A fault tolerant configuration shall provide synchronous read/execute/compare capabilities with no database transfer. Upon detection of a fault, self-diagnostics shall be run by both processors to determine which processor is defective. The non-defective processor shall then assume communication without affecting normal system operation. Upon replacement of the defective processor, the operator shall initiate the processor and the system shall automatically download the data base to the replaced processor and assume communications via the network without affecting normal system operation. The use of backup, "hot standby", or "automatic switch over" configurations are acceptable if the transition from failed device to backup device does not degrade the process monitoring and control system or the system's availability.

D. **Environmental Suitability:** All DCS devices provided under this contract shall be provided with enclosures which are suitable for use in a treatment facility environment where there are typically high energy AC fields, DC control pulses, and varying ground potentials between the transducers or process instrument locations and those occupied by DCS components. The system design shall be adequate to provide proper protection against interferences from all such possible situations. As a minimum, all DCS equipment shall be resistive to airborne contaminants commonly found in wastewater treatment facilities, and be suitable for installation in an environment which conforms to a G2 classification as defined by ISA-S71.04.

1. **Field-Situated Equipment**: DCS equipment being furnished under this contract shall be suitable for use in wastewater treatment facilities, some of which are in an environment of salt-sea ladened air with traces of methane and hydrogen sulfide. The system design shall be adequate to provide proper protection against such an environment. All DCS devices shall be housed in an enclosure suitable for its intended service and installation location. All DCS devices to be installed in MCC or other protected areas shall be furnished in NEMA 1 rated enclosures. All DCS devices to be installed in indoor unprotected areas shall be furnished in NEMA 12 rated enclosures. All DCS devices to be installed in indoor areas subject to hose-down conditions, or outdoor areas, shall be furnished in NEMA 4X rated enclosures. All DCS devices to be installed in areas where corrosive agents are present in quantities which exceed the warranty limits of the equipment (Headworks, Digesters, Solids Handling, etc) shall be furnished in purged, refrigerated/ air scrubbed NEMA 4X rated enclosures. As a minimum, the DCS shall be designed and constructed for satisfactory, long, and low maintenance operation under the following environmental conditions;

   a. Temperature Range: 0 through 50 degrees C (32 through 122 degrees F)

   b. Thermal Shock: 0.55 degrees C (1 degree F per minute maximum)

   c. Relative Humidity: 5 through 95 percent (non-condensing)

2. **Control Room-Situated Equipment**: Each Area control room or central control room will be normally air conditioned to maintain environmental conditions defined herein. No positive control of relative humidity is provided or contemplated. However, in the event of a failure of the air-conditioning system, the entire DCS shall be capable of operating continuously and satisfactorily for a period of up to twelve (12) hours with ambient temperatures of 15 through 35 degrees C (59 through 95 degrees F) and a relative humidity of 95 percent (non-condensing).

3. **Noise Tolerance:** The CSP shall furnish and install sound adsorption materials within/over (i.e., printer covers) DCS equipment enclosures to be installed in those area control centers where DCS devices share work space with personnel to ensure that, with only the DCS equipment operating, the ambient dB level is 55 dB or less when monitored three (3) feet from the operating DCS equipment. All DCS equipment to be located in the Facility control room, the COMC Building training room, and COMC control room shall have their electronics remotely located so that the DCS devices do not impose any additional noise on the rooms ambient noise level. The CSP shall furnish all remotely located electronics in office-type enclosures and furnish all required cables between the control room/training room areas and the remote electronics.

4. **Environmental Operating Range:** All indoor and outdoor enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Control Documents. Heating, cooling, and dehumidifying devices shall be incorporated in order to maintain all devices 20% below their rated environmental operating ranges. The CSP shall furnish all internal power wiring for these devices (i.e., heaters, fans, etc.). Enclosures suitable for the environment shall be furnished. All instrumentation in hazardous areas shall be suitable for use in the particular hazardous/classified location in which it is to be installed, and be in conformance with the National Electrical Code (NEC).

5. **Surge and Radio Interference:** All DCS devices shall be IEEE surge withstand qualified. radio Frequency Protection (RFI) shall conform to SAMA-PMC-33.1.

6. Each PCM shall be provided with a temperature switch which reports to the control room temperature excursions associated with PCM enclosures. For those enclosures which utilize purging, sensors shall be provided which report to the control room to high temperature, low pressure, and "door ajar" conditions. All I/O and sensors associated with enclosure monitoring is to be furnished by the CSP.

E. **Equipment Locations:** The DCS configurations indicated are diagrammatic. The locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the OWNER exercises the right to require changes in location of equipment which do not impact material quantities or cause material rework, the CSP shall make such changes without extra cost to the OWNER.

F. **Alternative Equipment and Methods:** Equipment or methods requiring redesign of any project details are not acceptable without prior written approval of the CONSTRUCTION MANAGER. Any changes inherent to a proposed alternative, including design modifications, shall be at no additional cost to the OWNER or CONSTRUCTION MANAGER. The required approval shall be obtained by the CSP prior to submittal of shop drawings and data. Any proposal for approval of alternative equipment or methods shall include evidence of improved performance, operational advantage and maintenance enhancement over the equipment or method specified, or shall include evidence that a specified component is not available.

G. **DCS Project Growth**: All equipment furnished under this contract will be provided with not only the resources required to meet the function requirements of this project but in addition, all equipment and resources including PCMs; I/O cards; graphic displays; data base; reporting packages; RAM, disks, processor cycle time and memory, etc., shall be provided to accommodate a [20] percent growth in project requirements. All equipment and resources, including but not limited to all costs associated with equipment procurement, equipment testing, system documentation, project management, system engineering, modification to documentation, etc, shall be provided under this contract such that the entire twenty (20) percent project growth can be implemented into the DCS without any additional cost to the OWNER. The 20 percent spare I/O point requirement shall be calculated by rounding calculations down when fractional points are less than 0.5 and rounding up to the nearest integer when fractional points are equal to or exceed 0.5

H. **DCS Ultimate Project Growth**: In addition to and over-and-above the requirements of paragraph 2.1 G, the entire DCS being furnished under this contract shall be capable of being modularly expanded to accommodate a 100 percent increase in process I/O points, process report/display requirements and manual input requirements. All equipment and resources provided under this contract shall be able to be modularly accept the anticipated future expansion without the need to replace or retire any DCS component or resource. The DCS provided shall be able to incorporate the ultimate system growth without any degradation of monitoring, control, or display response times. As a minimum, all DCS devices shall be sized to accept the DCS ultimate growth (current requirements multiplied by 2.2).

I. **Uninterruptible Power Systems:** All DCS components and instrumentation panels shall be powered form utility and UPS. Section 16611 defines the requirements for UPS associated with instrumentation panels only. UPS shall be furnished for DCS components in conformance with the requirements of Section 16611. All UPS for the DCS shall be sized by the CSP to furnish a minimum ride-through time of 30 minutes. In those instances where the UPS for the instrumentation panels and the DCS are proximal to each other, the CSP shall furnish a common UPS and provide all conduit and wire required to accommodate this arrangement. The CSP shall also furnish all wire, conduit, and I/O boards to enable the DCS to monitor the following functions associated with all instrumentation and DCS UPS;

1. Normal Mode
2. Emergency Mode
3. Bypass Mode

4. Low Battery
5. Trouble
6. Alarm

J. **PRIMARY SYSTEM COMPONENTS:** The DCS shall consist of the following primary components;

1. **Process Control Modules (PCMs)**: PCMs shall be directly hardwired to process I/O, intelligent transmitters, and Programmable Logic Controllers (PLCs). All PCMs shall be fault tolerant. PCMs shall receive power from dedicated UPS or, in the event of a failure to the UPS, from the supply power to the UPS. Each PCMs shall contain all of the required data acquisition, alarming and control strategies required to monitor and control its associated process. PCMs shall be configured by operator interface devices called Workstations (WS) which utilize object-oriented interactive editors to download database and control configurations over the Process Information Network (PIN). The failure of any other DCS device shall not affect the monitoring and control capabilities of the PCMs. PCMs shall dual ported to communicate with other DCS devices over the Process Information Network (PIN). For additional PCM requirements, see paragraph 2.2.

2. **Process Inputs/ Outputs (I/O):** All process I/O shall be terminated in an enclosure which is proximal or integral with the PCM that is associated with the I/O. All I/O modules shall be IEEE surge withstand qualified with individual A/D and D/A converters on a per-point basis. If the CSP's analog input/analog output I/O boards do not provide A/D and D/A conversion on a per-point basis, or adequate signal isolation, the CSP shall;

   a. furnish spare analog input/analog output or AD/DA boards to conform to the per-point requirement (i.e. if a board has 8 inputs which share an A/D, seven spare analog input boards or seven spare A/D converter boards shall be furnished.

   b. partition I/O so that the failure of an I/O board will not disable a control strategy. If the implementation of this partitioning results in the need to provide additional analog input/analog output boards, they shall be furnished by the CSP at no additional cost to the Owner.

   c. furnish and install signal isolators on the field side termination assembly of the PCM on a per-point basis.

   d. For additional requirements, see paragraph 2.3.

   e. All I/O shall be optically or galvanically isolated.

   f. Process I/O shall accept the following variations:

      (1) Analog Inputs To DCS

(a) Four (4) wire transmitters shall provide an isolated 4 to 20 mA signal.

(b) Two (2) wire transmitters shall provide an isolated 4 to 20 mA signal powered from the dc power supplies internal or external to the DCS.

(c) The DCS shall have a fixed input load of 250 ohms. Provision shall be made to ensure continuity of the loop independent of the DCS equipment status.

(2) Analog Outputs From DCS

(a) Outputs shall be isolated 4 to 20 mA dc signals powered from the DCS.

(b) Signal shall be capable of driving a loop impedance of six hundred (600) ohms maximum.

(3) Discrete Inputs To DCS

(a) Inputs shall be unpowered, isolated contact closures rated at 1A at 24 V dc. Contacts shall be of nobel metal or hermetically sealed.

(b) The DCS shall monitor the inputs using internal 24V dc power supplies.

(c) Field contacts for alarms will be wired to discrete inputs in a “fail-safe” mode; i.e. an open wire will result in an alarm.

(4) Discrete Outputs From DCS

(a) Outputs shall be unpowered, isolated contacts rated at 5 amps, 120V ac.

(b) 120V ac power for sensing all discrete outputs shall be provided external to the DCS.

(5) Intelligent Transmitter Interface To DCS

(a) Intelligent transmitters shall communicate with the DCS using a bi-directional communication interface.

(b) The DCS interface shall enable remote transmitter configuration and simultaneous DCS database updating from a DCS workstation (WS).

(6) Programmable Logic Controller (PLC) Interface With DCS

(a) The instrumentation panels to be provide under Section 13300 shall be provided with PLC controllers and membrane LED displays in lieu of the specified relays and window-box annunciators.

(b) PLCs shall communicate with the DCS using serial communication cables furnished and installed by others.

(c) The DCS PLC interface shall be capable of performing remote PLC configuration from the WS.

3. **Workstations (WS)**: WS devices shall be dual ported to the PIN to provide the operations staff with an object oriented advanced Graphical User Interface (GUI)used to monitor and intervene in the control of process areas. The sharing of electronics between any type of workstation device (i.e., WSs, PCWSs) is not permitted. Each workstation device shall be stand-alone. All non-DOS workstation devices (WSs, PCWSs) shall be able to run DOS applications. Each WS shall be X-WINDOW compliant and serve as a device which shall have all the utilities required to perform network management and system configuration functions (i.e. database, control strategies, process graphics, report formats, trends, x-y plots, alarm reports, etc). WS devices shall also be ported to the Facility Information Network (FIN) which provides;

   a. An interface into all FIN connected devices.

   b. Communicate with the Department Information Network (DIN) through a communications server to support WS information requests and to service requests from other DIN/FIN connected devices. This interconnectivity shall enable all WS, independent of their physical locations, to access all information which is available to another WS. All WS functionality shall be regulated by password authorization. Each WS shall interface with the various networks using the X-Window facility provided at each WS. For additional WS requirements, see paragraph 2.5.

4. **Process Information Network (PIN)**: The PIN shall consist of communications processors and fiber optic cables all of shall be dual ported into all connected DCS devices. The PIN, in its installed configuration shall be fault tolerant. The PIN provides connectivity between the WSs, PCMs, and the Historian System (HS) to enable the timely update and archiving of process information and timely control response. For additional PIN requirements, see paragraph 2.4.

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NTS: Specify the Redundant HS for major facilities, the non-redundant WS resident system for Pumping Stations.

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5. **Redundant Historian System (HS):** The HS shall consist of a fault tolerant processor, each with mass storage modules, data management and reporting software, and peripheral devices needed to support and maintain the HS. The HS shall be dual ported into the PIN in a fault tolerant manner. Additionally, the HS shall be ported into the FIN to provide connectivity with FIN devices. For additional HS requirements, see paragraph 2.8.

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NTS: Specify this non-redundant WS resident system for Pumping Stations.

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6. **Non-Redundant Historian System (HS)**: The HS shall consist of a single processor, with mass storage modules, data management and reporting software, and peripheral devices needed to support and maintain the HS. The HS shall be ported into the PIN. Additionally, the HS shall be ported into the FIN to provide connectivity with FIN devices. For additional HS requirements, see paragraph 2.8. For additional HS requirements, see paragraph 2.8.

7. **Facility Information Network (FIN)**: The FIN shall provide connectivity between the DCS and plant facility management systems. The FIN shall specifically have connectivity to WS and HS devices using X-Window facilities. For additional FIN requirements, see paragraph 2.4.

8. **Department Information Network (DIN)**: The DIN shall provide connectivity between the all Department facilities and resources by virtue of a network which incorporates high-speed fiber, telephone data links and radio technology. For additional DIN requirements, see paragraph 2.4.

2.2 PROCESS CONTROL MODULES

A. **General**: The PCM shall be a 32 bit microprocessor with on-board random access memory (RAM) for read/write functions. The PCM, in conjunction with field Input/Output (I/O) modules shall perform all system data acquisition, alarm detection, regulatory, logic, timing and sequential process control. PCMs shall perform continuous control, sequential control, and data acquisition concurrently in the same microprocessor. PCMs shall communicate with the Historian System (HS), Workstations (WS) over the Process Information Network (PIN). All PCMs shall be fault tolerant and be provided with the implemented built-in capability to provide continued correct execution in the presence of the failure of a common logic board or software faults. Failover from one processor to another shall occur within 1000 ms**.** Each PCM shall be supplied to provide complete redundancy (excluding I/O) configured for fault tolerant processing via standard system configuration procedures. Fault tolerant features shall each include, but not be limited to, control processors, power supplies, wiring and buses. PCM's shall be remotely configurable from WSs over the PIN.

B. **Communications:** PCM's shall communicate with each other directly in a peer-to-peer manner using peer protocol or logical link protocol in which the sequence of message exchanges between two entities in the same layer is facilitated by utilizing the services of underlying layers to effect the successful transfer of data/control information from one location to another location. It is the City's intent to integrate HVAC data into the DCS database using data communication interface with major HVAC vendors. The CSP shall include in their bid, all development, testing, training and documentation costs associated with the implementation of software drivers which communicate with RS-232 C networks offered by HVAC manufacturers Trane and Carrier. The RS-232 C port shall be located at each PCM and WS.

C. **PCM Functionality:** Independent of the operation or failure of any other DCS device, the PCM shall perform the following core or essential functions;

1. Real-time data acquisition at scan rates specified at the WSs.

2. Perform input signal smoothing, averaging, or totalization, as required.

3. Alarm limit checking for absolute limits, deviation rates, or warning limits on designated variables.

4. Real-time process control based on logic and control strategies downloaded from the WSs to the PCM's over the PIN.

5. Communicate variable data information (i.e., current value, alarm status, set point, output control constants, etc.) to the HS and WSs.

6. Communicate with all other system processors regardless of their function without the need for hardware or software gateways. Respond to interrogations for data and receive downloaded operating system, processing records, point data base information and updated parameters for application programs operating in the PCM.

7. Perform regulatory, logic and sequential control based on configuration data written in a high level process oriented control language, compiled, and downloaded to the PCM.

8. 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/or failures shall be indicated locally by Light Emitting Diode (LED) and reported at the WSs and printers.

9. The PCM shall function as a stand-alone unit which performs all of the functions described herein completely independent from the functioning of the HS device, WSs, the PIN, bridges, routers or other PCMs, i.e., a failure. Any device furnished under this section or other PCM(s) shall not impact data acquisition, control, scaling, alarm checking, or communication functions of a given PCM.

D. **PCM Hardware Component Platform**: Each PCMs hardware platform shall have a shared memory multi-processor variant of a von Neumann architecture. The PCM shall be based on the utilization of multiple Central Processing Units (CPUs) each with its own bus connection, consisting of the following components:

1. **Control Processing Unit**: The control processing unit (CPU) shall be a CISC- complex Instruction Set Computer or a RISC-Reduced Instruction Set Computer which utilizes CMOS

(i.e., complementary metal oxide semiconductor) technology and consists of a control unit (CU) and a arithmetic-logic unit (ALU). The CPU shall conform to the following:

a. 32 BIT processor, minimum 16 MZ cycle time.

b. Floating point processor.

c. Crystal controlled real time clock.

d. Power fail/auto restart.

e. Watch dog timer protection.

f. Isolated power supplies.

g. Serial interface to process I/O.

h. Ability to handle priority interrupts.

2. **Memory**: CPU memory shall be on-board and shall conform to the following:

a. CMOS shared RAM memory with battery backup. Subsequent to the configuration of all database and control strategies which incorporate the current I/O quantities plus the 20 percent growth required under 2.1 G, each PCM shall have 25 percent of (1) its memory which is dedicated to the storage of database and control strategies and (2) field I/O termination points unused with both resources available for future expansion. Requirements for spare memory capacity may be, on approval by the Engineer, applied on a Facility basis.

b. Cache memory which is positioned between the CPU and the bus which maintains a copy of referenced data from the shared memory.

c. CMOS-ROM in which firmware and the operating system resides.

E. An itemization of PCMs required for the Facility is located in the Appendix and defines the current I/O allocations associated with each device. These totals do not include spare I/O points and spare resources as defined in paragraph 2.1 of this section.

2.3 PROCESS INPUTS/OUTPUTS (I/O)

A. General: Process I/O boards shall rack mounted in an enclosure which is proximal or integral to/with the associated PCM. All process I/O boards shall be slot independent i.e. any I/O card can occupy any card slot. The backplane of the I/O nest shall permit the removal of I/O cards without the need to remove power from the I/O card being removed. All process I/O channels shall be electrically isolated (input isolated, output isolated, and power isolated) from field terminations and adjacent channels as defined in ISA-S50.1.

B. All I/O boards shall conform to SAMA-PMC33.1 ,and IEEE 472.

C. I/O boards shall provide 120 dB and 80 60dB common mode and normal mode noise rejection respectively. Process I/O boards shall have an on-board isolation of 500 DCV pr peak ac between channels.

D. Analog input boards or modules shall be provided to interface with process I/O and intelligent transmitters as follows;

1. Analog input boards shall be provided to accept 4-20 mA, pulse frequency, and thermocouple (Type K,T,J,R,S) inputs. Through board level jumper selection on a point-by-point basis, the analog input channel can act as either source for two wire transmitters) or sink (four wire transmitters). Each analog input shall have a minimum of 12-bit resolution, accuracy of 0.025 percent, and a dedicated A/D converter.

2. Intelligent transmitter modules(ITMs) which allows receiving continuous self-diagnostic data shall be provided. The reading of transmitter data or value shall not disturb or interfere with the reading of the measurement signal.

a. Intelligent process instrumentation shall be directly connected to the DCS through a bi-directional digital communication interface at the PCM. Analog transmission of variables from intelligent transmitters shall not be acceptable.

b. Each ITM shall contain a minimum of six (6)individual channels, each of which provides isolated power and communication to the intelligent device. All digital communication with the intelligent process instrumentation from the DCS WS shall be in engineering units and shall be received a minimum of ten (10) times per second. Each message shall contain the following;

(1) Primary measurement information such as flow, pressure, level, etc.

(2) Transmitter temperature readings in a 32 bit floating point format which complies with IEEE.

(3) Data security information

(4) Diagnostic information

(5) Message checking

c. Information, which shall be displayable at any DCS WS, shall include;

(1) The assignment of configurable parameters such as tag number, location,address, tag name, designation of digital or 4 to 20 mA output, upper and lower ran values, zero elevation or suppression, linear or square root output for d/p cells, and damping time.

(2) Perform a loop integrity check.

(3) Rearrange without using calibrating input pressure.

(4) Display the 4 to 20 mA signal in terms of percent of span, or engineering units.

(5) Last calibration date.

(6) Fail-safe direction.

(7) Read process variables in user selected engineering units.

(8) Diagnose problems and determine fault between processor or transmitter.

d. All ITMs shall be slot independent. ITM operation shall not be impacted in the event that one of a pair of fault tolerant PCM processor fails.

e. The transmitter bus provided shall be easily upgradeable to ISA SP50, or ISP (InterOperable Systems Project) standards by a simple chip replacement which can be accomplished in the field. All hardware, software, documentation, and field labor costs associated with this upgrade shall be included under this project.

f. In addition to ISA SP 50 and ISP conformity, all ITM devices shall be furnished to communicate with devices which use the HART protocol.

E. Analog output boards shall be provided to output 4-20 mA commands. Each analog output shall have a minimum of 12-bit resolution, accuracy of 0.025 percent, and a dedicated D/A converter.

F. Discrete input boards shall be of the voltage monitoring type and shall be powered by the PCM. The discrete input board shall accept 24 V dc.

G. Discrete output boards shall be unpowered isolated contacts rated for 5 amps at 120 V ac.

H. PLCs shall be interface to the DCS through a foreign processor interface (FPI) which is defined as follows;

1. The DCS shall be provided with an integrated fault tolerant foreign processor interface (FPI) with PLCs which permits the monitoring and configuration of PLCs from the DCS WS without the need for drivers or custom interface devices.

2. The DCS shall have an open architecture which shall enable the FPI to provide a means of integration of with multiple vendors in a manner which is transparent to the user at the WS level. All of the data associated with the FPI shall appear at the WS as being identical in format and presentation to data derived from PCMs. All WS interaction functions that the operator uses to monitor and control inputs/outputs associated with the PLC(s) shall be identical as those used by the operator to interact with inputs / outputs associated with the PCM(s).

3. The FPI shall be provided to interface with all PLCs which provide inputs/outputs to the DCS.

4. The FPI shall support the following functions;

   a. Peer-to-peer communications between all PLCs and the PCMs.

   b. The monitoring and display of all PLC diagnostics which at the WS. The diagnostics displayed and executed shall represent the full offering available from the PLC manufacturer.

   c. The configuration of ladder logic, regulatory controls, and PLC images at the WS.

   d. The downloading of all PLC configurations, ladder logic, regulatory controls, and PLC images from the WS to the PLC via the PIN.

   e. The ability to have closely-coupled continuous and sequential control strategies which involve PCM and PLC coordination.

   f. Seamless service and support for the integrated system.

5. All self-documentation features which relate to DCS devices shall also related to the documentation of PLC configurations. All documentation produced shall be in like format as that for all other DCS components.

6. The FPI shall support field situated industrial workstations which are "slaved" to the PLC.

7. As an alternative to the above, if the FPI utilizes custom software drivers to communicate with various manufacturers PLCs/PLC networks, the CSP shall include all costs associated with providing, licensing, documenting, and revising these software drivers throughout the duration of this contract. If a software driver is used at more than one location, the CSP shall furnish the additional software driver(s) at no additional cost. A minimum of one (1) set of hardware and all required software shall be furnished to interface with each of the following PLCs and PLC communications networks;

2.4 COMMUNICATION SYSTEMS

A. **General:** Data communication subsystems shall be comprised of industrial grade redundant communication buses that provide high speed data transmission between all distributed processors and I/O modules. Each communication network shall be designed around the International Standards Organization's Open System Interconnection (OSI) model, IEEE 802 industry standards and support a hierarchical communications network. Communications shall be masterless with communications residing in each distributed processor. All communication cables shall be installed in conduits. The CSP shall review the contract drawings to review the current communications system design. The CSP shall furnish all cable required to accommodate the communications system being provided. If the CPS's PIN does not have lower level protocols which conform to IEEE 802. 3/4, the CSP shall provide every software driver which is currently available in their product line, or which is made available during the duration of this contract, to maximize the multivendor aspects of their product offering. All costs associated with the licensing, implementation, testing, training and documentation of the drivers for the duration of this contract shall be borne by the CSP.

B. **Low-Level Protocols**: Physical and data link layer protocols shall support local area networks (LANs), metropolitan area networks or wide area networks (WANs). Information shall be conveyed in packets with a sustained signaling rate of 2 million bits per second. Carrier Sense, Multiple Access Protocol with Collision Detection (CSMA/CD) shall be used to enforce decentralized control of the shared bus.

C. **Mid-Level Protocols**: Network and transport layer protocols shall provide addressing and routing facilities to enable a host on one network to send a block of information to host located on another network thereby expanding a hosts communication environment from a single network to a network of networks, or an ethernet, joining addressable hosts. Mid-level protocols shall support the implementation of half-gateways i.e., LAN - backbone coupling and full gateways i.e., LAN-LAN couplings. Node-node gateways shall perform protocol translation and if necessary implement virtual circuits where required. For those applications which access the network layer directly, a programming interface shall be implemented in the packet network to facilitate the use of datagrams i.e., blocks of information embedded within single packets which can be sent to individual hosts without using additional protocol software.

D. **High-Level Protocols**: The Session, Presentation, and Application Layers shall use the transport mechanism provided by the Mid-Level Protocols to implement a distributed computational environment. Session Layer services shall augment the virtual circuit facilities present at the Transport Layer. The Presentation Layer shall regulate the representation of data items conveyed across the network.

E. **Process Information Network (PIN)**: The CSP shall furnish and oversee the installation of a Process Information Network (PIN) which shall connect all DCS and information system devices in a manner which creates an environment in which applications on distinct devices shall accomplish work cooperatively by sharing information as well as synchronizing the operation of the two applications of a common task. The PIN shall be the CSP's standard and most secure offering for a process control network, and shall be based on a star or "chain of stars" physical topology. The PIN shall conform to the following;

1. Each DCS and information system device shall be furnished with a PIN communication device, complete with detailed device command algorithms encoded as processor instructions, to manage the device/controller interface.

2. The PIN shall be able to support the system response times stated in paragraph 2.5 with a database sized in conformance with 2.1 H (i.e. 220% of the current database).

3. It is anticipated that a minimum information throughput speed of 2 million bits per second is required.

4. The PIN shall utilize redundant fiber optic cables between structures. Within structures, coaxial cable may be used, provided that levels of induced electrical noise do not interfere with data transmission. The cables shall be furnished by the CSP and installed by others.

5. The CSP shall review the contract documents to determine exact length requirements and to compare the tensile strength associated with the cable to be provided with the handhole/pullbox spacing indicated in the contract documents. If additional handholes/pullboxes are needed to accommodate the characteristics of the CSP's cable, they shall be furnished by the CSP at no expense to the OWNER. The PIN shall utilize a medium which as a minimum conforms to the following:

    a. Industrial grade, water resistant optic fiber, coated with a suitable material to preserve the intrinsic strength of the glass, suitable for installation in conduits which are encased/directly buried/ cable trays.

    b. Cable of all dielectric construction.

    c. Multi-mode, graded index, solid glass waveguides with the following characteristics:

Nominal core diameter	62.5 microns
Minimum ellipicity	2.0 percent
Outside clad diameter	125.0 microns
Maximum Numerical Aperture (NA)	0.275
Maximum attenuation (850)	3.75 dB/Km
Maximum attenuation (1,300)	1.5 dB/Km

    d. Each fiber continuous with no factory splicer.

    e. Tight buffer.

    f. FDDI compatible and meets the requirements of ANSI X3T9.5 for FDDI cable.

    g. Drop cables shall be of variable lengths of flexible fiber optic cable, typically not to exceed 400 feet so that loss in the drop cable is less than 1 dB. This length of drop cable shall permit relative freedom in routing the trunk cable and locating the station.

F. **Facility Information Network (FIN)**: The intent of these contract documents is to conceptually describe the desired level of functionality and key criteria associated with the FIN.

1. **FIN CONCEPTS:** The FIN shall connect all WSs associated with the facility with multiple file servers which will run various future applications. The FIN shall provide connectivity betwee n the DCS and plant facility management systems. The FIN shall specifically have connectivity to WS and HS devices. Each WS shall interact with (i.e. monitor and manipulate data) resources associated with the FIN. The HS shall provide a DCS historical resource for the FIN connected devices to support FIN applications. All FIN resources and applications, including those implemented under this contract and future applications, shall all be accessible and manipulatable from the WS in a manner that is identical to any terminal directly connected to the FIN while the WS is using X-WINDOW utilities. The FIN shall have access to the current DCS database, all WS display graphics, and the DCS historical database. Any PCWS device connected to the FIN shall have monitoring and display capabilities equivalent to that of the WSs. The FIN shall be switched Ethernet.

2. **FIN Design Criteria:** The FIN shall be designed to empower the plant staff with the freedom to select different third-party applications which run on varying hardware and software platforms. The FIN shall comply with IEEE 802.3 for 10 BaseT Ethernet. Within a building, the FIN configuration shall provide a dedicated 10 Mbps Ethernet 10BaseT port to each device on the FIN, using switched Ethernet. Switching shall use the fragment-free or store-and-forward method. Stackable switching hubs, provided with UPS power, shall provide support for SNMP management, and for multiple MAC addresses. External to a building, backbone connections to the switching hubs shall be 100 Mbps FDDI or Fast Ethernet. All FIN WSs and PCWSs shall be provided with 10/100 network interface cards. The FIN to be designed and furnished by the CSP shall conform to the following;

    a. Machine Independent

    b. Operating system independent

    c. Network independent

    d. Transport protocol independent

    e. Accommodate multiple servers

    f. Accommodate 75 nodes

3. **FIN Applications to be Incorporated under this Contract::** The CSP shall provide a FIN which effectively efficiently integrates the following FIN applications. The following resources shall be provided, and shall be accessible and manipulatable from the WS in a manner that is identical to any terminal directly connected to the FIN while the WS is using X-WINDOW utilities;

a. **Computerized Maintenance Management System (MMS):** The MMS shall provide predictive and corrective maintenance management capabilities. The WS shall be able to access all maintenance management data, receive reports and work orders, and input data to the MMS in a manner identical to that of any other FIN connected device.

b. **Laboratory Information Management System (LIMS)**: The LIMS shall provide sample logging, reporting, calculation and data validation utilities. The WS shall be able to access all LIMS data and be able to input manual data into LIMS in a manner identical to that of any other LIMS connected monitoring or input device. Additionally, the LIMS information shall actively support process graphics, tutorials, and other WS functions.

c. **Management Information System (MIS) Web Server:** The MIS Web Server shall provide overview reports, process analysis, statistical process control (SPC), and E-Mail utilities. The WS shall be able to transparently utilize SPC data to initiate operator initiated control changes.

d. **Electronic Operations and Maintenance Manuals (EOMMs):** The EOMMS shall provide scanned images of manufacturers technical manuals and data sheets, specific customized operations and maintenance procedures for both processes and process equipment, tutorials, Intergraph-based CAD images of all drawings associated with the facility interactive instructional video to support prescribed O&M activities. All documents except Intergraph CAD images will be in HTML format accessed using a standard World Wide Web Browser (Netscape Navigator or equal) and stored on the MIS Web server.

e. **Drawing View and Markup**: The drawing view and markup package shall provided the ability to load, view, and redline Intergraph drawings from any WS

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NTS: The Document Retrieval System Web Server is for major facilities, such as treatment plants, only.

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f. **Document Retrieval System (DRS) Web Server**: The CSP shall integrate a Document Retrieval System based on an Intranet Web Server onto the FIN. The FIN shall be furnished with a file server (FFS) which shall be installed in the Process Computer Room. The DRS shall meet the requirements of Section 2.33.

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NTS: End of the Document Retrieval System Web Server specification.

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4. **FIN Cable To Be Incorporated Under This Contract:** The CSP shall furnish all FIN cable for installation by others. The CSP shall provide a complete FIN design and shall oversee the installation. FIN cable shall conform to the cable specified for the PIN, and when routed through the process areas, shall use the same conduits as the PIN. In the operations building, the FIN cable shall be routed to a patch panel which shall be provided under this contract. The patch panel shall be located in the telephone room. From the patch panel, the FIN shall be extended to the various office sites as indicated on the electrical drawings. From the patch panel, the FIN shall be extended to the various office sites (as shown on the contract electrical drawings of the Reference Documents) **FIN Applications to be Incorporated under this Contract:**using 4-pair solid conductor #24 AWG cable wired in conformance with AT&T 258 A cabling specifications. The untwisted pair (UTP) cable shall not be run in conduits that carry el ectrical cable and shall not be run near fluorescent lights or large electromagnetic machinery. Teflon sheaths shall be used for plenum installations. All closet connections and wall plates shall be clearly labeled for easy identification of origin and end node. UTP shall be AT&T DIW 24/4 EIA/TIA 568 Category 5, or equal. Under this contract is envisioned that the PIN and FIN be different strands within the same bundle of fiber. The CSP shall allocate one spare strand for every strand used for PIN and FIN application.

5. **FIN Testing**: The capability of FIN devices to extract data from the PIN and compile this data into Excel spreadsheets shall be tested. The capability of WSs and other FIN devices to use the Wordperfect and Microsoft Windows resources shall be tested.

G. **Department Information Network (DIN):** The intent of these contract documents is to conceptually describe the desired level of functionality and key criteria associated with the DIN.

1. **DIN CONCEPTS:** Initially, the DIN shall interconnect with the FINs and PINs associated with North City Water Reclamation Plant (NCWRP), Fiesta Island Replacement Project/Northern Sludge Processing facility (MBC/NSPF) and the Point Loma Wastewater Treatment Plant (PLWTP). This interconnection shall utilize a multistranded fiber optic FDDI data communication link between all facilities. In the near future, various Department facilities such as pump stations and metering stations will transmit data via radio/telephone telemetry to the DIN or to facilities which are connected to the DIN. The DIN shall be designed to provide connectivity between all the Department facilities and resources by virtue of a network which incorporates high-speed fiber, telephone data links and radio technology, all used to convey and integrate the transmission of voice, data and video mediums. A WS at any facility shall be identical to and have the same access to all process displays and FIN data. The DIN shall be serviced by a Facility DIN file server (FDS) which shall be located at the Facility. The FDS shall have interconnectivity with all PINs and FINs to support its database and report generation functions. However, due to the critical need to support information needs, decisions made on DIN processors and device locations shall be consistent with the design of a highly reliable and flexible network. The DIN shall be designed so that the failure of any one device shall not disable or impair DIN functionality beyond the functionality associated with the failed device. All critical devices shall be redundant. The DIN shall interface with a Department Headquarters FIN which is described herein.

Additionally, the DIN shall interface with a LAN at the Department Headquarters which in turn shall be ported to the following devices;

FDS shall provide long term storage, trending, report generation, and file server functions. File server functionality shall conform to the network management, network security and X-Window requirements specified herein. The hardware requirements for the FDS shall be determined by the CSP with sufficient resources being provided to meet the functional requirements of these specifications. However, as a minimum, the FDS shall conform to the requirements of paragraph 2.6 with the following variation;

a. The bulk memory devices associated with the FDS shall be provided with adequate historical resources to permit the on-line storage (i.e. does not require loading CDs or other shelved storage mediums) of a minimum of two (2) years of previous Department reports with an additional 25% spare bulk storage capacity. See paragraph 2.1 for additional expansion requirements.

b. Bulk memory shall be augmented with CD facilities which shall receive data from the hard drive buffers to provide long term on-line storage.

c. WORM drive facilities shall be provided to archieve report data. The WORM drive resources shall be adequate to retain the previous two (2) years of the facilities reports. These will function as a backup copy to the disks image of reports.

d. Communication servers, bridges, hubs or routers which enable communication with other DIN connected devices.

2. **DIN Design Criteria:** The DIN shall provide a service backbone network for the Department. At the COMC WSs located in the Department Headquarters, the Department shall have the capability of the following;

a. Dynamically view any WS process display screen associated with the selected facility connected to the DIN.

b. View all displays associated every facilities' FIN resources. This shall include dynamically linking into MMS, MIS, LIMS, etc data associated with the selected facility.

c. View current and historical associated with both the PIN and FIN resources at any facility.

d. Receive, in a dynamic manner, all high priority alarms associated with any facility. All alarms shall go to the alarm printer.

e. Generate overview process reports based on data extracted from each plants historical database. It is anticipated that a total of 30 pages of process reports, with 20 variables per page, will be required for each facility connected or node. The system shall be designed to accommodate 100 nodes.

f. Generate overview reports based on data extracted from each plants FIN database. It is anticipated that a total of 30 pages of management / maintenance / laboratory / process data, with 20 variables per page, will be required for each facility or node, shall be generated on a daily, weekly, monthly and annual basis.

H. **Mobile Information Network (MIN):** The MIN shall support informational/control requests between the operator and the DCS when the operator is not at a WS location. All information and control functions shall require the validation of the operators password and security authorization. The MIN shall be based on wireless technology. Key components of the MIN shall include portable telephones, laptop computers, and network based communications processors (CPs).

1. Portable Laptop Computer Interface (PLCI): The operators PLCI shall enable the user to access DCS displays when the operator is remote from a WS area. The PLCI shall work in conjunction with a portable telephone to provide the operator with portable graphics capability. The operator shall be able to access all process graphics and perform process control from the laptop. All graphics shall appear as they do on the WS.

a. A se cond interface to laptop technology shall be provided which permits use of the laptop without the need for the PTI. Each PCM shall be provided with a jack to enable the operator to use a laptop computer to access DCS process displays and perform process control without the need of a portable telephone. The jack at each PCM shall be serviced by a common strand that is part of the PIN cable.

b. A third laptop interface shall be provided which will enable the laptop to access information when the PIN is down. In this instance, the laptop shall be able to port directly into the PCM to locally access and control process data. In this mode of operation, the laptop shall be able to be powered from a PCM power source or from their integral batteries. Facilities shall be provided at each PCM to protect and store the laptop within an enclosure/the PCM enclosure.

2. Portable telephones and Laptop Computers: The quantity of sets of portable telephones and laptop computers that shall be provided is listed in the APPENDIX. Laptop computers shall each be furnished with active matrix color screens, Intel Pentium 75 MHz processors, 28.8K baud modems, 500 MB or larger hard disk , 16MB of RAM memory, auxiliary battery packs, and a battery charger. Portable telephones shall be fully paid and certified and furnished complete with carrying case, batteries and battery packs.

2.5 WORKSTATIONS (WS)

A. **General**: Each WS platform shall feature graphics, multitasking with preemptive priority scheduling and virtual memory to enable concurrent processing without degradation of response times required for critical tasks, and networking capabilities that enable the workstations to run sophisticated applications and bridge the gap between various MIS functions and the process. WSs shall function as a stand alone process control and system configuration device. Each WS shall have the resources to maintain an integrated facility-wide, department-wide, and community-wide database. WSs shall present a windowed, high resolution, color-graphic interface to the operator in the depiction of present and past values of process.

B. **WS Functionality**: The DCS shall be provided with WSs that provide an engineering interface to the control system. The WS shall be designed to function as a workstation for process control and instrumentation engineers. The WS interface shall operate in both a (1) fill-in-the blanks mode wherein the user interacts through an interactive prompt and response sequence and (2) a graphics-oriented mode wherein the user implements control logic & CRT based graphics by physically drawing configurations and schematics on the screen. The CAD-like interface shall also permit the user to diagnose, simulate and debug control logic by displaying current process values/logic states and calculated outputs. The WS shall have inherent pan and zoom features which enable the display of control schemes, logic and displays which exceed the spatial constraints of a CRT screen. Each WS shall be configure to be universal in scope (e.g. have access to all system displays and data). Each WS shall have a password security system to prevent the unauthorized access of system configuration activities. The security system shall be comprised of at least 12 layers of prescribed access with associated authority. While the WS is in a configuration mode, all data entered shall be subject to reasonableness and validity checks. If an invalid/unreasonable input has been made, the engineering interface shall detect the condition and provide prompts or help facilities.

C. **WS Display Response Times**: The interactive shared display system coupled with the data communication networks described herein shall perform in accordance wit the following response dynamics:

1. Steady state displays shall display data which is no more than one (1) second old.

2. The time between an Operator manipulation and a reaction at the final control element shall not exceed two (2) seconds.

3. The elapsed time from when the Operator requests a new display to a display being presented shall not exceed one (1) seconds.

D. **Operator Interaction**: The Operator shall be provided with a means of interacting with the various displays which assist monitoring (overviews), permit control intervention (groups), provide parameter review and adjustment (detail), are predictive (trends) and assist the Operator in diagnostics (alarms, schematics, menus). The Operator shall interact with these displays, order changes in values, and modify configurations in a man-machine conversational mode via the following three (3) interfaces: track ball/mouse, function oriented touch-pad keyboard. The entry device shall be integrated with the man-machine design structure to enable a minimum amount of key strokes in common operations such as "Alarm Acknowledge" and "On/Off", "Fast/Slow" manipulations. Long strings of alphanumeric coded entries via buttons are unacceptable for process operating procedures.

E. **WS Hardware Component Platform**: Each WSs hardware platform shall utilize a Reduce Instruction Set Computer (RISC) with integrated mass storage and communication devices to enable independent stand-alone operation. All hardware platforms which comprise the DCS shall exhibit object code compatibility in that the same object code can be executed on all hardware platform implementations with the need to recompile, relink, or change formats. The following WS hardware and software requirements present a representative estimate of resource requirements. The CSP shall furnish all additional resources required to meet the requirements of these specification.

1. 32 bit, 50 MHz processor.

2. Floating point processor

3. (20") flat profile, high contrast colorgraphic monitor with 1280 x 1024 pixel resolution and a 76 HZ vertical refresh rate.

4. 64-MB of RAM on the motherboard.

5. 1- 1.05 Gbyte SCSI-2 3.5" hard disks with an average seek time of 12 msec or less, a synchronous burst transfer rate of 5-MB/sec or greater, and a raw disk transfer rate of 2.5-3.0 MB/sec or greater.

6. 1- 3.5" floppy diskette drive with 1.44 MB format.

7. On boa rd SCSI-2 controller and high speed access to external disk capacity of up to 20.8 GB with 3- 5 MB/sec synchronous SCSI controllers.

8. Fully buffered DMA operations.

9. Ethernet port.

10. A tape drive with a 2.3 GB formatted capacity and which uses 8-mm helical scan tape for each facility main computer room.

11. Compilers for (C), and Fortran.

F. **WS Operating System (OS) Software**: The OS shall comply with the requirements of paragraph 2.14.

G. **WS database Management System (DBMS)**: Each WS shall have its own Real-Time Data Base (RTDB) that reflects the current state of all process variables. All real time process datat shall be resident in the Workstation.

H. **WS Tools Platforms (TP)**: The TP shall extend the functionality of the multitasking OS by providing application tools or extensions of the OSS platform. The TP shall provide, through a procedural call interface, software to support:

1. User-operating system interface (shells) to allow the user to manipulate files and run application programs in a concurrent manner.

2. Database management systems (DBMS) which employ Structured Query Language (SQL) interface to a relational database.

3. Multimedia input/output to mass storage and image input/output i.e., optical disks using mapped files and special storage device drivers incorporated into the OS platform.

I. **WS Standards Compliance**: The following standards shall apply to maximize the interoperability and connectivity of the system and to provide object code compatibility between all hardware platforms used on this project:

1. Floating point processor shall comply with IEEE-754.

2. Network communications shall comply with IEEE-802.3/802.4.

3. Peripheral interface shall comply with SCSI.

4. Compatible with network protocols TCP/IP.

5. User interface based on X Windows, X11.

2.6 PERSONAL COMPUTER (PCWS) WORKSTATION

A. **General:** Where indicated, PCWSs shall be utilized as an interface device to access PIN, FIN, or DIN data. Trackball or mouse devices shall be the primary operator input devices, with keyboards as the supplementary input device. All PCWSs shall be functionally interchangeable and identical in display arrangements, menu selections, command terminology, and data access methods. All PCs shall be capable of accessing both typical operator process control functions and engineering configuration functions, through configurable software modes using X-WINDOWS. PCWS functional modes shall be password protected for system security and user identification.

B. Each PCWS shall consist of individual electronics (i.e., PCWS electronics shall NOT be shared amongst more than one PCWS) to support one 19-inch high resolution colorgraphic CRT, network communications and utilize a password-protected resource configuration mode for high level system and control configuration. PCWSs shall function with equal process monitoring and manipulation capability, thereby giving complete flexibility for password-protection of configuration and assignment of displays and software modes for a given situation.

C. Each PCWS shall be as follows:

1. A motherboard with 32-bit bus width using PCI.

2. An Intel Pentium Pro CPU

3. 32 MB EDO ECC RAM with 256K static RAM cache

4. 1.2 GB SCSI-2 8ms with 256 cache hard drive with a 32-bit PCI SCSI-2 4 MB cache controller

5. A tape drive capable of backing up the 1.2 GB hard drive on a single tape

6. 3½" diskette drive

7. Six expansion slots: 2 PCI, 4 ISA

8. A 19" SVGA 1280x1024 0.26 N/I monitor with 4 MB PCI accelerated graphic/video card, MGA Millennium or equal

9. An combination Ethernet/Fast Ethernet TP network interface card

10. A PC compatible mouse, Microsoft or equal

11. A six- speed CD ROM drive

12. Two serial and one parallel ports

13. A quietkey 101-key keyboard

14. A full size 8-bay tower with dual fans and 300 + watt power supply, FCC Class B certified for low emissions

15. Additional CPU fan and heat sink on CPU

16. Preloaded Microsoft Windows NT Workstation, Wordperfect and Excel (latest version)

G. A color dot-matrix printer with parallel interface. The printer shall utilize a 24 wire pin configuration, have a 4K buffer, print at 220 cps with automatic feed and accommodate paper up to 16 inches in width.

2.7 ENVIRONMENTALLY HARDENED WORKSTATION (EHWS)

A. **General:** Where indicated, EHWS devices shall provide the operations staff an interactive display station suitable for service in a NEMA 4X mode which experiences temperatures in the range of 32 to 104 degrees F.

B. Each EHWS shall be a fully functional WS meeting the requirements of Paragraph 2.5, with the following modifications:

1. A sealed membrane keypad with LED labels which shall be used to invoke displays and enter numerical data. As an alternative, a touch screen mode of display selection may be used in lieu of the membrane pad.

2. An audible alarm with a sealed "acknowledge" key.

3. A sun screen and rain guard to eliminate the effects of glare and standing water.

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NTS: The fully redundant historian system is used for major facilities. For pumping plants and smaller facilities use a non-redundant historian.

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2.8 REDUNDANT HISTORIAN SYSTEMS

A. **General:** The Historian Systems shall consist of two independent systems, the Facility Historian System (FHS) and the Oil Systems Historian (OSH). The Facility Historian System (FHS) shall consist of a set of fault tolerant microprocessor stations which executes computation intensive file server functions to support system and historical data management functions. The OSH shall consist of a non-redundant 2,000 point Oil Systems Plant Information system with PCWS operator interface and a Sun SPARCStation server. Except as noted in the Appendix, the following applies to both the OSH and the FHS. The Historian (OSH and FHS) processors shall:

1. Communicate with internal electronics over the highway network with all system processors to execute requests of bulk storage file data.

2. Collect performance statistics, perform processor reloads, provide message broadcasting, handle all processor alarms and messages, and maintain consistent time and date information in all system processors.

3. Maintain a process information data base to support historical data storage, retrieval operations, report/log generation, trending, event reconstruction, operator "help" and system electronic documentation.

4. Function as a stand alone device which enables the User to directly communicate with the data highway network from system devices.

5. Maintains an on-line plant-wide historical database which contains the following:

a. A contemporary database consisting of the most recent ninety (90) days of six (6) second averages of all analog and calculated values. This storage segment shall be sized on the basis of accommodating a number of variables equal to twice the number of analog inputs associated with this project. After data is over ninety (90) days old, data shall automatically compressed into the storage of hourly averages and daily averages. This compressed data shall be stored on line for a minimum period of two (2) years. Subsequent to the expiration of the two (2) year period, data shall be archived to either optical or tape mediums. The selection of the medium shall be user selectable. Adequate resources shall be provided in both mediums to archive a total of two (2) years of data.

b. A report database shall be maintained by the retaining of all reports generated during a thirteen (13) month period. The recall of these reports from memory shall not require the recompiling of report data. At the users option, all report data may also be copied to optical storage in parallel with the storage of report formats in FHS disk memory.

c. An alarm and event database which retains discrete occurrences with timestamps for a period of one (1) year. This storage segment shall be sized on the basis of 1/100th of the number of discrete inputs associated with this project being stored each minute. Subsequent to the expiration of the one (1) year period, data shall be archived to either optical or tape mediums. The selection of the medium shall be user selectable. Adequate resources shall be provided in both mediums to archive a total of one (1) year of data.

6. The Facility Historian shall be the WDPF Historian.

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NTS: The fully redundant historian system is used for major facilities. For pumping plants and smaller facilities use a non-redundant historian running on a WS. At least two WS must be provided to support the non-redundant system.

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2.8 NON- REDUNDANT HISTORIAN SYSTEM

A. **General:** The Facility Historian System (FHS) shall consist of a single microprocessor station which executes computation-intensive file server functions to support system and historical data management f unctions. The Historian processor shall:

1. Communicate with internal electronics over the highway network with all system processors to execute requests of bulk storage file data.

2. Collect performance statistics, perform processor reloads, provide message broadcasting, handle all processor alarms and messages, and maintain consistent time and date information in all system processors.

3. Maintain a process information data base to support historical data storage, retrieval operations, report/log generation, trending, event reconstruction, operator "help" and system electronic documentation.

4. Function as a stand alone device which enables the User to directly communicate with the data highway network from system devices.

5. Maintains an on-line plant-wide historical database which contains the following:

   a. A contemporary database consisting of the most recent ninety (90) days of six (6) second averages of all analog and calculated values. This storage segment shall be sized on the basis of accommodating a number of variables equal to twice the number of analog inputs associated with this project. After data is over ninety (90) days old, data shall automatically compressed into the storage of hourly averages and daily averages. This compressed data shall be stored on line for a minimum period of two (2) years. Subsequent to the expiration of the two (2) year period, data shall be archived to either optical or tape mediums. The selection of the medium shall be user selectable. Adequate resources shall be provided in both mediums to archive a total of two (2) years of data.

   b. A report database shall be maintained by the retaining of all reports generated during a thirteen (13) month period. The recall of these reports from memory shall not require the recompiling of report data. At the users option, all report data may also be copied to optical storage in parallel with the storage of report formats in FHS disk memory.

   c. An alarm and event database which retains discrete occurrences with timestamps for a period of one (1) year. This storage segment shall be sized on the basis of 1/100th of the number of discrete inputs associated with this project being stored each minute. Subsequent to the expiration of the one (1) year period, data shall be archived to either optical or tape mediums. The selection of the medium shall be user selectable. Adequate resources shall be provided in both mediums to archive a total of one (1) year of data.

6. The Facility Historian shall be the WDPF Historian.

B. **Station Hardware:** The CSP shall furnish all necessary interconnecting cables, accessories and appurtenances as well as additional processor or peripheral hardware as required for proper operation of the system and to meet the functional requirements indicated on the Drawings. The FHS processor shall be physically and functionally independent of other system processors, as indicated on the Drawings. All major FHS components and peripheral devices shall be of the same CSP. The FHS processor shall be capable of tolerating and riding through a power interruption of 100 milliseconds or less without interruption of normal operation. The FHS processor and peripherals shall be housed in a separate enclosure using a self-supporting mounting structure and shall not share any common components or devices with other processors. FHS components shall include CPU, bus interface, main memory and mass storage devices.

C. **Central Processing Unit:** the CPU shall be a redundant pair of high-speed, Reduced Instruction Set Computing (RISC) 50 MHz random access, digital processor with direct memory addressing capability. The CPU shall include, but not be limited to the following features:

1. Automatic hardware bootstrap.

2. Hardware interrupt system with multiple levels of hardware priority.

3. Hardware real-time clock interrupts.

4. Real-time clock with battery backup, accurate to within plus or minus 5 seconds per month.

5. Hardware watchdog timer with audible alarm.

6. Microcode implementation of integer and floating point arithmetic operations for addition, subtraction, multiplication and division.

7. Byte parity checking.

8. Minimum processing performance equivalent to 25 Mips (million instructions per second).

9. Capable of supporting at least six SCSI peripheral devices (i.e., CD ROM drives, WORM drives, Hard Disk Drives and Streaming Tape Drives, with controllers). The unit shall be capable of supporting a maximum of four (4) hard disk drives from this complement, for a maximum hard disk storage capacity of 5.2 Gb possible.

10. One 1.44 Mb, 3.5-inch internal Floppy Disk Drive (non-SCSI).

11. The CPU shall have the capacity to support all supplied software for the system without utilizing more than 50 percent of its processing capability during any 60 second interval. The spare processing capacity is required for future expansion of the system. The CSP shall submit verification of this design requirement during the submittal phase of the project.

12. In addition to the FHS having adequate storage and processing resources to support all specified software and system functionality, the FHS shall be provided with a minimum of fifty (50) percent spare processing and memory resources.

D. **Main Memory:** The CPU shall be provided with solid-state memory sized to meet the maximum operating requirements of the system as supplied, and shall include at least 100 percent spare capacity. Spare capacity must be completely free and available for the Owner's use at the time of final acceptance. The main memory supplied with the system shall be modularly expandable beyond that delivered with the initial system. It shall be possible to expand the main memory storage to two times that required by the initial system without requiring major software modification. The FHS processor shall be supplied with 54 Mb of main memory minimum.

E. **Fixed Disks and removable Media:** The FHS shall include not less than one fixed disk and one removable media drive. Additional disk or removable media drives shall be provided as required to meet capacity requirements.

1. The FHS shall be provided with at least two (2) 3.5-inch 1.05 Gbyte fixed hard disk drives to store all system software, database information and all run-time data. An external 2.1 GB fixed hard drive for historian data shall be provided for each FHS node.

2. The FHS shall be configured to back up the hard disk data to 1/4 inch or 8 mm DAT tape via the DIN or FIN.

3. The FHS shall also include one (1) 1.3 Gbyte write-one ready-many (WORM) magneto-optical disk drive for long term historical data storage. The WORM drive shall receive historical data from the hard disk drive at data transfer rates from 0.8 Mbytes/sec. (sustained) to 5 Mbytes/second (burst).

4. Each media storage device shall incorporate parity or error-detecting code generation and checking. Detected errors shall be either corrected automatically or reported by FHS system management software for software action.

F. **Historian System Interface Terminal:** The FHS shall include one (1) FHS interface terminal to be used for programming, housekeeping, and diagnostic functions. The FHS interface terminal shall be a VT type terminal. Any workstation on the network shall be able to be used as a FHS interface terminal.

G. **FHS Communication Software:** The WDPF Historian/Log Server shall use the FIN and PIN for communications.

2.9 PERIPHERAL DEVICES

A. **General:** A peripheral device processor shall be provided to translate messages from other processor stations on the network into device specific messages. The processor shall provide the interface to hard copy output devices within the system and other terminal I/O devices.

B. **Communications Processor:** The Communications Processor shall be microprocessor based with onboard memory to provide buffer storage of data for output devices. Data shall be ported through RS-232-C asynchronous channels at up to 9600 bit/second. All communications channels shall be isolated from power, with signal isolation to 500V.

C. **Alarm/Event Printers:** Printer for alarm/event service shall be the microprocessor based color 24 pin dot-matrix type with continuous tractor feed mechanisms suitable for fanfold forms to 16 inches wide. Printer shall have a 9 x 23 dot density with selectable pitches between 10 and 20 characters per inch and support the 128 ASCII character set. Printer speed shall be 300 characters per second bi-directional and designed for 100 percent duty-cycle applications. All printers shall be identical and interchangeable. Printers requiring thermal-sensitive, chemically treated or other special paper will not be acceptable.

D. **Log/Report Printers:** The log/report printers shall be Hewlett-Packard Laserjet 5MV with HP Jet Direct network card. A TCP/IP address shall be assigned to each printer.

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NTS: The HP 5MV is a $3,000 printer with 11-inch by 17-inch paper capacity and a 35,000 page per month duty cycle, suitable for a 10-person workgroup. For small facilities, such as pumping plant consider the following $900 HP 5P.

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D. **Log/Report Printers:** The log/report printers shall be Hewlett-Packard laser printers with the following minimum features:

1. 600 dots per inch
2. 6 pages per minute output
3. 2,000 pages per month duty cycle
4. 250-sheet paper capacity
5. Internal 20 MHz processor with font management software
6. 45 scalable typefaces
7. Laserjet 5P or equal

E. **Ink Jet Printers:** A full color, non-impact, ink-jet type printer shall be furnished to produce quality multi-colored reproductions of the graphic operator interface CRT displays. The printer shall produce an image on standard 8-1/2 x 11 inch single-sheet paper in less than 120 seconds with a graphic resolution of 600 x 600 dots per inch. Printer shall utilize disposable print cartridges and be capable of accurately reproducing all color shades which can be generated for the DCS graphic displays. Printer shall also accept clear polyester film for creating transparencies of CRT displays, reports and logs. Printers shall have 1 MB built-in RAM, 150-sheet paper feeder, and shall be Hewlett-Packard Deskjet 850C or equal.

F. **VT-300 Series Emulator:** The VT-300 Series Compatible Terminal shall provide direct access to the DCS directory and file structure for performing system troubleshooting and maintenance. The unit shall be provided with a 14 inch diagonal tilt and swivel, green phosphor monitor, a 105 full touch key QWERTY keyboard with numeric pad, cursor control and 15 programmable function keys. Character size shall be 7 x 9 matrix in 10 x 10 cell utilizing the full ASCII character set.

G. **Printers:** Printers shall be provided in accordance with the allocations in the Appendix.

2.10 PERIPHERAL CABLING

A. The CSP shall provide and install all peripheral device cables. The CSP shall review the contract documents to determine exact length requirements.

2.11 EQUIPMENT ENCLOSURES AND CONSOLES

A. **General:** The DCS equipment furnished under this contract shall be housed in enclosures designed to provide physical and environmental protection for the interior modules, busses and terminations. All enclosures shall be provided with dual feed, fully redundant power modules utilizing power auctioning to provide intermediate power to all enclosure components. Input power source shall be 120 Vac 60 Hz and 125 or 24 V dc. Enclosures shall contain racks which allow easy removal of all modules, i.e., processors, I/O boards, power supplies, etc. without removal of wiring or power. All modules shall be restrained to prevent accidental disconnection. Each enclosure shall be designed to pass through a 36 x 90 inch doorway opening.

B. **Field Enclosures:** Field enclosures shall provide moisture and contaminant protection and meet the electrical classification specified. Enclosures shall as a minimum provide NEMA 1 protection. Internal air circulation fans to aid in convection cooling or other means of temperature conditioning shall be provided as needed. Power and signal wiring shall enter the enclosures from its top or bottom section and terminate at termination assemblies residing in the bottom or side sections of the enclosure. Terminal algorithms for external connections shall be suitable for 14 AWG wire. A terminal shall be provided for each conductor of external circuits plus one ground for each internally powered analog signal shield. Each analog loop shall be individually fused with all fuses or circuit breakers clearly labeled and located for each maintenance if individual isolation is not provided at the board level.

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NTS: Modify the following Area control room console paragraph for use at pumping plants where a steel Evans-type console in not desired.

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C. **Area Control Room Consoles:** Area control room consoles shall be ergonomically designed to optimize the utilization of the WSs and printers, provide proper operational and maintenance access, and conceal interconnecting cables and wires. Consoles shall consist of free-standing high-quality modular office systems designed for computer use and support. The CSP shall coordinate with the Facililty architectural designer to determine colors, materials, arrangement, and lighting. Each console shall provide covered storage space for reference materials, drawer unit(s) for office supplies, and at least three linear feet of free desk area per workstation. Power poles for data and power cables shall be provided. Area control room consoles shall be provided with one design-coordinated ergonomic chair for each WS and shall be manufactured by Knoll, Steelcase, or equal.

D. **Main Control Room Consoles:** Main control room consoles shall be located at COMC and at each facilities operations building central control room. The operations building console shall be designed to accommodate WSs, alarm/event printers and inkjet printers. The quantities of each to be accommodated are shown in the Appendix. The height of each console shall be limited to a maximum of 48" so as to not obstruct the console occupants' view of the large screen projection image. Console shall be provided with ergonomically designed chairs and shall be manufactured by Evans, American Video Communications, Rochester or equal, and conform to the following;

1. Consoles shall consist of a steel and aluminum framework assembled in modular sections.

2. Constructed to suit 22-1/2 degree, 30 degree, 45 degree, and long/short apex equipment.

3. Printers shall be accommodated with two paper feed slots, paper storage slide-out shelves, and paper form feed bins.

4. All electronics shall be remote mounted in the adjacent computer room.

5. All work surfaces shall be approximately 28" above floor level.

6. All work surfaces shall be finished in a high-pressure laminate on a 11/16" 45 pound core.

7. Consoles shall be furnished complete with telephone blank panel kits, pencil drawers, recessed keyboard and trackball kits, and halogen task lights with valances.

8. All cable interconnections between console mounted devices shall use flexible cables with plug connectors. Cable lengths shall be of sufficient length to enable the withdrawal of equipment from the console without the need to disconnect plugs.

9. Console color and finish shall be submitted to the CONSTRUCTION MANAGER prior to fabrication.

2.12 NITROGEN GAS PURGE SYSTEMS FOR PCMs

A. Where required, the CSP shall furnish a nitrogen gas purge system which continuously purges PCM enclosures with nitrogen gas at the rate of one (1) complete volume change per day.

B. The nitrogen gas 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;

1. a discharge pressure regulator on the manifold
2. an isolation valve for each cylinder
3. a check valve for each cylinder
4. an isolation valve on each branch circuit
5. a check valve on each circuit
6. all ancillary piping, fittings, and accessories

D. Suitable couplings and flexible pipe sections shall be provided on each branch to permit the quick removal and installation of cylinders on a routine basis.

E. All valves, fittings, and accessories shall be 316 stainless steel.

F. All components, including but not limited to, piping, enclosures, liquid nitrogen cylinders, gauges, fittings and other accessories shall be purchased. Temporary rental or leasing arrangements shall will be acceptable.

G. A minimum of two (2) liquid nitrogen cylinders, each containing the equivalent of three thousand six hundred (3600) cubic feet of nitrogen gas at atmospheric pressure will be provided for each system.

H. Each cylinder shall deliver gas reliably and continuously without pressure fall-off. The pressure building regulator shall maintain minimum operating pressure while the economizer regulator shall reduce excess pressure during non-use periods.

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

1. Allow direct gas flow without auxiliary equipment.
2. Sustain discharge at required pressures.
3. Be capable of providing gas at a maximum continuous rate of twenty five (25)cubic feet per hour
4. Be capable of providing gas at a maximum intermittent rate of one hundred (100) cubic feet per hour
5. Both of the flow rates noted in preceding items 3 and 4 shall be delivered with only regulator and piping attachments required. An external heat exchanger shall not be utilized.
6. Have a built-in shock absorbing system to resist rough handling during transport.
7. Have self-contained controls and piping which is protected by a stainless steel ring which is welded to the top of the cylinder.
8. All valve handles shall have a low thermal conductivity to permit comfortable operation without the need for gloves.
9. A strong internal support system to provide added stability and added protection under all working conditions.
10. Fully insulated cylinder walls to reduce evaporative losses through the pressure relief valve.
11. A built-in automatic pressure building system to allow immediate operation after filling or pressure transfer.
12. A built-in evaporizer to provide direct gas flow without auxiliary equipment. A built-in economizer circuit shall be provided to reduce evaporative pressure build up during idle time and provide virtual no-loss operation. Evaporative losses during periods of non-use (zero-gas withdrawal) shall not exceed two and one-half (2.5) percent of the stored volume per day
13. Designed for unattended service or operation subsequent to initial set up without the need to make repetitive pressure adjustments.
14. The following devices shall be provided for each cylinder in conformance with the technical requirements which regulate the quality of such devices as defined in the contract documents;

a. gas pressure gauges
b. Container bursting disc
c. safety relief valve
d. manual gas vent valve
e. economizer regulator
f. pressure building regulator
g. manual pressure building valve
h. liquid level gauge
I. casting bursting disc
j. manual liquid fill and withdrawal valve
k. pressure building coil
l. vaporizer
m. gas withdrawal check valve.

J. Each cylinder safety relief valve shall be set at 235 psig with a normal container gas operating pressure of one hundred twenty five (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.

K. Unless otherwise specified or shown, all piping, fittings, valves, and other accessories shall be 1/4 inch diameter.

L. All cylinders shall be secured by retainers to prevent tipping over.

M. All PCMs which are purged shall be provided with sensors which detect and transmit to the DCS the following conditions:

1. An low pressure condition internal to the enclosure.
2. A high temperature condition internal to the enclosure.
3. A enclosure-door-open condition.

N. The complete nitrogen purge system shall be checked-out and in operation prior to the installation of related PCMs. All costs associated with nitrogen deliveries and refills prior to system acceptance shall be the responsibility of the CSP.

O. All cylinders, valves, piping, enclosures, and other equipment comprising the nitrogen gas purge system shall become the property of the Department upon system acceptance.

$#

NTS: The VIDEO PROJECTION (VPS) is for major treatment facilities only. Delete pumping stations.

#$

2.13 VIDEO PROJECTION **(VPS)**

A. **General-VPS:** The CSP shall be responsible for the design, fabrication, installation supervision, testing, alignment, and commissioning of the quantity of video projection systems indicated in the Appendix. The VPSs shall utilize large screen, high resolution, projection technology and be furnished complete with all hardware required to meet these technical specifications. VPS units shall be of the rear screen projection (RSP) type and ceiling mounted projection (CMP) type. VPS shall be provided to integrate and display all DIN/FIN data and data processed by ancillary devices such as overhead presenters, slide-to-video presenters, VHS presenters, and compact disc presenters in a large screen format suitable for preformatted training, workgroup, management and public presentations. Each VPS shall be furnished complete with a computer front-end (CFE) processors furnished with video digital interfaces VDIs) which provide an RGB interface to the VPS projector. All other devices required to port the VPS on the communication network shall be furnished. All VPS equipment shall conform to the requirements of paragraph 2.1 D(3) by imposing no noise on the environment in which they are being installed. All systems shall be furnished as integrated units. All devices external to the projectors shall be housed in an wood-grain-finished enclosure which provides a central focus for system plug-ins and operations while concealing all interconnection wires. RSP units shall use a "folded beam" reflected image projection technique to reduce the required floor space. All VPS shall be designed to operate in parallel with the output from the workstation video display units. Operators shall be able to select the VDU or one of the multimedia inputs to display on the VPS.

B. **Experience:** The CSP shall utilize an organization which has a minimum of three (3) years experience in the design and implementation of VPSs and VCSs. In addition, the organization shall have an authorized service center within two (2) hours of the installation sites.

C. Video Projector: Video projectors (VPs) shall conform to the following:

1. Orientation: Suitable for use in front or rear projection orientations.

2. Brightness: 900 lumens

3. Resolution: 2560 by 2048 addressable 1350 by 1100 ANSI pixels.

4. Horizontal Frequency: 15 khz to 130 khz.

5. Vertical Frequency: 45 Hz to 150 Hz

6. Convergence Accuracy: Less than 1 mm accuracy for the entire screen.

7. Video bandwidth: 100 Mhz

8. Retrace: Horizontal -2.1 to 6.0 microseconds; Vertical-300 microseconds (max).

9. Inputs: Analog inputs for RGB with separate composite and H/V sync; Automatic sync switching; audio follow on all inputs.

10. Geometry Distortion: 1% max.

11. Displayed colors: Workstation/input source dependent.

12. NTSC Composite Input: With multi-stranded decoder and line doubler module which accepts 525-line formats (NTSC, S-VHS, RGB etc) and converts them into line-doubled, artifact-free, high resolution signals connected to projection display units.

13. Manufactured by: **ELECTROHOME, SONY, or equal.**

D. **Rear Screen Projection Units:** Rear Screen Projection Units shall conform to the following:

1. Mounting: Welded steel frame which bolts together the job site. Frame shall be universal to allow a system to be upgraded in the future. All units shall be commercially available, off-the-shelf assemblies as opposed to a custom fabrication.

2. Mirrors: Mirrors shall be constructed of first class optical quality glass with an aluminized surface.

3. Screens: Screens shall be Fresnel-Lenticular type with a minimum axis gain of 4 and a gain of 1.5 at 60 degrees. Screen frames shall be provided which prevent light spillage between screens.

2.14 OPERATING SYSTEM SOFTWARE

A. **Operating System Software (OSS)**: The OSS shall be a multiprogramming network operating system in that it shall support multiple processes by sharing computer resources with processes intercommunicating with various forms of resource sharing occurring via a network. The OSS shall be a multitasking (i.e., supports multiple processes per user). A processes shall be defined as units of activity characterized by a single sequential thread of execution, a current state, and an associated set of resources. The OSS shall be open (i.e., have a publicly specified interface, be non-proprietary, and be based on a public domain specification). The OSS shall be a UNIX variant (SVID) with an IEEE P1003 POSIX compliant interface or equal. The OSS shall provide the following functionality:

1. Multi-tasking to provide task suspension and priority scheduling of task execution.

2. Hardware interrupt priority handling.

3. Network communications to accommodate program downloading from the host and to respond with data transfers as required by the host or interactive shared display system.

4. Support for continuous control, sequential control and data acquisition.

5. TCP/IP shall be implemented on this project. All OSS's shall be UNIX and be provided with SMP. OSS's which feature SMP and TCP/IP but which do not implement it are not acceptable.

2.15 SYSTEM CONFIGURATOR

A. **General:** The following software components shall be furnished to structure and customize process operations and information management tasks. The ability to modify the structure at a later date shall also be provided.

1. **Display Building, Configuring and Editing Tools:** Software tools shall be provided for developing, editing, using and managing displays. Sophisticated display structures shall be configured as defined by the CSP subsequent to the finalization of user meetings and graphic submittals. Displays shall be constructed from a combination of pre-defined graphic objects that shall be developed, maintained, and manipulated. The Display Builder shall contain libraries of grouped objects and separate libraries of user- and system suppliers-defined marker tables. Addition to the libraries shall be provided by incorporating user-defined objects named and created with the Display Builder. Addition to the marker tables shall be provided by using the Marker Editor in the Graphics Utilities.

2. **Display Builder:** The Display Builder shall use pull-down menus and a high resolution pointing/input device, such as a mouse or trackball, for function selection. It shall also create overlays as unique files. It shall be possible to configure any number of overlays to exist on the screen at any one time. Overlays or "windows" shall contain any information that must be invoked quickly from a "base" display (typically for gaining more detail). The builder shall be a general purpose, object-oriented editor for the construction and editing of detailed, interactive displays. It shall produce an object-oriented data base that is used during the building process. The software shall enable the operator to build displays representing any type of application.

   a. The following types of objects shall be furnished as a minimum:

      (1) Geometric Shapes -- Lines, rectangles, polygons, arcs, and ellipses.

      (2) Text -- Alphanumeric characters in a variety of fonts and sizes.

      (3) Markers -- Small, single-color shapes such as pumps, valves, and icons, that are used repeatedly.

      (4) Groups -- Object(s) composed of other objects.

      (5) Library Group -- Standard and user-defined objects for inclusion in user-built displays.

   b. There shall be no inherent limit on the complexity of objects or the number of objects contained in another object. Display objects shall be connected to control algorithm parameters and system variables. Configured displays shall remain editable by the Display Builder. Display objects shall have the following editing features as a minimum:

      (1) Move -- Change the location of an object within a display.

(2) Stretch/Shrink -- Alter the dimensions of an object.

(3) Cut/Copy/Paste -- Delete, duplicate, and add objects.

c. Drawing functions shall be organized as a set of tools and resources, selectable from the menu bar, that are used to construct and edit objects. Resources shall be used to aid in the construction. These major functions shall include as a minimum:

(1) Filing

(2) Library functions

(3) Drawing

(4) Editing

(5) Resources

(6) Grid

3. **Display Configurator:** A Display Configurator shall be furnished to convert static displays into dynamic displays that interact with the process, and provide a logical hierarchy of control capability. Connection of display objects, trend objects, or X/Y plot objects to shared system variables to reflect the current value of the variable, or to connect to control variables to allow the operator to view and change the value of the variable shall be provided.

a. Selectability configuration of a given display object shall be provided to perform one or more of the following functions when the operator picks that display object:

(1) Run/execute a program

(2) Call up a display or overlay

(3) Close the current display or overlay

(4) Write text to a file

(5) Set a relative pick

(6) Ramp

(7) Momentary contact (Hold-down Pulse or Timed-Pulse)

(8) Trends, X/Y profile plots

4. **User Interface:** Associated variables (process or shared) with display objects shall use both graphical and hierarchical methods to move about and within the display object data base. Pull-down menus accessible from the display field shall select objects in the display hierarchy and specify connection attributes.

   a. **Display Object Data Base:** The Display Object data base shall be composed of all the display objects that are all part of the hierarchy of object groups. The root group shall contain all display object groups. At each level in the hierarchy, the associated display menu shall indicate the position of the currently selected object in the hierarchy as well as of the connectable attributes of that object.

   b. **System Data Base:** The System data base shall be any system variable or value in the system that is accessible through the Object Manager. This shall include all shared program variables and all control variables. The system data base shall be accessed by typing the qualified path name of the system variable to be read or written in the appropriate connection dialogue box.

5. **Display File Manipulation:** The Display Configurator shall accept Display Builder files to configure as well as installed files to re-configure. Direct access to Display Builder software for necessary object changes shall be furnished. Once a display is configured, it shall be installed automatically for use by Display Manager in an interactive mode.

6. **Connection Types:** Any connection between an external variable and a display attribute shall be active or passive, and continuous or discrete. Active connections shall alter process or system variables in response to operator manipulation of the display. Passive connections shall alter attributes of display objects in response to changes in process or system variables. Also, attributes shall be active and passive and the system shall be able to configure both an active and a passive connection for them. The active connection shall determine the behavior of the object (position, shape, text contents, etc.) as long as the object is selected for user manipulation. The passive connection shall determine the behavior at all other times. Continuous connections shall vary continuously over a given range, such as flow. Discrete connections shall exhibit a finite number of states, such as pump status or steps in a sequence.

7. **Connection Configuration:** Selecting an object and the desired object attribute for connection shall present an appropriate configuration dialogue box. The dialogue box shall allow the operator to enter a connectable variable and related configuration information (e.g., state table, type of pulse, change delta). If the object selectability attribute is to be configured, the function menu shall become selectable. Selecting the desired function accesses the appropriate dialogue box for configuration. Selecting a trend or plot shall provide access to configuration dialogue boxes specific to trends or plots. Changes to or deletion of configured connections shall be by the connect menu.

8. **Display Conventions Configurator:** The configuration shall be a menu driven subsystem that allows the operator to build and edit named conventions used to connect display object attributes, such as color and text contents, to individual bits in control strategy: algorithm

parameters and global variables. Bit assignments for algorithm parameters, connections to any data type: long integer, floating point, byte, character shall be possible. Objects shall be bitmapped: rectangle, polygon, arc, text, and marker. Their attributes include visibility, color, fill color, line style, marker number, text contents, and background color. Display Builder and Display Configurator shall be used in conjunction with Display Conventions Configurator. Conventions shall be stored in a file that is read by the Display Configurator.

9. **Graphics Status Attributes Configurator:** This software shall be furnished to edit a configuration file used by the Display Manager to show out-of-service (OOS) and bad input/out (BADIO) status of control algorithms in Detail displays, faceplates, and user displays. Display objects that are connected to a point that reports one of these states shall change the graphic attributes of the object. Display actions for BADIO and OOS shall be separately configurable. The configuration file shall be global and shall govern the graphic behavior of all workstations. The configurator shall be a prompt driven configurator which is accessible via the Virtual Terminal mode. It will provide a brief description of the command options, show the selected configuration, and prompt for any changes. Also, a file with default values shall be supplied for the system. Display objects to display the connection status are:

a. Rectangle	d. Normal Text	g. Overstrike Text
b. Polygen	e. Circle	h. Arc
c. Line	f. Polyline	i.. Marker

j. As a minimum, their attributes shall include visibility, color, fill color, line style, marker number, foreground and background color.

10. **Graphics Utilities:** A collection of general purpose graphics editors and utility files for the construction of new fonts and markers, or for editing system supplied fonts and markers shall be furnished. In addition, a color palette shall be available with both the system supplied colors and colors that are customizable.

a. The editors shall be used to modify both the standard system graphic utility files which store system markers, fonts and colors, and user graphic utility files for user markers. These files shall be referenced by all displays upon display callup.

b. The fonts, markers, and colors shall be accessible in the Display Builder and Display Configurator software for use in building and configuring displays.

c. Font Editor software shall allow the operator to edit a font set or create a variety of fonts for use on displays. When accessed within the Display Builder, the selected character font set shall be made available in one of four sizes: single-width, single-height; single-width, double-height; double width, single-height; double-width, double-height.

d. Marker Editor software shall allow the operator to create graphics symbols that are used repeatedly. Symbols shall appear as industry-standard shapes, and shall be included in a marker table.

e. The Color Palette Editor shall allow the operator to edit colors in the system palette file or create palette work files. The user shall be able to change the eight foreground and 32 background colors available from the color palette to create more than 16 million colors. The first sixteen background colors are standard colors related to system displays. Blink colors and blink rate shall also be set.

11. **Workstation/Mode Configuration:** The User's view of the system and the process to which it is connected shall be provided. A specific mode shall be associated with a user, a group of users, or fixed for a given workstation.

This shall be the first level of security for accessing and manipulating system information. The second level of security shall be provided by restricting the selection of individual fields within displays. Different modes shall have different groups of selectable fields for the utmost security. Workstation configuration shall be enabled by the Password Mode Configurator. It shall allow the flexibility to set up security schemes to match plant operation setup.

a. The configurator shall be a collection of mode editing functions and tools that maintain a set of configuration data files that allow the following functions:

(1) Provide access security for the different operation modes of the system.

(2) Allow an authorized user to modify mode menus (menu bar entries), and to associate specific displays with the invocation of any given mode.

The configurator shall be able to run in any workstation as a transient application task, and shall operate primarily with simple menu selections and dialogue box prompts. An alphanumeric keyboard and a high resolution input device, such as a mouse or trackball, shall be required for configurator operation. Any input device can be used to access menus subsequently built.

b. There shall be five default modes:

(1) Process Operator's Mode

(2) Process ENGINEERS's Mode

(3) Plant Management Mode

(4) Maintenance Mode

(5) Software ENGINEER's Mode

The content of all modes and menu bars shall be able to be configured to suit the user. Additional modes shall be assigned by using the configurator.

2.16 WORKSTATION (WS) APPLICATIONS

A. **General:** Window systems shall manage the user-OSS interface that deals with multiple processes and the display of those processes from virtual displays via space multiplexed physical displays. Each WS shall employ a base window system designed for use in a networked, bitmapped workstation mode. The operations for placing information on the screen include graphic oriented and character oriented commands for monochrome and color displays. The windowed implementation shall divide an implementation into a client and a server with a specialized interface between them. The protocol between the client and server shall be of a sufficiently high level (and general) that the client and server can be implemented on distinct machines interconnected by the network although the usual workstation configuration is to implement the two parts on a single machine. The user interface shall provide the fundamental facilities required to support a desktop management implementation which explicitly addresses space multiplexing for representing virtual terminals-across multiple physical screens that operate with a single physical keyboard and mouse, each with its own application process.

B. The display software furnished shall enable any WS to interact with any and all of the real-time plant, field and process data that is provided in the system. Areas of operational access or "modes" for the workstation shall be changeable on-line and shall be pre-configured by using a Password Mode Configurator.

C. All screen selections shall be based on intuitive "picking" of display objects and menus on the screen. A common menu bar structure with pull-down menus shall be presented at the top of all displays to enable fast access amongst available workstation functions. Multiple windows with icons shall also be available. Content of the menus shall form the display hierarchy.

D. The Real-Time Display Software shall support either single-screen or multiple-screen operation. Single-screen operation shall allow workstations to operate independently of one another; e.g., duplicate workstations can have duplicate or independent responsibilities. Multi-screen operation shall allow configuration of a group of WSs to form a multi-screen cluster. They then can be operated as a single multi-screen workstation. Multiple workstation displays shall operate in a coordinated arrangement to support single or multiple operators. As a minimum, multi-screen real-time software shall provide the following:

1. Ability to direct input devices such as a mouse, trackball, or keyboard, to multiple screens.

2. Ability to enable/disable input devices on-line.

3. Ability to redirect displays from one screen in the cluster to another and toggle any screen between multi-screen and single-screen mode.

4. Ability to call up multiple displays simultaneously with a single request.

5. Ability to determine on-line those screens that are to be allocated to multi-screen use.

E. Windows and menus shall be used by the OPEN LOOK Graphical User Interface to provide an intuitive windows mode. Windowing shall take advantage of the multi-tasking operating system capability. It shall allow to begin a task in one window while continuing work in another. It shall also allow a single CRT interface within the system using X Window for interfaces with the DIN and FIN (information networks). As a minimum, the following applications that concurrently appear in its own window shall be:

1. Network Manager

2. Display Manager

3. Data Acquisition and Control Configurator

4. Report Configurator

5. Historian Configurator

6. Operator Message Interface

7. Spreadsheet

8. Virtual Terminal Mode

9. Electronic Documentation Print Routine

10. Loadable Documentation

11. Help Functions

12. X Window from FIN and DIN

2.17 NETWORK MANAGEMENT SOFTWARE (NMS)

A. **General:** Each network connected device shall be provided with NMS which provides an operator with a means to:

1. Define users, groups, and their access privileges. The NMS shall be able to define the domains to which the users and groups belong. Domaines shall define a set of servers and resources to which users and groups have automatic and transparent access.

2. Analyze the server performance and resource statistics to determine potential bottlenecks.

3. Monitor the network traffic, to identify problems after they occur, and more importantly, to spot potential trouble before it happens.

B. **Intelligent Facilities**: The intelligent facility operators' information and object domain shall be managed by NMS. NMS shall regulate all aspects of heterogeneity, resource management, performance monitoring and tuning, and other administrative tasks. The end result shall consist of the organization and management of facility and Department objects not files and directories. Facility and Department objects may physically consist of files and directories, but the emphasis shall be on managing the object as a whole by the NMS.

C. **Information and Object Domains:** The NMS shall provide users access to resources in an efficient and easy-to-use way. An intelligent facility worker's information and object domain will be managed by the NMS which shall be responsible for of all aspects of heterogeneity, resource management, performance monitoring and tuning, and other administrative tasks. Note that this is an organization and management of facility objects not files and directories. Facility objects may physically consist of files and directories, but the emphasis is on managing the object as a whole by the NMS. The NMS shall employ a global naming service in that the NMS shall support an intelligent facility mode which concentrates on the administration and management of intelligent facility objects, such as the following;

1. Processes
2. Process Elements
3. Process Area
4. Facility Plans and Fire Detection
5. Maintenance Management
6. Laboratory Information Management
7. Operation and Maintenance Data
8. Plant Security and Communications
9. Training Network
10. Energy Management
11. Peripherals and devices
12. Policies and procedures
13. Plant/Department Staff

D. **Global Naming Service:** The NMS shall provide users access to resources in an efficient and easy-to-use way. The NMS shall employ a global naming service in that everything on the network shall be assigned an item name, a group name, and an organization name. Using this approach, if a user wishes to get run-time related maintenance management data from the MBC locale, the item is called "run time"; the group is called "maintenance management" and the organization "MBC". The name "RUN TIME @ MAINTENANCE MANAGEMENT@ MBC would precisely define the location of the data in a straightforward manner.

E. **Standard Protocol**: The NMS shall conform to a standardized protocol that makes it possible to maintain complex internetworks and reconfigure resources as patterns change. The NMS shall be designed for the purpose of monitoring network performance, detecting and troubleshooting network faults, and configuring or reconfiguring network resources.

F. **NMS Organization**: The NMS shall be based on three major components; the NMS protocol, the management information base (MIB), and the structure of management information (SMI). The NMS shall be an application-layer protocol stack that defines a common method of communications among network devices. The MIB shall define a common set of information variables and statistics that must be kept. In addition, the MIB shall define an OSI-compliant registration hierarchy that groups logically related information into tables. For example, information relating to the error rates and addresses of communication interfaces would be placed in the interface table. The NMS shall also consist of agent software, which resides at the location of each resource being managed. The other element of the NMS is the network management station, which contains the master database of resources being managed.

G. **NMS Components**: NMS shall consist of a bundle of software that resides and runs somewhere on a network device. It communicates closely with the network chipset, monitoring the activity of the chips and the network/ring and making any necessary modifications. The responsibilities of NMS shall be divided into two basic categories; state machines and frame services. The state machines shall provide the network reliability component of NMS by monitoring the FDDI/802.xx chipset and adapting to changing network conditions. The frame services shall provide the network management component by responding to in-band requests from the network manager. The following modules shall comprise the state machines and the frame services. The NMS shall consist of the following object components;

1. Ring Management (RMT) which shall;

    a. Initialize MAC (medium access control layer) for data transmission

    b. Detect and resolve duplicate address conditions

    c Detect stuck beaconing conditions and restricted dialog on the network

    d. Transmit directed beacon frames.

2. Connection Management (CMT)shall manage the connection of the physical network. CMT shall consist of;

a. Entity Coordination Management (ECM) which shall;

(1) Control the optical bypass
(2) Implement the hold policy
(3) Propagate trace to detect ring fault domains
(4) Starts and stops other NMS232 stste machines

b. Physical Connection Management (PCM)which shall;

(1) Initialize port-to-port connections.
(2) Monitor bit error rates on links.
(3) Enforces connection policies.
(4) Controls PHY (physical layer) and PMD (physical medium dependent layer).

c. Configuration Element Management (CEM) which shall;

(1) Clear ring of frame fragments.
(2) Reconfigure station resources.
(3) Enforces configuration rules.
(4) Controls the CCE.

3. NMS Agent which shall receive, parse, and respond to frame-based requests from the network.

4. Neighbor Notification Transmitter (NNT) which shall monitor the identity of the MAC's upstream and downstream neighbors.

5. Status Report Frame (SRF)which shall implement a protocol used to notify the network of changes in station status.

6. Management Information Base (MIB) which shall provide access to NMS variables in a generic manner. The following types of data shall be in the MIB;

a. SMT- Items about SMT in general
b. MAC- Items specific to a MAC
c. Pathclass- Items relating to paths in general
d. Path- Items relating to a specific nonlocal (primary or secondary) path.
e. Port- Items relating to a specific port
f. Attachment-Items relating to a specific attachment.

H. **Network Security**: The NMS shall defines the access rights of the users on the networks and determines what resources a user has access to and what operations that user may perform on those resources. Security and authorization shall be based on the concepts of users and passwords. The network administrator shall be able to define every new user for the system, gives the user an account, and assigns that user to the rights to various network objects. To gain access to the system, users must log on to the system, specifying both their user names and their passwords. Passwords shall be unique and shall be specified to be of minimum acceptable length. All passwords shall be encrypted and are sent across the network only in encrypted form. The NMS shall facilitate the periodic changing of passwords on a routine basis.

I. **Network Authorization:** Files, directories and devices shall be protected by a number of access rights. The user shall be given privileges (such as read, write, update, delete, modify attributes, perform directory search, execute, create, and supervisory) at the file or directory level. Files themselves shall be further protected by attributes such as read-only, which shall prevent the file from being modified. The NMS shall feature a security database which shall be responsible for assigning and tracking the privileges of all objects on the network. All objects, such as users and files must be registered in the security database. This database then determines who is allowed access to what object.

J. **NMS Displays**: NMS shall run on any workstation in any mode with the capability of NMS menus and displays appearing on any number of workstations simultaneously. There shall be multiple copies of this software concurrently resident within the system. Operator actions shall be performed through a number of menus and displays that are initially accessed by pull-down menus. NMS shall determine which conditions exist and shall put up the appropriate NMS health display. The NMS shall display shall show all stations/ connections on the network. Selection of the NMS display feature shall give the stations and their logical names showing the all domain and station status. Pointing/input devices used for displays shall be mouse, trackball, or touchscreen. Using NMS, the operator shall be able to have access to the following features;

1. Viewing hierarchical system and network displays indicating the health of system equipment and network communications. Access to information from the system network down to the intelligent sensor level shall be available both in a graphical and tabular format.

2. Network statistics for analyzing network performance.

3. Display system monitor domain information and complete information about stations and peripherals within the domain.

4. Display health and operational information about Intelligent Transmitters.

5. Allow an operator to perform equipment change actions, such as rebooting a station or putting a peripheral off-line.

6. Running On-Line and Off-Line diagnostics.

K. **Network Configuration**: NMS shall utilize a system configurator which consists of a series of editors used to create a network by linking all network hardware and software modules. Each editor shall list all available hardware and software resources. The NWS shall be used to define all logical and physical connections associated with the network. This network configuration function shall be accomplished by selecting items from logically organized pull down menus, selecting appropriate software modules, and assigning network identification tags and descriptors. The NWS shall have self-checking utilities that verify the existence of all necessary logical connections. If the network has logical gaps, the NMS shall identify the concern and display the missing linkages or modules.

2.18 DISPLAY MANAGER

A. The Display Manager window, shall present the initial control systems display and shall always be present on the screen (as window or icon) and shall be used to view process displays. It shall also provide consistent access to other application windows via the top menu bar and pull-down menus. Workstations shall be directly connected to applications running on other platforms to allow single operator interface to multiple systems and multi-media capability.

1. The contents of the selected application shall be displayed in a base window on the background screen area (workspace). Control of the workspace shall be handled by using the mouse/trackball buttons, touchscreen (to emulate left button), and function keys to perform the following actions as a minimum:

    (a) Access function menus, window, and icons - stack a window in front or back of another window.

    (b) Make selections from menus.

(c) Manipulate the size and location of windows - toggle between two window sizes, and change window dimensions.

(d) Iconize a window - change the window to an icon representing it in compressed form or open an icon to its full size window.

B. The types of menus as a minimum shall be:

1. A window menu for performing functions related to the window, such as re-sizing, moving, re-stacking, opening/closing.

2. A Workspace menu for accessing a function or sub-menu of functions, such as, programs, utilities, properties.

3. Scroll bar menu, for scrolling specified text in the application pane to new locations within the pane or back to the previous position.

4. Pop-up windows for filling in information or making choices. These menus shall be available under menu buttons in the control area or as pop-up menus at the pointer location. Menus shall be accessible on a temporary basis, available until dismissed, or push pinned to the workspace for ready access.

2.19 DATABASE CONFIGURATOR

A. **General:** Each WS shall provide a comprehensive, distributed interactive database system for creating, storing, editing and monitoring all process inputs, outputs, manually entered data, and internally calculated values. Process data point creation shall utilize conversational fill-in-the-blanks techniques for ease of use by the process engineer. The Database Configurator shall provide a file-oriented structure for the purposes of data acquisition, data conversion, digital filtering, scaling, and alarm checking. All of the parameters and features noted shall be individually selectable and modifiable in an on-line fashion at the CRT console. As a minimum, the configuration software shall provide/perform the following functions:

1. Each input or calculated value shall have a unique tag and descriptor. The configurator shall accept a tag of up to 12 characters and a descriptor length of up to 32 characters. All data shall be tag accessible and not require an imbedded hardware address.

2. Process inputs shall be capable of being processed for alarm detection and control processing at a user adjustable rate between 0.1 and 3600 seconds.

3. All process outputs shall be capable of being updated at an adjustable rate between 0.1 and 3600 seconds.

4. Filter, scale and linearize raw input signals into engineering units based on a scale of 0 to 65,000 counts. Point resolution shall be user definable to 12, 13, 14 or 15 bits.

5. Check input signals for instrument limit conditions.

6. Assign alarm limits for high, low, and rate-of-change limits.

7. Assign alarm priority levels. Up to 4 levels of alarms shall be definable.

8. Each data point shall have the capability of assuming various grades of quality status. The state shall provide the operator with and indication of the quality of the hardware and software. As a minimum, the following states shall be provided:

   ON: This state shall indicate hardware and software are functioning properly.

   OFF: In this state, the data point shall not be processed. Data values may be inserted by the operator.

   BAD: This state shall indicate a software malfunction. The data point shall be returned to ON only by operator or technical intervention.

   HOLD: This state shall indicate hardware malfunctions such a multiplexer failure, transmitter failure, open thermocouple detection, etc. In this state, the last reasonable data value shall be maintained in memory. When the hardware malfunction clears, the data point shall be automatically returned.

B. **Data Validation:** The data point state shall be combined with the process alarm conditions to indicate data point status in a concise manner. Hardware and software malfunction shall precede process alarms. If the data point state is BAD, its status shall also be BAD, irrespective of previous process alarm condition. However, if the data point is being monitored with a high alarm present, its status shall be HIGH.

2.20 DATA ACQUISITION AND CONTROL CONFIGURATOR

A. **General:** The Data Acquisition and Control Configurator shall enable the development and modification of control strategies using a menu driven fill-in-the-blanks conversational technique. The CSP shall furnish a standard library of data acquisition and control algorithms to monitor process variables, detect errors between desired setpoints and measured variables, and issue corrective commands to manipulated variables such as final control elements. Control algorithms shall also be provided to perform sequential and ladder logic control. As a minimum, the library of control algorithm algorithms shall provide the following functions:

1. Process Inputs and Outputs: Analog Input, Contact Input, Analog Output, Contact Output, Boolean Alarm, Pattern Alarm, Event, Flow Calc..

2. Process Control: PID with Options, Ratio, Bias, Differential Gap, Pulse Duration, Self-Tuning Adaptive, High, Low, Switch Position, Universal Ramp, Timer, Status.

3. Calculations: Impulse, Lead-Lag, Dead-Time, Add/Subtract, Multiply/Divide, Square Root,k Exponentiation, Characterizer, Pulse Counter, Accumulator, High/Low Clamp, Rate of Change Clamp, Packed Boolean.

4. Logic: AND, OR, NAND, NOR, XOR, NXOR, Logic Switch, Compare, Bi-Directional Delay, On-Off with Feedback, NO Contact, NC Contact, Energized Coil, Latch Coil, Unlatch Coil, Retentive Timer On-Delay, Retentive Timer Reset, Up-Counter, Down-Counter, Counter Reset, Compare, Program Flow Control, Immediate Input, Immediate Output.

5. Sequential Control: High Level Batch Language (HLBL).

B. Configuring a data acquisition and control scheme shall be performed by linking, from a pre-defined standard list of control algorithms. Operation shall be in an off-line and on-line fashion and shall in no way disrupt the normal operation of independent loops. Pull down menus shall be employed so as to maintain a consistent human interaction with the system.

C. A backup image of the data acquisition and control configuration shall be available at each WS for automatic reloading of the controller when required. The storage medium shall be an "on-line" WS bulk storage device. The data base of each module in the system shall be automatically down-loaded when the module is powered up without operator/engineer intervention.

D. Automated system security measures shall preclude the possibility of dissimilar database structures, data acquisition strategies, or control strategies from being resident in the set of fault tolerant processors associated with each PCM. All database structures, data acquisition strategies, and control strategies shall be either downloaded to both PCM processors simultaneously or sent to the "backup" processor which automatically reflects or mirrors the image to the "on-line" processor.

E. The control configurator shall be self-documenting. The present operating control schemes shall be accessible at the WS. All additions or modifications shall be automatically recorded and shall require no additional operator action.

F. **Data Acquisition Software Algorithms**: The following data acquisition algorithms are being defined to indicate the level of functionality and inter-algorithm interaction associated with fundamental data acquisition functions required for this project. This listing is not all inclusive of project requirements in that additional algorithms may be required to configure a complete and operable system. In all cases, each PCM shall scan analog and discrete inputs at a uniform rate. Existing data samples and status information stored in the PCM current data base memory shall be updated by data and status entries obtained during each new data channel scan.

1. **Analog Processing Algorithms**: All analog inputs shall be sampled at a fixed rate and normalized to eliminate zero drift errors and gain errors. Normalization shall be provided for by applying at least two calibration signals (zero and a positive calibrated reference signal) to a dedicated analog-to-digital converter assembly and then applying a normalization

equation. Signal conditioning shall be applied where applicable including digital filtering, linearization, etc. Digital filtering requirements will be determined by the CSP during the construction period. All transducer signals which bear a nonlinear relationship to the associated measured variable shall be linearized. Signal linearization may be accomplished using table look-up linear interpolation techniques, straight line segment conversion multi-techniques, or by using conversion equations. All analog inputs shall be validated prior to signal conversion and subsequent entry into the current database.

a. Fifth-Order-Polynomial
$Y = K_1 + K_2 X + K_3 X^2 + K_4X^3 + K_5X^4$

b. Power
$Y - K_1 + K^2 (X)^{K}3$

c. Exponential
$Y = K_1 + K_2e^{K}3^{X}$

d. Logarithmic
$Y = K_1 + K_2 (\ln X)$

Where:

Y = Linearized variable

X = Measured variable

e = Base of the natural system of logarithms (e = 2.7182818…)

In = Natural logarithm

K = Constant whose value and polarity shall be selectable at the WS for each individual measurement channel.

e. Scaling: All 4-20 MA analog inputs shall be scaled to a common span. Scaling operations shall not reduce the accuracy of the data. Analog data shall be converted to engineering units by means of the following algorithm:

$$Y = (H-L) \frac{(X)}{(Z)} + L$$

Where:

Y = value in engineering units

H = high value of span, expressed in engineering units

L = low value of span, expressed in engineering units

X = digital value of normalized and linearized data sample

Z = full scale digital data value

f. Filtering: A digital filtering algorithm of the exponential smoothing type shall be provided to smooth time-varying analog input data in accordance wit the equation given below. The filter time "constant" shall be a function of the sampling period and the digital filtering constant, both of which shall be user adjustable.

$$V_F = V_{F-1} + K (V_u - V_{F-1})$$

Where:

V_F = new filtered value

V_{F-1} = last filtered value

K = digital filtering constant which is given by t/T where t = sampling period and T = required time constant.

V_u = new unfiltered value

2. **Discrete Processing Algorithms**: Discrete inputs include both alarm and status inputs. At each scan interval, all discrete inputs shall be checked to determine status changes or alarm conditions. If an input changes status, the new status and time of occurrence shall be recorded in the current data base. Discrete inputs must be processed by suitable time delay/logic algorithms before alarms are noted.

3. **Manual Inputs**: Numerical engineering unit data may be entered manually in a "fill-in-the-blanks" mode at the WS. This data shall consist of additional values for the current data base (e.g., laboratory analyses result); substitution data for measured variables normally scanned, substituted output data for failed algorithms; and new or modified fixed data values (e.g., tank volumes). Variable identification symbols for non-scanned data such as laboratory analyses shall be compatible in format to those symbols used for scanned analog input variables. Replacement data entered manually to control programs shall be treated as out-of-scan analog or discrete input data. All inputs shall be subjected to validation checks to verify reasonableness of data. The system shall be configured to accept a minimum of [500] lab-oriented manual inputs which will be defined by the CONSTRUCTION MANAGER during the system construction period.

G. **Calculation Algorithms**: Calculated variables, such as summed variables, mass flow variables, tank volumes, etc., shall be derived from manually inputted constants and analog inputs which have been normalized, conditioned, and converted into engineering units. Calculated variables shall be computed with the same frequency as their associated analog inputs and shall be stored in the current data base. Suspect data flags shall be set for calculated variables when any of the analog input variables used in their computation have exceeded any signal amplitude or rate-of-change high/low limit. Calculated variables associated with discontinuous processes shall be activated and deactivated by either a software interlock or a process input to avoid the accumulation of erroneous measurements.

1. **Square Root Extractor Algorithm**: A square root algorithm shall extract the square root of an input signal and also have the capability of applying a gain factor and bias to the output signal. A typical square root extractor equation shall be of the form:

   Output = K_1 */Y + K_2

   Where Y is the input signal

   K_1 and K_2 are adjustable parameters.

2. **Summer Algorithm:** A summer algorithm shall have the capability of summing or subtracting at least two input signals. The summer shall have the capability of applying a gain factor and bias to each of the inputs, and applying an additional gain factor and bias to the output or the equivalent. A typical summer equation shall be of the form:

   Output = K_1 * X + K_2 * Y + K_3

   Where X and Y are inputs

   $K_{1,}$ $K_{2,}$ and K_3 are adjustable parameters.

   Note: * indicates multiplication

3. **Multiplier Algorithm:** A multiplier algorithm shall have the capability of computing the product of two input signals. The multiplier shall have the capability of applying a gain factor to the product and bias to the output, or the equivalent. A typical multiplier equation shall be of the form:

   Output = K_1 * X * Y + K_2

   Where X and Y are input signals

   K_1 and K_2 are adjustable parameters.

4. **Divider Algorithm:** A divider algorithm shall have the capability of dividing one input signal by another input signal. The divider shall have the capability of applying a gain factor to the quotient and bias to the output signal, or the equivalent. A typical divider equation shall be of the form:

   $\text{Output} = K_1 * (Y/X) + K_2$

   Where X and Y are input signals

   K_1 and K_2 are adjustable parameters.

5. **Real-Time Data Averaging Algorithm**: Real-time data averaging algorithms shall be provided to calculate running averages of measured and virtual variables. The software shall not require the PCM to store all of the discrete data samples being averaged. Real-time modules shall be provided to time integrate measured and calculated variable rate data.

6. **Max/Min Algorithms**: Max/Min algorithms shall be provided which record the maximum and minimum data value generated by measured and calculated variables during a designated time interval. Two maximum/minimum identification detection modes shall be provided. The first shall consist of monitoring discrete data values which are sequentially compared against the previously detected discrete maximum and minimum values. The second mode shall consist of averaging the three most current data values and then comparing the average against both existing and maximum and minimum averaged values. The second mode is provided to reduce the effects of random values. For both modes, previously detected maximum and minimum values shall be replaced whenever exceeded by current high and low data values, respectively.

7. **Logged Variables**: Input data shall be sorted, compressed, totalized, averaged, filed and then transferred to the WS/HISTORIAN in response to an Operators request to support functions associated with the WS/HISTORIAN.

H. **Control Algorithms:** The following control algorithms are being defined to indicate the level of functionality and inter-algorithm interaction associated with fundamental control applications associated with . This listing is not all inclusive of project requirements in that additional control algorithms may be required to configure a complete and operable system. In all cases of regulatory (modulating) control algorithm configuration, the algorithm shall be configured to track the manipulated variable or manual setpoint to avoid process excursions.

1. **PID Control Algorithms**: Continuous digital control (PID) shall be implemented in the PCM using a high level process control language. Control calculations for PID shall be performed after each scan of the associated controlled variable(s) and new controller set points or final control element operating values generated and issued as required. Control loop states shall be changeable from automatic to manual and vice versa via Process Control Module Logic (PCML) and under Operator control at the WSs. Manually entered control strategy data

shall be validity and quality tested in the same manner as scanned input variables or calculated variables.

a. Position and incremental outputs to final control elements shall be constrained using a PID algorithm with both high, low and rate limits.

b. Set points shall be constrained to lie between adjustable high and low limits. In addition, if a PID algorithm is employed with an error-based derivative term, an adjustable set point ramping rate limit shall be provided to minimize process variable excursions when set point changes are introduced.

c. Manually entered analog data values shall be buffered so that the affected parameter is ramped to its new value at a specified maximum rate.

d. Provision shall be made to prevent windup in the PCML control algorithms.

e. If a control strategy failure has occurred, i.e., the control strategy output exceeds second level high/low amplitude limits, an analog input failure has occurred, i.e., the input value exceeds second level high/low amplitude limits or a control strategy linkage has been broken by the Operator, all attached PID algorithms shall revert from auto control to manual.

f. When a PID algorithm incorporating feedback, feedforward or cascaded control loops is in the "auto" state, the output of the control algorithm shall be automatically fed to the associated final control elements or to the set point of a secondary control algorithm. In addition, all other loops within the PID algorithm shall be in the "auto" state.

g. When a PID algorithm incorporating feedback, feedforward or cascaded control loops is in the "manual" state, the control algorithm output shall be disabled and the output to the associated final control elements shall be under the manual control from the WS.

h. If one or more of the feedback control loops has failed with the outputs of all failed feedback loops being deactivated and placed under manual control one or more of the feedback loops is in a "manual" state because of a control loop failure where all failed inputs and outputs have been replaced with manually entered data; or because one more loops is in a "manual" state because the Operator has replaced valid sampled or derived data with manually entered data, then the PID algorithms incorporating feedback from the attached control loop shall revert to a manual state.

2. **Sequential Digital Control (SDC)**: Control calculations for SDC shall be performed as necessary after each scan of discrete and analog inputs associated with a particular SDC algorithm. SDC control states shall be changeable from automatic to manual and vice versa via PCML. SDC algorithms shall be linked to PID algorithms where appropriate. A SDC loop status shall be changed from automatic to manual and a change-of-status alarm generated if an associated analog input exceeds a second level high/low amplitude limit or

if there are irrational combinations of associated discrete inputs. Two SDC control loop out put states shall be possible as described below.

a. When a loop is in the "automatic" state, the output of the control algorithm is fed directly to the associated final control element(s).

b. When a loop is in the "manual" state, the control algorithm output is disabled and the output to the associated final control element(S) is under the manual control.

3. **Lead/Lag Algorithms**: Lead/Lag algorithms shall have the capability of providing dynamic lead/lag compensation to an input signal. The lead/lag element shall represent the transfer function:

Output = K (T1 * s + 1)
(T2 * s + 1) *X

Where X is the input signal.

T1 is an adjustable lead time constant.
T2 is an adjustable lag time constant.

s is the LaPlacian operator.
K is a gain factor.

4. **High/Low Selector Algorithms:** High/Low selector algorithms shall have the capability of selection of the highest or lowest of at least two input signals. A high selector shall have an output equal to the highest of the input signals. A low selector shall have an output equal to the lowest of the input signals.

5. **High/Low Override Selector Algorithm**: High/Low override selector algorithms shall have the capability of selecting one of eight control loops to manipulate a final control elements. The override selector shall select either the highest or lowest of the input signals to manipulate the final control element. Additionally, the override selector shall provide a feedback signal to non-selected controllers to prevent them from "winding-up" in the low or high direction. The operator shall be able to specify a limit for the difference between the selected and non-selected controller outputs.

6. **Auto/Manual Station Algorithm**: Auto/manual station algorithms shall have the capability of an auto/manual station which shall allow the operator to place an external bias on the input signal when in auto mode. When in manual mode, the operator shall be able to manipulate the station's output. The auto/manual station shall be self-balancing to enable bumpless transfer from manual to auto and auto to manual without any manual balancing.

7. **In-service/Out of Service Algorithm:** In-service (IS)/out-of-service (OOS) algorithms shall have the capability of masking or blocking out all or selected alarms associated with

the OOS device i.e., if a wetwell is declared OSS, low level alarms shall be inhibited. Additionally, if a device has been designated OSS, all control routines shall declare the equipment as being unavailable for service. These algorithms shall be selectable from the operator interface. Numerous algorithms shall be linkable in order to facilitate a series or a train of equipment being taken out of service. This will also apply to valves. Further requirements for display of Out of Service status are in Section 2.24.

a. The OOS algorithm shall be available for any plant equipment monitored by the DCS and greater than 5 HP.

b. The MMS EMPAC modules shall dynamically receive out-of-service status from the DCS.

c. A “tag out status” for a piece of equipment entered on the MMS system shall automatically result in the assignment of an “out of service” status on the DCS.

2.21 ALARM CONFIGURATOR

A. **Alarm Algorithms**: A WS configurable alarm subsystem which manages the initialization, configuration, display, and actions of alarm messages and alarm associated keys within a workstation shall be provided. It shall provide as a minimum:

1. Blink control of the SYS and ALARM fields.

2. Co ntrol of Current Alarm Display (CAD) and actions associated with process alarm messages.

3. Managing Alarm History Displays.

4. Configuration and control of annunciator panels.

B. **System Alarms:** Alarms related to the health of the network and of the stations and peripherals on the network shall be provided.

C. **Plant/Process Alarms:** Alarms related to the process control compounds and algorithms shall be provided. Information available for this type of alarm shall include the control strategy/algorithm/point name, date and time of alarm, value at time of alarm, type of alarm, and value of alarm limit exceeded.

D. **Annunciator Keyboards:** (not used)

E. **Voice Alarm Annunciation:** The alarm subsystem shall support voice alarms using digitally recorded audio files on the WS hard disk. An audio signal output on the WS shall provide a standard audio pre-amp signal to external speakers which have built-in amplifiers. The notification of alarming at a workstation shall be suppressed by assigning an alarm the lowest priority via the

Integrated Control Configurator. The sounding of an voice alarm at the workstation shall be configured based on a priority of 0 for system alarms and a priority of 1-4 for the incoming process alarms. The priority threshold for the alarm shall be user-defined. Alarm Panel and Alarm Table configurators and a user changeable file for alarm default configuration shall be provided for defining and setting up alarms.

F. **Current and Historical Alarms**: The Alarm Subsystem shall support both an Alarm History and Current Alarm Queue. The Alarm History display shall show the latest 500 plant/process alarms in chronological order. The CAD shall show the plant/process alarms sorted by chronological sequence, priority, and acknowledged status. Alarm entries shall clear from the CAD based on the acknowledgement and return to normal states. From this display, graphics associated with the alarms in the CAD shall be able to be redirected to other workstations. The Alarm Subsystem shall allow the operator to preselect, on a per-control-algorithm basis, the display that is preferred for interaction when a plant/process alarm occurs. Each Alarm Subsystem shall allow the operator to specify a display to be associated with each control algorithm with its domain. These displays shall be invoked through the Top Priority Alarm Display key based on current conditions. The Top Priority Alarm Display shall be available from the CAD and Alarm History Display screens.

G. **Alarm Processing Modules**: On each scan, the PCM shall test for the occurrence of such events. Upon recognition of an alarm or "return-to-normal" condition, the PCM shall retransmit the data for annunciation, display, printing, and recording purposes. Alarm messages shall generated upon the occurrence of an alarm condition or when alarm summaries are requested. Alarm sources shall be as specified below:

1. Alarm Processing:

a. All hardwired alarm inputs shall be transmitted to the associated PCM.

b. All analog inputs and associated calculated variables shall be tested for high/low amplitude limit violations by the associated PCM.

c. All analog inputs and associated calculated variables shall be tested on each scan for high/low rate-of-change limit violations by the associated PCM.

d. A discrepancy alarm shall be generated for any final control element if an irrational combination of associated discrete inputs and outputs occurs. If a discrepancy exists between a PCM command and the device status, e.g., the PCM commands a drive to start after establishing that the device is in the "ready-to-run" condition, and the drive fails to start, then a discrepancy alarm shall be generated. Likewise, involuntary changes in device status shall be noted, e.g., pump starts when not commanded to do so or pump runs and then shuts down even though it still has a command to run. All discrepancy alarms shall be listed in the software submittal.

e. Because many discrete final control elements have a cycle time in excess of the scan interval, each output shall have an associated delay period selected to be longer than the operating period of the final control element. Delay periods for each final control element shall be adjustable at the WS. All time delays shall be listed by the CSP in the software submittal.

f. Alarm/Event Logging: A program shall be included to log the following events as they occur on the printers; Record all hardware and software generated alarms and Record "return-to-normal" for all alarms.

g. Although many of the analog data points shown in the Contract Documents were not represented with high and low alarms, the CSP shall configure alarm points for all inputs, outputs, and calculated data points.

2. **Limit Checking**: Dual level limit checking modules shall be provided which shall identify a limit violation when every time a measured or virtual variable goes out-of-limits and returns back into limits. The software shall determine the time at which each limit excursion occurred. An alarm limit deadband shall be provided to prevent a point which is hovering around an alarm limit for becoming an eventual nuisance. The deadband shall be expressed as a percentage of span or in engineering units and shall be adjustable from the WS. All high/low limits shall be set independently for each analog data channel. An unreasonable data alarm shall be generated whenever a signal amplitude or rate-of-change value exceeds or becomes less than a first level high/low value. Whenever a second level high/low amplitude limit value is exceeded, the operational status of associated, software-based control strategies shall be unconditionally changed from automatic to either provisional or manual control and a change of status alarm shall be generated. Whenever a signal amplitude value becomes less than a second high/low limit value a change of status alarm shall be generated but the associated control strategies shall remain in provisional or manual until placed under automatic control by the Operator. All limit check alarms shall be displayed at the WSs. The value of all high/low limits shall be established by the CONSTRUCTION MANAGER duri ng system construction.

3. **Erroneous Alarm Suppression:** Due to the discontinuous nature of many of the subprocesses associated with a treatment plant, certain discrete and analog input alarms must be processed via logic modules such as AND, OR, Exclusive OR, NOT etc. to produce conditional inputs. Typically, if a pump is directed to be in the "OFF" state, low discharge pressure alarms shall be suppressed. Additionally, if a flow meter is indicating zero flow but its associated pump is confirmed as being in the OFF condition, the non-zero value shall be set to zero to preserve system logging and trending integrity. The CSP shall submit a complete listing of data and status points which must be suppressed/manipulated in the software submittal.

4. **Rate Checking**: Rate checking modules shall be provided which shall identify a rate limit violation every time the time-rate-of-change of a measured or virtual variable exceeds or becomes less than rate limit selected at the WS. The software shall determine the time at

which each rate limit excursion occurs. A rate-limit-out/rate-limit-in deadband shall be provided (expressed as a percent of the rate limit value or in engineering units) whose width may be altered at the WS.

5. **Inferential Alarming**: The PCM shall be capable of receiving down loaded process scenarios in the form of logic associations between process I/O, manual inputs and calculated invariables and use these scenarios to generate inferential alarms with an associated priority level. Process scenarios shall be developed by the CONSTRUCTION MANAGER and will consist of the implementation of AND, OR NOR, NAND GATES, signal characterization, look-up tables, signal monitors and timers. Typically, inferential alarming shall have the functionality to compare parameters associated with process equipment (amp draw, speed,), extrapolate a theoretical output from the equipment curves, and compare this calculation to measured parameter such as flow, level or pressure. If a deviation or an incongruity exists between the monitored and calculated values, an inferential or an advisory alarm will occur. A typical example of inferential alarming shall be the monitoring of the variable speed primary sludge pumps. In this instance, the DCS shall store the pumps speed versus flow parameter (either as a look-up table or as a mathematical relationship and shall also monitor pump discharge flow with a dedicated flow meter. If the pump is active and a discrepancy of "X" percent exists between the extrapolated flow and the measured slow, an inferential alarm would be generated. A total of twenty five (25) inferential alarming schemes shall be implemented by the CSP. Subsequent to the initial development, the CSP shall incorporate this work into the software submittal and implement. Inferential alarms shall have display and print capabilities identical to all other DCS alarms.

H. **Alarm Display and Processing:** All alarm detection shall occur at the PCM level. Once detected, alarms shall be announced at the WS in the following manner:

1. Conditional text shall appear on the CRT graphic in a colored consistent with the alarms dedicated priority. Text shall describe the alarm condition and indicate present value.

2. Shapes associated with the alarm condition shall blink.

3. An alphanumeric message announcing the alarm condition shall appear in a CRT screen area exclusively reserved for alarm posting. This alarm scratch pad area shall always be present on each CRT independent of operator function. Messages shall contain time of occurrence, tag number, alarm description, current value alarm limits.

4. A hard-copy printout shall occur indicating the alarm's time and date of occurrence, tag numbers, alarm description, current value, alarm limits and shall appear in a color consistent with the alarm's priority.
5. Control room, process area and facility audible alarms shall annunciate alarms at an adjustable (60-120 db) annunciation level.

6. NOTE: Each of the preceding alarming features shall be capable of being utilized or silenced based on the priority assigned to an alarm. The alarm subsystem shall accept a minimum of 5 distinct priorities.

7. Operator acknowledgment of an alarm shall cause text/horn to change state/silence.

I. **Alarm Actions**: There shall be four (4) priorities available for alarming. The alarms shall appear on the alarm list in reverse video indicating that they are "unacknowledged". Once acknowledged they shall return to normal text. The priority should be 0(white), 1(yellow), 2(magenta), and 3(red) - lowest to highest. As a minimum, the alarming package shall perform as follows:

1. Detection of a priority No. 1 alarm (indicative of process excursions).

   a. Shapes or text associated with alarm point flash in a white color on the CRT.

   b. Operator console annunciator announces the alarm with a Priority No. 1 intensity and pitch.

2. Detection of a Priority No. 2 alarm (indicative of impending hazard to equipment or process).

   a. Shapes or text associated with alarm point flash in a yellow color on the CRT.

   b. Operator console annunciator announces the alarm with a Priority No. 2 intensity and pitch.

   c. Annunciator horn located on process floor announces the alarm with a Priority No. 2 intensity and pitch.

   d. Alarm printer notes and time stamps the initial detection of the alarm and the return to normal.

3. Detection of a Priority No. 3 alarm (indicative of impending hazard to personnel safety).

   a. Shapes or text associated with alarm point flash in a red color on the CRT.

   b. Operator console annunciators announce alarm with a Priority No. 3 intensity and pitch.

   c. Annunciator horns located on the process floor and external to the process building which contains the alarm point announce the alarm with a Priority No. 3 intensity and pitch.

   d. Alarm printer notes and time stamps the initial detection of the alarm in red and the return to normal in red.

J. **Alarm Horns and Beacons**: The CSP shall provide all required external horns and beacons. Alarm horns and beacons shall be provided and installed by others external to each building that houses a WS.

2.22 REPORT CONFIGURATOR

A. **General:** The report Configurator shall consist of all resources needed to generate process, facility, department and system reports. All software algorithms shall be object oriented and linked to facilitate revisions and modifications and to minimize redundant coding of identical tasks. All software shall be structured so that an expansion in digital system hardware and/or the addition of new process inputs and outputs can be accomplished without having to reengineer report software.

B. The report configurator shall allow the operator to generate printed reports listing the status of a set of control strategies and algorithms that are in an exception condition; e.g., in alarm, in manual, not on control. The operator shall be able to write the report to a file, to be copied to diskette for long-term storage of report data.

C. The configurator shall be able to be accessed concurrently by several WS Processors. The configurator shall contain an easy-to-use operator interface.

D. The configurator shall let the operator select configured report files that already exist, or define new report files. Files that contain reporting selections shall include a list of available printers; control strategy and algorithm names; specifications for the control strategies/algorithms and their associated exception states and report types; alarm conditions.

E. The report configurator shall have the computational capabilities to perform the following operations;

1. Summation, subtraction.

2. Multiplication, division.

3. Integration.

4. Differentiation.

5. High/low select.

6. Average Value; hourly, shift , daily , weekly, monthly, yearly average.

F. The report configurator shall interact with resources that collects current values of specified variables from on line data storage areas, statistically manipulates data, and creates and maintains a data base of values collected. Statistical manipulation shall include linear averaging, filtered averaging, and noting of "bad" or suspect values.

G. The configurator shall enable the operator to select configured report files that already exist, or define new report files. Files that contain reporting selections shall include a list of available printers; tag d and algorithm names; specifications for the tags/algorithms and their associated exception states and report types; alarm conditions.

H. The report configurator shall support the generation of 4 distinct types of report generation. Each of these types of reports shall be capable of having any or all of reporting frequencies based on hourly, shift, daily, weekly, monthly,or yearly. Process reports shall consist of a total of seventy five (75) pages with twenty (20) variables per page; management reports shall consist of a total of one hundred (100) pages with twenty (20) variables per page; Department Management reports shall be as defined under 2.4 herein; and control system reports shall consist of minimum of ten (10) pages. Report types are as follows;

1. Facility Process Reports: Contain data derived from on-line process a measurement and lab data which has been manually inputted with an associated time and date.

2. Facility Management Reports: Contains data derived from the resources associated with FIN. Reports shall include MIS, MMS,and LIMS data.

3. Department Management Reports: Contains data derived from resources associated with DIN, FIN, and PIN.

4. Facility Control Systems Reports: Contains data relating to component availabilities (uptime); diagnostic results; network diagnostic results; listing of all alarms associated with a tag, algorithm, or hardware device; time stamps of when automatic system backup occurred; listing of all points not in scan, etc.

2.23 HISTORIAN CONFIGURATOR

A. **General:** The Historian System (HS) shall be a real-time software supported system which shall provide process management capabilities. The system shall:

1. Communicate with the Lab and Office terminals over the FIN, WSs, DIN devices, and all process control modules (PCM's).

2. Maintain a process information data base to support historical data storage, retrieval operations, report/log generation, trending, and event reconstruction with a data compression algorithm.

B. All software shall be provided to enable historical data base generation to be accomplished by a conversati onal fill-in-the-blanks technique on WS display formats in which operational characteristics (i.e., name, scan class, alarm limits, etc.) are inserted into linkable prewritten software modules which perform scanning, computational, and collection functions. Once the information is transcribed into system algorithms, the data base software shall:

1. Read and interpret the information.

2. Manage all process input and output hardware assignments.

3. Generate data files.

4. Perform self documenting functions such as producing hard copies of listings, main and disc memories, and data sorts by analog input, analog output, contact input and contact output.

C. The software system shall incorporate a disk memory resident data base which shall store all software elements necessary to implement all data acquisition, calculation, logging and reporting functions. The system data base shall be comprised of the following elements:

1. Current data base; includes process status information.

2. Historical data base; includes non-current process status information.

D. The HS shall scan algorithms and shall extract data from the communications networks at specifiable rates as defined at the WS. In addition to defining the historical database contents and the data associated collection rate, the operator at the WS shall also be ale to define signal and unit conversion (floating point) requirements, floating point formats, and calculation requirements. All data shall be stored in a system data base. Typical input signals to be scanned include:

1. Limit, status, or position information from open/close valves, motors and process monitoring devices such as flow, temperature and pressure switches.

2. Measured variables such as flows, pressures, etc.

3. Measurements, setpoints and outputs from PCM-resident controllers.

4. Computed values such as inferential measurements.

5. Operational commands from WSs.

6. Manually Inputted data.

7. Password Activity (sign on/sign off times, WS activities during interval between sign on and sign off by password, etc)

E. HS computational algorithms, which are configurable at the WS shall be shall be provided to perform:

1. Summation, subtraction.

2 Multiplication, division.

3. Integration.

4. Differentiation.

5. High/low select.

F. The HS shall be provided complete with all programming that collects current values of specified variables from on line data storage areas, statistically manipulates data, and creates and maintains an historical data base of values collected. Statistical manipulation shall include linear averaging, filtered averaging, and noting of "bad" values. Statistically manipulated data shall then be stored in an historical data base.

1. The frequency of historical collection shall be selectable from once per second to once per month. The type and quantity of historical data shall be selectable by addition and deletion to/from the historical data base. The HS software shall be capable of supporting up to 10000 individual tags at varying collection intervals.

2. All required software shall also be provided to enable delta-band data storage techniques.

3. The HS shall be furnished complete with all utility and application software required to enable interaction with all subsystem specified.

G. The CSP shall provide fully paid up licenses for all software packages provided.

H. The CSP shall provide any necessary licenses, media or documents normally provided to support the operating Historian System.

I. Historian software shall be the Westinghouse WDPF Historian.

2.24 STATION (WS) CUSTOM GRAPHIC SCREENS

A. **General:** All process graphic displays shall reside in non-volatile or battery-backed RAM/DRAM memory resident in each workstation (WS) and be updated in accordance with the display response time requirements specified herein. All process graphics shall utilize advanced graphic features such as isometric representation of process equipment, tanks, and flow lines; line-fills which use the dynamic movement of color and patterns to indicate the current process flow routing in pipelines or channels; permissive dialog boxes which itemize all of the permissives, and their current state, associated with control strategies related to the currently displayed process graphic. The number of unique process graphics required under this contract is listed in the APPENDIX. All graphics shall be stored in non-volatile memory and shall be updated in conformance with display response times stated herein. The CSP shall furnish a minimum number of process graphics as listed in the APPENDIX, with each graphic containing a minimum of (a) five (5) analog or calculated variables, (b) fifteen (15) discrete status information points used to annotate equipment s tatus coloration, (c) five (5) fields of conditional text which are generated by discrete alarms and high/low current trips associated with analog values discrete and current trips, (d) seven (7) process equipment/tank shapes, drawn in an isometric format, which are color annotated by associated status and alarm conditions, (e) three (3) instrument shapes, (f) ten (10) main process lines, drawn in an isometric format, which are dynamically filled by the detection of an associated device's active status, (g) five (5) poke points which are used to invoke displays associated with control stations for process equipment, displays which list the status of all permissives associated with a particular control routine or process equipment device, or preformatted trend displays. These custom graphics which do not include template graphics (such as trends, manual/auto (M/A) stations or other generic graphics required for this project), shall typically incorporate a total of thirty (30) variables for each process graphic.

B. **Display Hierarchy**: Each WS shall be configured with displays arranged in a hierarchial manner which enable rapid movement between various levels via paging or other logic oriented functions. The hierarchy shall apply to both process and system oriented displays. Each WS shall, as a minimum, be configured in conformance with a hierarchy consisting of the following displays levels:

1. Global level
2. Regional level
3. Group level
4. Loop level
5. Component level

C. **Process Global Display Layer**: The process global display layer shall be a level of display which presents a department-wide overview. Process Global Displays shall consist of a series of pages which:

1. Depict system, date, time and status on all displays.
2. Graphically depict, in a algorithm diagram format, each on-site and off site regional plant process area and the logical association between each area.
3. Indicate the current and historical operational level based on percent of capacity.
4. Indicate the current and historical energy efficiency based on connected load. An X-Y plot of operational versus energy efficiency shall be displayed.
5. Itemize each process area which currently exhibits alarms of a given priority (E.G., separate listings of priority No. 1,2,3 alarms associated with each area).

6. Presents a main menu which lists all process regions or areas. The operator shall be able to use this menu to page or link down to the Process Regional Display Layer.

D. **System Global Display Layer**: The system global display layer shall be a level of display which shall depict the current status and "health" of all on-site and off-site DCS components. System Global Displays shall consist of a series of pages which:

1. Depict system date, time and status on all displays.

2. Graphically depict the on-line, off-line, backup and failure status of all devices.

3. Indicates the accumulate run time for each device. For those devices which have backup controllers, the accumulated run time for on-line mode operation shall be indicated for each controller.

4. Indicate the availability of each device or component for which a run time is being accumulated. This display shall also indicate the availability for the entire system. All calculations to support the availability calculations shall be in conformance with these specifications. These calculations shall be distributed throughout the system to preserve the calculations integrity.

5. Indicate all system diagnostic results including time-out response, allocated time to transmit and actual time to transmit.

6. Indicate all system alarms, and their associated priority, which have occurred in the previous twenty-four (24) hours.

E. **Process Regional Display Layer**: The process regional display layer shall be a level of display which presents a detailed view of a prescribed process area. Process Regional Displays shall consist of a series of pages which:

1. Depict system date, time and status on all displays.

2. Present a deviation overview which displays, in bar graph form, the deviation of this area's key process variables from their corresponding setpoints. All loops which have exceeded a prescribed deviation shall have their respective bar graph change color.

3. Presents a bar graph depiction of all process variables engineering values with their associated alarm limits being indicated. If a variable has exceeded in rate or absolute alarm limit, the bar graph shall change color.

4. Presents a display, in an isometric PID ID format, which illustrates all of the process equipment and instrumentation associated with this area. All process graphics shall be drawn in an isometric format and shall depict critical engineering values, all equipment status indicated by conditional text and color, and all process lines shall be dynamically filled

with the appropriate color when flow is detected or equipment is active. All operator actions shall be pokable. These displays shall also incorporate the windowing of trend and X-Y plots.

5. Presents an alarm and event history of all area alarms or operator interface events. All data shall be annotated by tag names, descriptors, event, occurrence, type of alar, priority, current value, alarm limits, and alarm status. All unacknowledged alarms shall be annotated in a reverse video format.

F. **System Regional Display Layer**: The system regional display layer shall be a level of display which shall depict the current status and health of each DCS component within a prescribed process area. System Regional Displays shall consist of a series of pages which:

1. Depict system date, time and status on all system displays.

2. Graphically depict the on-line, off-line, backup and failure status of all devices.

3. Indicates the accumulated run time for each device. For those devices which have backup controllers, the accumulated run time for on-line mode operation shall be indicated for each controller.

4. Indicates the availability of each device or component for which a run time is being accumulated. This display shall also indicate the availability for the entire system. All calculations to support the availability calculations shall be in conformance with these specifications. These calculations shall be distributed throughout the system to preserve the calculations' integrity.

5. Indicate all system diagnostic results, including time out response, allocated time to transmit, and actual time to transmit.

6. Indicate all system alarms, and their associated priority, which have occurred in the previous twenty-four (24) hours.

7. Present a graphic depiction of all of the printed circuit boards associated with a particular device. All boards which have failed diagnostics shall be alarmed and be annotated by a change in color.

8. Present a board-level diagnostic fault display analysis which itemizes the specific cause for fault assignment. All descriptions shall be English language devoid of computer terminology.

9. Present a graphical input/output display which enables the detection of a problem or failure down to the point level. This display shall also indicate A/D and D/A performance, accumulated run times per board and availability per board.

G. **Process Group Display Layer**: The process group display layer shall be a level of display which presents the operator with information on and a means to control key variables and equipment within the prescribed area from which this display was accessed. Process Group Displays shall consist of a series of pages which:

1. Depict system date, time and status on all displays.

2. Depict bar graphs showing values of setpoints, alarm limits, control outputs and process variables. All alarms shall be annotated by color change. All values shall be in engineering units.

3. Depict manual, automatic and cascade mode status.

4. Depict, in a graphical format, logic stations which enable the operator to perform logical operations such as opening and closing valves, starting and stopping motors and starting and stopping control sequences. Every control output shall have a dedicated logic station.

5. Depict trend displays which are windowed into displays with associated data.

6. Depict, in an isometric P & ID format, a detailed view of each subprocess.

7. Depict In/Out of Service Status for each device.

   a. The OOS assignment shall be made from a button on the pop-up control window for each device.

   b. The Out of Service Status shall be indicated by "graying-out" the device symbol on the control graphic.

H. **Process Loop Display Layer**: The process loop display layer shall be a level of display which presents an interface for the operator to interact with the process on a loop level. Process Loop Displays shall consist of a series of pages which:

1. Depict system date, time, and status on all displays.

2. Depicts, in a graphical format, M/A control stations for each analog output in the area. This display shall display process variables in engineering units, display controller output in percent, display the mode that the control system is in, display alarm limits in engineering units and in percent output. The display shall enable an operator with proper security clearance to perform any one or all of the following:

   a. Change control modes

   b. Ramp set point

   c. Enter finite value for set point

d. Delete variable from scan

e. Change alarm limits

f. Delete alarm actions

3. Depicts, in a graphical format, a high speed X-Y plot or trend which can be windowed into displays with control status.

4. Depicts control loop tuning displays which are designed to be used by operators, process engineers and instrument engineers. Plant personnel shall be able to use these displays to make step changes, activate/deactivate loops, trend process variable versus output versus response time and perform on-line tuning adjustments. All of these tasks shall require proper security clearance. These displays shall be generated for each loop and shall contain:

a. A control station displayed in graphical format.

b. A windowed fast trend X-Y plot.

c. A listing of all the tuning parameters associated with the loop, (e.g., proportional band, reset rate, derivative rate, etc.)

I. **Process Component Display Layer**: The process component display layer shall be a level of display which presents a highly detailed historical accounting of all major process equipment, all DCS components and all field analog devices. Process component displays shall consist of a series of pages which:

1. Depict system date, time and status on all displays.

2. Graphically depict the current status of each process equipment device which utilizes over five (5) HP or more on a dedicated P&ID isometric formatted graphic. Each graphic shall display current status, values in engineering units which are associated with the device, alarms, accumulated run time, a history of all past alarms, indication of manufacturer, model number and date of installation of all associated components.

3. Graphically depict the manufacturer, model number, date of installation, accumulated run times, alarm history and availability of each DCS component.

4. Graphically depict the manufacturer, model number, date of installation, drawing reference and calibration data associated with each analog device being installed under this project. Displays shall also have an imbedded alarm history based on process and validity of alarms.

2.25 WORKSTATION (WS) PROCESS TUTORIAL DISPLAYS

A. **General**: Each process graphic shall have associated with it process tutorial displays designed to promote the operators process knowledge and familiarity with plant procedures. All process graphic shall have a uniquely define ICON, which is a replica of the Departments Logo, which when selected displays in a windowed fashion, related process tutorial and assistance displays.

B. **Process Tutorial Displays**: Each process graphic at the Global, Regional, Group and Loop Level shall have, an associated process tutorial graphic display. The minimum number of process tutorial displays which shall be conceptually developed by the Owner and implemented by the CSP is listed in the Appendix.. Each process tutorial shall contain the following information in a graphical and text presentation:

1. Description of process objective

2. Description of process dynamics

3. Depiction of process units in a algorithm diagram format.

4. Description of available process control alternatives.

5. Indication of current active mode.

6. Indication of all key process variable current values.

7. Indication, via calculation, of past process performance

C. **Operator Assistance Displays**: Each process graphic at the global, regional, group and loop level shall have an associated operator assistance graphic display. Plant or process emergency displays shall be displayed either by ICON selection or automatically based upon event detection. The minimum number of operator assistance displays which shall be conceptually developed by the Owner and implemented by the CSP is listed in the Appendix.. Operator assistance displays shall contain the following information in a graphical and text presentation.

1. Plant/process start-up procedures

2. Plant/process shutdown procedures

3. Plant/process emergency procedures pertaining to the lose of power, rupture lines and vessels, failed equipment, or the detection of hazardous materials.

2.26 WORKSTATION (WS)-TREND SUBSYSTEM

A. **General:** A collection of pre-built (preformatted) display fields that show lines (trends) representing changing data values from the real-time database and from the historical database shall be furnished. The Trend Subsystem shall be able to trend any variable in the data base, both analog and discrete.

B. The maximum number of trends shall be limited only by the display storage media capacity. Each trend line shall be capable of at least 900 samples of the process variable. Any CRT shall be able to display any historized variable from any historian in the system. Historical trend data shall be capable of being archived to streaming tape and/or floppy disk to be able to be displayed at any future date.

C. Trends shall represent changing data values from the real-time database, and from the historical database. Trends shall be configured on-line with the Display Configurator, and shall be laid out using the Group Display Configurator. The on-line trend configurator shall be selectable from a Detail display, to allow change of trend area attributes and trend line attributes without disrupting the process.

D. The Trend Sub system in conjunction with the Trend Pen Configurator shall allow Analog Output variables to be assigned to Analog Strip Chart/Pen recorders for hard copy of real-time trend data.

E. A library of standard trend areas, X/Y plot areas, and profile plot areas which can be copies into any display shall be furnished. The trend areas shall vary in size (resolution) and shall be of two types: real-time and historical. The X/Y and profile plot areas shall also vary in size. The Display Builder and Display Configurator software shall include these areas in user-defined displays, and the Display Configurator shall be used to assign the desired configurable options. Trend areas to include as a minimum:

1. Up to eight trend lines per trend area representing variable data types (Boolean, signed integer, real, and signed long integer)
2. Tick marks indicating division of the axis
3. Time axis length shall be chosen freely
4. Y-axis scaling shall be independent of its length
5. Off-normal limits shall be available in different colors
6. Background color of a trend area shall be changeable
7. Trend line color shall be changeable per trend line
8. Solid trend shall be drawn instead of a line trend
9. X-Y trend objects (one variable versus another)
10. Reassignment to any process variable in the system

F. Text fields shall be defined and configured:

1. Loop Tag

2. Loop Descriptor

3. Any parameter engineering unit

4. Engineering Unit Descriptor

5. Scroll frequency for an entire trend area (limited to real-time trend objects)

6. Per-trend variable:

    a. High range value

    b. Low range value

    c. Value at ruler (for direct readout)

    d. Off-normal limits

G. **Real-Time Trending:** Real-time trend areas shall scroll dynamically as data changes occur according to the selected scroll frequency (e.g., 1, 2, 5, 10, 30, 60 seconds). Scrolling and updating of real-time trends start immediately after calling up the display. Real time trends shall be capable of collecting and displaying all 1 second samples without averaging or compression.

H. **Historical Trending:** Historical trend areas shall provide purely historized data from the historical database files, which shall include sample data and reduction group data; archived sample group data and archive reduction group data; restored archive sample group and archive reduction group data from floppy disk or streaming tape. Historical trend variables shall incorporate any data reduction and archiving functions thereof. On-line Historical Trend Area interactions shall include:

1. Selection of parameters to be viewed from the Historian data base.

2. Specification of the high and low scale of the Y-axis for each variable for more or less detail.

3. User definition of the time window (base time and/or time span) specified by the time axis in order to view another portion of the history or to view a portion in more or less detail.

4. Use of a moveable ruler to position and numerically read out historical variables within a displayed time window.

5. Specification of off-normal limits.

6. Zero axis readings.

2.27 WORKSTATION (WS)-X/Y PLOTS AND PROFILE PLOTS

A. **General:** The X/Y plots shall contain two variables which are plotted against each other. These variables shall be real-time data taken from object manager-connectable variables within the system or a file of X/Y pairs. The data points shall be collected at a configured scan rate and displayed as a series of points or markers that can be connected. Color shall be used to designate the latest X/Y pair and previously plotted points. Via the use of colors, file data shall be visually compared to recent real-time data. Plots shall include as a minimum:

1. Background color of X/Y plot shall be changeable.
2. Objects shall be capable of being added to the background area.
3. Style selection of real-time and file plot data
4. Standard grid
5. Multiple colors for representing the most recent data point, real data, and file data.

B. The X/Y plot line attributes for each variable shall include: high scale value, low scale value, and delta change value (for real-time data). Default values for these attributes shall be accessed directly.

C. The profile plot area shall display data accessed from a data array of the following type of data: float, long, integer, or byte. The plot shall display each data point along the X-axis with the value of each point associated with the Y-axis. The profile line shall include: high and low scale values, high and low alarm values, the start and end offset for the data array, and the location to which a selected point value is to be sent. The profile style shall be either line profile or bar profile and updates occur simultaneously or by exception. Plot shall include as a minimum:

1. Up to four lines of bar lines per plot area.
2. A reference line representing the median value for each line
3. Line color specified per lot line under normal conditions
4. Off-normal limits specified in a different color
5. Reference line color
6. Lines or bar lines shall be mirrored along the Y-axis

2.28 AUTOMATICALLY GENERATED DISPLAYS

A. Automatically generated displays shall be fully operational displays, which are presented in three levels of control hierarchy:

1. Station display

2. Control strategy and Algorithm Overview display

3. Detail display

B. A Station Algorithm, shall convey information about the system capacity parameters for a Process Control Module type station. This algorithm shall be installed automatically when the database is downloaded, and provides global data storage for system functions. Information displayed includes: percent of CPU time used for processing input/output, all algorithms and continuous control algorithms; free memory available; Object Manager scanner data; cumulative algorithm processor overruns; total inter-station IPC connections; and peer-to-peer point connection status.

C. To access a control scheme without configuring displays, the operator shall be able to request the Control strategy and Algorithm Overview display. The current level of criticality (the highest priority alarm that exists in any algorithm within the control strategy) and relevant data shall be displayed for each control strategy and algorithm. All alarm information displayed or set by Default Displays shall be received from or sent to Processors. This includes the acknowledged and/or unacknowledged status of the alarms.

D. Displays for individual control strategies shall be accessed from the Compound and Algorithm Overview display. Control strategy displays shall be live displays that allow interaction with all algorithms within a single control strategy. Control strategies from several processors shall be grouped and turned on or off as a group.

E. Detail displays for individual algorithms shall be accessible from the Control strategy and Algorithm Overview, Alarm History and Current Alarm displays. Detail displays shall allow operator manipulation of all valid algorithm parameters. They shall show all connectable algorithm parameters, a faceplate area and a real-time trend area (for continuous control algorithms). In graphic format and in a small area, faceplates shall provide information as to algorithm type and description; measurement, setpoint, output values; algorithm state and status; alarm condition; auto/manual and remote/local designation. There shall be three categories of algorithm types/domains as a minimum:

1. Continuous Control

2. Sequence Control

3. Ladder Logic (Programmable Logic Algorithms)

2.29 PREFORMATTED GROUP DISPLAYS

A. **General:** Preformatted displays provided shall be modified or new ones created through a menu-driven configuration and editing process. Link preformatted displays shall be linked to each other and to graphics to form a user-defined display hierarchy.

B. The group display shall present information for up to eight control algorithms in a four-over-four screen layout. It shall show each algorithm as a faceplate with a unique layout available for each algorithm type. The display shall contain faceplates, trends, or X/Y plots or a combination of all three. Display Builder and Display Configurator shall be used to edit displays.

C. Sequence algorithms shall be intermingled with Continuous algorithms and PLB algorithms in the group display when required. All control algorithm types/domains shall be supported. Group display interactions shall be performed with screen functions keys. Interactions to include as a minimum:

1. Control and alarm monitoring of algorithms

2. Ramping or numeric entry of set points, ratios, targets, outputs, etc.

3. Toggling discrete values and controller states

4. Requestin g the Detail display for a selected algorithm

5. Direct access to the previous display

2.30 INVOKING DEFAULT DISPLAYS

A. Default displays, preformatted displays, and user-defined displays must all be invoked in an identical manner. Any specific pre-defined display shall be assigned to and called from any menu, attached to a hard annunciator key or soft (screen) key, called via an application program, or attached to an active display object with a display.

2.31 ELECTRONIC DOCUMENTATION

A. **General:** Systems documentation shall be provided on the system itself in electronic format. It shall be available as loadable diskettes or CD-ROMs to be run as a separate entity, and as on-line help that is associated with the software functions themselves. Diskettes shall be used as they are needed or be loaded onto the hard drive for easy access.

B. Documentation shall be broken down by function and user. Information required by process operators shall be included in a Process Operator's Guide; information required to configure process control algorithms shall be included in Integrated Control documents and shall be geared toward the process engineer.

1. **Loadable Documentation:** Loadable documentation shall provide comprehensive information about hardware and software. It shall consist of text and graphics displayed on the workstation

screen. Documentation shall be able to run in its own window concurrently with other applications. Documents shall be accessed via the menu bar pick, with further selections made from another menu and table of contents. Documents shall be picked from an alphabetical list or from functionally organized subgroups. Once a document is selected, choice of reading the entire document, a specific area of interest or list of figures, or an index that shows the document selections that discuss the subject area desired will be made available. Various screen control functions shall be provided as selectable icons displayed at the bottom right of each screen of text. These shall include Next Screen, Previous Screen, Next Section, Table of Contents, Exit, and Return. A distinction shall be made between active and inactive selections using different icons.

2. **Printing Loadable Documentation:** Loadable documentation shall be printed by a special utility that prints all text sections in the document. Each printed page shall contain up to two screens of text.

3. **Embedded Help:** Embedded help shall provide information and assistance for software program/functions. The information shall relate to the current display, current program operation or selection. It shall change as the operator proceeds through the program to provide appropriate information. Help shall be requested by selecting HELP from the menu bar. A menu of topics relating to the current display or selection shall appear on the screen. Selection of a topic from a menu displays the Help text in a partial screen overlay. Screen control functions shall be displayed as selectable icons below each help overlay. They shall be Return, Next Screen, Previous Screen, and Exit Help. For operator guidance, embedded help shall also be user-created to be associated with operational displays.

2.32 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. **General**: All DCS components shall be powered from utility and UPS. Completely static AC uninterruptible power supply system(s) shall be furnished by the CSP and installed by others. The CSP shall be responsible for sizing all UPSs provided for the DCS equipment. Each UPS system shall consist of a static invertor, rectifier charger, static transfer switch, manual bypass switch, and storage batteries. The UPS shall be housed in a NEMA 1 free-standing enclosure. All free-standing UPSs shall be provided with stabilizing brackets. Operating temperature range shall be 0-40 degrees C. Operating humidity shall be 0-95 percent non-condensing. Audible noise shall be less than 49 dB at one meter. UPSs shall be provided under this Contract as identified in Attachment A.

B. **Operation:** The UPS system shall be dual conversion on-line type and shall operate as follows:

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

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

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

4. Loss of Battery Charger, Battery, or Invertor: Static switch shall bypass critical load to normal AC power upon deviation of invertor output power from preset voltage and frequency parameters. Sensing shall be accomplished at input terminals of static bypass to prevent disturbance in excess of 1/4 cycle for any failures up to these terminals. Upon restoration of normal invertor operation for a preset timing interval and automatic re synchronization to AC power line, the static switch shall return critical load back to invertor without disturbance. A synchronizing check shall prevent return if the invertor and line voltage are not in phase.

C. **Output Capacity**: The continuous output capacity of each UPS shall be sufficient to supply its associated equipment with regulated AC power for 30 minutes from the battery only. Input to the UPS shall be 115 V ±10 percent, 60 Hz ±1 Hz or 480 V, 3 , 60 Hz as specified. UPS output shall be 115 V ±2 percent, 60 Hz ±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 CSP to supply a UPS with sufficient output capacity to supply the inrush current requirements of the DCS equipment including peripherals when starting up. Automatic switch over to the AC line during high current inrush with automatic switch back to th e invertor when current returns to normal are acceptable. The invertor shall have the ability to supply 150 percent of the full load DCS requirements for 10 seconds minimum and 125 percent of the full load DCS requirements for 20 minutes without degradation of service life.

E. **Frequency Stability**: It shall be the responsibility of the CSP to supply a UPS with frequency stability matched to the requirements of the DCS. Rate of frequency change (Hz/SEC) of the UPS system during switch over shall be held to a limit which will not cause malfunction of the DCS including peripherals.

F. **Protection**: Circuit breakers shall be provided with each UPS. Circuit breakers shall be provided on the input to the rectifier battery charger and to the static switch, on the DC output of the charger and on the AC input and AC output invertor. Short circuit of the system output under any condition, including transfer to the AC line, shall cause no 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 invertor; under these conditions, the charger shall be able to fully recharge the battery within 8 hours after the battery has supplied the full load for 30 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 charge 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 battery cells shall be sealed lead-acid type and sealed in plastic containers to form a permanent leak-proof unit. Covers shall be fitted with spray-proof vent plugs. External batteries shall be mounted on a step-type battery rack. Rack shall be steel framed, firmly braced and protected by 2 coats of acid-resistant paint. Rack and its mounting shall provide an earthquake-proof support for the batteries. Batteries shall have the capacity required to supply the invertor at full load for the specified number of minutes. Battery rack shall be enclosed in vented metal cabinet with hinged access doors. All batteries shall be easily accessed for checking electrolyte and repairing. Cabinet shall be finished to match floor standing enclosure using acid resistant paint. The batteries shall be provided with intercell cables and connectors, stainless steel terminal lugs, cell lifter, lug wrenches, portable hydrometer and portable thermometer.

I. **Static Invertor**: The static invertor shall be of solid state construction. Output shall be sine wave with less than 5 percent harmonic distortion from zero output to full load. Output of invertor shall be in phase 5 degrees of normal utility current if utility frequency is between 59.5 and 60.5. Automatic current limiting shall be provided to prevent damage to the invertor. The invertor shall have panel mounted AC output ammeter and volt-meter. Invertor shall have an AC low voltage alarm contact in parallel with the battery charger alarm contact specified above.

J. **Static Transfer Switch**: The static transfer switch shall use thyristors to switch the load from the invertor to normal utility power upon invertor failure. The switch operation level shall be adjustable from 60 to 100 percent of normal voltage. Transfer back to the invertor shall be prevented for 15 seconds after utility power has returned to normal frequency and voltage parameter. Static transfer to "Bypass" source shall be prevented if the UPS is overloaded. The switch shall have the same overload capacity as the invertor. The switch shall have an alarm contact in parallel with those above to indicate the switch malfunction. The switch shall have the following panel-mounted controls:

1. Position indicating lamps.

2. Switch to manually initiate transfer in either direction.

K. **Bypass Switch**: The UPSs shall be provided with manual bypass switches (internal or external) to remove the unit for maintenance or replacement. The bypass switch shall have contacts to permit isolation of the static transfer switch under no load conditions.

L. **UPS Monitoring**: The UPS system(s) shall be provided with isolated contact outputs to the DCS for monitoring of the unit(s). The shall furnish all wire, conduit, and I/O boards to enable the DCS to monitor the following functions associated with all instrumentation and DCS UPS:

1. Normal Mode
2. Emergency Mode
3. Bypass Mode
4. Low Battery
5. Trouble
6. Alarm

M. **Records, Manual, Spare Parts, Shop Drawings:** Test records, operation and maintenance manual, spare parts tests, and shop drawings shall be submitted as stated in these Specifications. Maintenance tools and spare parts normally supplied by the manufacturer shall be furnished. The UPS warranty shall be a minimum of 3 years. UPSs shall be manufactured by Deltec PowerWorks RS Series, or equal.

N. **Terminal Blocks:** The DCS equipment shall be wired to the UPS unit via terminal blocks located at the back of the UPS unit to supply 115 V AC power to the DCS equipment requiring 115V, 60 Hz power.

O. **Receptacles:** A minimum of four 5-15R standard duplex receptacles shall be provided with each UPS on the rear of the unit..

2.33 DOCUMENT RETRIEVAL SYSTEM

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NTS: The Document Retrieval System Web Server is for major facilities, such as treatment plants only.

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A. **Document Retrieval System (DRS) Web Server:** The CSP shall integrate a Document Retrieval System based on an Intranet Web Server onto the FIN. The DRS Web server shall be a Sun Systems web optimized Netra I 1/150 enterprise server, or current model approved by the CONSTRUCTION MANAGER, with, as a minimum, the following:

1. 4.2 GB Fast/Wide SCSI drive

2 SUN CD4 CD-ROM drive

3 Sun Fast Ethernet 10/100 Sus adaptor

4 128 MB ECC Memory

5 Netscape Web Server

6 Netscape Live Wire

7 Netscape Catalog Server

8 Netscape Proxy Server

9 14 GB 8mm tape drive

B. **Web Server Software**: Software shall meet the following requirements:

1. Multiple server administration from a single point
2. SNMP compatibility
3. Usage reporting
4. Secure administration
5. CGI (common gateway interface) support
6. Support for multiple processors
7. User authentication including IP addressing and public-key certificates
8. SQL database connectivity (equal to Netscape Live Wire)
9. Searching tool supporting full-text, structured relational, Boolean queries and catalog content indexing (equal to Netscape Catalog Server)
10. Content filtering and access control (equal to Netscape Proxy Server)
11. Mail services, SMPT-compliant (equal to Netscape Mail server)
12. Netscape Enterprise Server or equal

C. **Web Browser Software**:

1. Support for JPEG, GIF, and table viewing
2. Integrated E-mail
3. Netscape Navigator 2.0 or equal

D. **Web Server Disk Array**:

1. 80 GB RAID Array
2. Fully hot swapping, dual auto-failover power supplies
3. Rack mounting
4. Global Hot Spare Drives
5. Utilities for remote monitoring and management
6. Full hot swapping of all active drive components
7. 24 hr replacement time for all failed components
8. 15 MB/s min sustained transfer rate
9. 16 MB of dedicated cache min
10. Single, port interface
11. Expansion to 200 GB min
12. RAID levels 5,4, and 1
13. Single, or multi -port interface
14. Equal to SPARCstorage Array Model 214 RSM

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NTS: End of Document Retrieval System Web Server Specification.

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PART 3 -- EXECUTION

3.1 EQUIPMENT, MATERIALS AND WORKMANSHIP

A. **General:** It is the intent of these Contract Documents to secure high quality in all equipment and materials, and to require first-class workmanship, in order to assure long, trouble-free operation and minimum maintenance of the DCS.

B. Equipment and materials shall be the products of reputable, experienced manufacturers with a verifiable history of manufacturing similar equipment. Similar items in the project shall be the products of the same manufacturer. All equipment shall be of industrial grade and standard construction, shall be of sturdy design and manufacture, and shall be capable of long, reliable, trouble-free service.

C. All work, including calibration, testing, adjustment, start-up and maintenance, shall be done by qualified experienced personnel who are technically skilled in their trade, are thoroughly instructed, and are competently supervised. The resulting completed installation shall reflect professional quality work, employing the highest industrial standards and methods.

3.2 OPERATIONAL READINESS TESTING (ORT)

A. **General:** The complete system, including all, DCS equipment, peripheral devices and interconnecting cables shall be assembled on the Department Headquarters Staging Floor, and all programs shall be completely tested under simulated operating conditions. Further tests shall be performed in the field at time of start-up with external sensors and field wiring connected to determine final specification compliance.

B. All hardware test procedures shall strictly conform to the following sections of ISA-RP55.1 - 1975 (R 1983):

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. Four certified copies of all test data and results shall be submitted to the CONSTRUCTION MANAGER. All test documentation and results shall comply with ISA-RP55.1-1975 (R1983) Type 2 and type 3 documentation as described in section 10.2 of the referenced standard.

D. The equipment shall be operationally tested for compliance with the conditions of these Specifications. ORT operational readiness test set-up shall include simulated inputs. On line configuration of the monitoring and control loops using simulated inputs shall be demonstrated without error or malfunction. Logs and report generation capability shall be demonstrated by simulating process inputs and manually entering data.

E. The ORT shall also compare the actual throughput of the as-tested system with the requirements of these specifications to the throughput of the PIN by:

1. Simulating a sine wave process disturbance in which:

    a. At least 50 percent of all alarms are active.

    b. WSs are being used for display purposes.

    c. The Historian system is active.

    d. All control loops are active.

2. Using a current driver to input 4 analog inputs into "PCM-X" and a 4 channel strip chart recorder which time stamps data.

3. Using a 4 channel strip chart recorder which time stamps data output from "PCM-Y".

F. The CSP shall submit a detailed ORT specification to the CONSTRUCTION MANAGER at least 6 weeks in advance of commencement of the ORT. The CONSTRUCTION MANAGER shall be notified at least 30 days in advance of the ORT and reserves the right to have his representatives in attendance.

G. Each item of equipment shall be fully inspected, calibrated and tested for function, operation and continuity of circuits as applicable. Exceptions shall be approved in writing from the CONSTRUCTION MANAGER.

H. System performance shall be tested using a complete integrated system including all peripheral devices and interconnecting cables assembled on the test floor, complete operational programs loaded, and simulated inputs applied. The CSP shall carry out a 100-hour full system test during which the entire system shall operate continuously without failure, all in accordance with the requirements of the specifications and drawings. If a system component fails during the test, the 100-hour test period shall be restarted after its operation is restored.

I. After successful completion of the factory test, 4 certified copies of all test results shall be furnished to the CONSTRUCTION MANAGER together with a clear and unequivocal statement that all ORT requirements have been met. The CONSTRUCTION MANAGER will give written notice of the acceptability of the ORT within 30 days of receipt of the ORT results.

J. Three CONSTRUCTION MANAGER/OWNER Representatives shall witness the ORT and at least 30 working of inner conductor

days written notice shall be given prior to date of starting tests. One copy of each acceptance test procedure shall be submitted to the OWNER 30 days prior to the start of the acceptance test.

K. In the event that the system does not function as specified, it shall be modified at the factory to meet the specification requirements, and shall be retested as specified herein. Costs for all such retesting and witnessing shall also be borne by the CSP.

All of the CONSTRUCTION MANAGERS/OWNER's travel and per diem costs associated with all ORT testing and retesting shall be borne by the CSP.

L. Prior to installation, all PIN, FIN, and DIN cable shall be ORT by the CSP to verify that the attenuation does not exceed prescribed limits and to ensure that concealed or internal discontinuities which could cause reflections do not exist. In conformance with the submittal requirements of these specifications, the CSP shall submit certified test reports which contain the following data:

1. Dielectric constant

2. Outside diameter

3. Inside diameter of outer conductor

4. Attenuation constant

5. Plot of each cable attenuation-frequency response per 100 feet of cable.

3.3 INSTALLATION SUPERVISION

A. **General:** The CSP shall provide personnel to properly oversee the installation of all DCS equipment performed by others. Subsequent to the installation of all DCS equipment, the CSP shall certify to the OWNER that the DCS has been properly installed.

B. The CSP shall furnish the services of trained engineer(s) to check the completed installation and to make all necessary adjustments for satisfactory operation of the DCS. There shall also be furnished complete installation drawings and instructions in accordance with these Specifications.

3.4 CALIBRATION

A. **General:** The CSP shall calibrate the complete system after installation. This shall ensure that those components having adjustable features are set carefully for the specific conditions and applications of this installation and that the components and systems are within the specified limits of accuracy. Defective elements which cannot achieve proper calibration or accuracy, either individually or within the system, or subsystem, shall be replaced.

1. Analog input channels shall be verified at 25 percent, 50 percent and 75 percent of span by applying simulated analog test signals. Applied test data shall be processed by the associated PCM using programs assigned to the particular data channels being simulated with the resulting engineering unit data presented on a CRT display. At least one simulated analog signal shall be routed through each analog-to-digital converter. The accuracy of the analog-to-digital converters and data processing activities shall be verified at each calibration step for each channel being simulated by comparing the known input against the Root Mean Square Summation tolerances calculated for each engineering unit data value noted.

2. The accuracy of all digital-to-analog converters shall be verified by manually entering engineering unit data values at the WS and then reading and recording the resulting analog output data. All analog output data shall be compared against calculated Root Mean Square Summation tolerance requirements.

3.5 TESTING OF FIBER OPTIC CABLE INSTALLATION

A. **Acceptance Testing**: The CSP shall perform pre-installation and post-installation fiber optic cable acceptance tests of cable installed by others. The CONSTRUCTION MANAGER shall be notified a minimum of 5 days in advance so they may have the opportunity to witness the tests. Each of these tests is described as follows;

1. **Pre-installation tests:** Prior to he installation of cable, the CSP shall perform the following test;

   a. The purposes of these tests is to perform acceptance tests on the shipped cable prior to installation in order to validate that the cable conforms to the manufacturers specifications, and is free of defects, breaks, and damages caused by transportation and manufacturing processes. The CSP shall perform all tests on all reels of cable. These tests shall be documented and submitted to the CONSTRUCTION MANAGER for review. Subsequent to the receipt of the CONSTRUCTION MANAGERS approval, the cable shall be available for installation.

   b. The tests shall measure a total attenuation or loss for each fiber on each cable reel and document results of physical inspections to identify any cable and reel damage conditions, less or more than the specified fibers in the cable, and any deviations from the manufacturers specifications.

2. **Post-Installation Tests:** The CSP upon completion by others of the fiber optic cable installation and splicing, shall perform the following tests;

   a. A recording optical time domain refractometer (OTDR) shall be utilized to test for end-to-end continuity and attenuation of each optical fiber. The OTDR shall be equipped with a 1300 nm and 1550 nm light source for the single mode fiber (SMF) (850 nm for multi mode fiber (MMF)). The OTDR shall have an X-Y plotter to provide a hard copy record of each test measurement. The OTDR shall be equipped with sufficient internal masking to allow the entire cable section to be tested. This may be achieved by using an optical fiber pigtail of sufficient length to display the required cable section.

   b. The OTDR shall be calibrated for the correct index of refraction to provide proper length measurement for the known length of reference fiber.

   c. A transmission test shall be performed with the use of a 1300 nm/ 850 nm stabilized light source and 1300 nm /850 nm power meter for SMF/MMF respectively. This test shall be conducted in both directions on each fiber of each cable.

   d. Upon completion of the previous tests, all fiber optic cable coils shall be secured with ends capped to prevent intrusion of dirt and water.

3.6 INSTALLATION TEST

A. **General:** The CSP shall be responsible for the oversight of installation of all DCS equipment being furnished under this project. If a DCS device (including network cables) have been installed by others in a faulty manner, the CSP shall notify the CONSTRUCTION MANAGER. Systems shall be exercised through operational tests in the presence of the CONSTRUCTION MANAGER in order to demonstrate achievement of the specified performance.

B. A complete integrated distributed control system test shall be performed. All modes of operation and man/machine interactions shall be exercised. Compliance to specified system failure detection and failover requirements shall be verified by selectively disabling individual CRT's, common logic files, data communication equipment and data links. Compliance to signal failure detection and response requirements shall be verified by employing analog test equipment to apply excessive signal amplitude and rate-of-change values. All data communication equipment shall be thoroughly tested for function and accuracy.

C. The results of all distributed control system installation test activities shall be documented. All analog-to-digital converter and digital-to-analog converter accuracy tests shall be documented on test forms, approved by the CONSTRUCTION MANAGER, which include calculated Root Mean Square tolerance limits for each calibration step.

D. Upon the satisfactory completion of all distributed control system installation tests, a certified report, including all test documentation, shall be furnished to the CONSTRUCTION MANAGER together with a clear and unequivocal statement that the installed system has been successfully calibrated, inspected and tested. The CONSTRUCTION MANAGER will give his acceptance of the installation tests within 10 days of his personal receipt of the test report if the results of the computer installation tests are acceptable.

3.7 SYSTEM COMMISSIONING AND PERFORMANCE TESTING

A. **General:** System commissioning and performance testing shall comply with the provisions specified herein and the contract drawings and specifications. Further, system commissioning and performance testing shall commence after all installation tests and inspections have been conducted and accepted in accordance with the following B, C, D, and E, and shall demonstrate that all components of the control system can meet all contract requirements with the equipment operating over full operating ranges under actual operating conditions.

B. All commissioning and test activities shall follow detailed test procedures, and check lists, previously reviewed by the CONSTRUCTION MANAGER. All tests data shall be acquired using equipment as specified and recorded on test forms, previously reviewed by the CONSTRUCTION MANAGER, which includes calculated tolerance limits for each calibration step. Completion of all system commissioning and test activities shall be documented by a certified report, including all test forms with tests data entered, delivered to the CONSTRUCTION MANAGER with a clear and unequivocal statement that all system commissioning and test requirements have been satisfied. The CONSTRUCTION MANAGER will give his acceptance of the system commissioning and test activities within ten days of his personal receipt of the report if the report is accepted.

C. The proper control of all final control elements and control panels shall be verified by tests conducted in accordance with the requirements specified herein. Where feasible system commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent practicable, normal final control element operating ranges and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using the distributed control system and local field mounted control circuits. All hardwired control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control modes. The stable steady-state operation of final control elements running under the control of field mounted automatic analog controllers shall be assured by adjusting the controllers, as required, to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control field mounted automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any) and making necessary controller adjustments, as required, to eliminate excessive oscillatory amplitudes and decay rates.

D. All control stations incorporating proportional, integral and/or differential control circuits shall be tuned experimentally, by applying control signal disturbances and adjusting the gain, reset and/or rate setting(s) as required to achieve a proper response. Measured final control element variable position/speed set-point settings shall be compared to measured final control element position/speed values at 25 percent, 50 percent and 75 percent of span and the results checked against specified accuracy tolerances. Specified accuracy tolerances are defined as the root-mean-square-summation of individual component accuracy requirements. Individual component accuracy requirements shall be as specified in the contract or as specified by published manufacturer accuracy specifications whenever contract accuracy requirements are not specified.

E. Subsequent to the performance testing of process/process equipment furnished by others, the CSP shall conduct a successful 90 day performance test for the distributed control systems furnished under this contract. In the test, the entire DCS shall be continuously operated and maintained (i.e., 7 days per week, 24 hours per day) during the test period with zero downtime resulting from system failures. If a system failure occurs, the 90 day test shall be considered a failure and not acceptable. The CSP shall reinitiate the 90 day test. The DCS shall be acceptable only after all equipment has satisfied the performance test requirements and demonstrated a system availability of 99.98 percent.

F. The system availability shall be calculated based on the following equation:

$$A = (MTBF \times 100\%)/(MTBF + MTTR)$$

where, A = system availability in percent

MTBF = average time interval between consecutive system failures

MTTR = average time required to repair system failure

G. Downtime resulting from the following shall be considered system failures:

1. Downtime of any system component which is automatically "backed-up" and the back-up unit fails to automatically assume control within the specified time or if a component failure cannot be repaired/replaced within 2 hours.

2. Downtime of any component (exclusive of I/O) whose failure results in the inability of the Operator to monitor and manipulate control loops from the associated EC/OC using standard man-machine interface procedures.

3. Downtime resulting from the concurrent failure of any two (2) workstations, or any two (2) operator workstation input devices associated with the same workstation.

4. Downtime in excess of 2 hours resulting from any I/O component failure.

5. Downtime resulting from concurrent failure of two or more I/O components in a single PCM.

6. Downtime of any component/peripheral associated with the Historian if the failed component (1) results in a disabling of the historical functions and (2) the failed component is not repaired or replaced within 8 hours.

H. The CSP shall submit a performance test completion report which shall state that all contract requirements have been met and which shall include (1) a listing of all DCS equipment maintenance/repair activities conducted during testing and (2) a listing of all components which were unable to operate successfully. Final acceptance, in writing, of the DCS will be provided by the CONSTRUCTION MANAGER if the results of all of the performance tests are acceptable.

I. The CSP shall guarantee the required availability of the entire distributed control system for a period of one (1) year after acceptance of all required performance tests. The CSP shall be responsible for furnishing and maintaining the spare parts/tools on-site at an inventory level it determines is sufficient to achieve the system availability requirements specified herein. All spare parts/tools stored on-site shall become the property of the OWNER upon completion of the guarantee period. If the DCS does not comply with the availability requirements stated herein within the first year of system operation, the CSP shall forfeit that amount of the performance bond equal to the replacement cost of the entire DCS bid under this contract. The CSP shall guarantee the following:

1. The completed system shall perform all of the data acquisition, control, and reporting functions as shown and specified.

2. The availability of the entire distributed control system shall not be less than 99.98 percent with a mean time to repair (MTTR) of 2.0 hours for any consecutive period of 6 months during the guarantee period. Availability, MTTR and other supporting terminology shall be as defined in SAMA Standard PMC 32.1-1976.

3.8 TRAINING OF PERSONNEL

A. **General:** The CSP shall furnish training for the purpose of familiarizing OWNER's personnel with the distributed process control systems. The minimum training quantities shall be as listed in Appendix A-4. Training shall be provided at the Department Headquarters (DH) and On-Site (OS). All DH training shall be complete with all materials, resumes, test equipment, etc., that is normally associated with training offered at the CSP’s facilities. None of the courses detailed here shall overlap. Courses shall be scheduled in series so as to allow the same personnel to attend more than one training course. The training shall be scheduled a minimum of 60 days in advance of when they are to be given. Proposed training materials, including a detailed training agenda itemizing relative emphasis on various topics of each course, shall be submitted to the CONSTRUCTION MANAGER at least 60 days in advance of when the course is to begin. The CONSTRUCTION MANAGER shall review this outline and provide comments that shall be incorporated into the course.

B. In addition to providing training in the operation and maintenance of equipment manufactured by the CSP there shall be training courses covering all items which are manufactured by others. Each of the courses (both at the Department Headquarters and on-site) shall be taught by authorized representatives of each respective equipment manufacturer. Each manufacturer's representative shall be fully knowledgeable in the operations and maintenance of their equipment and shall be a full-time instructor under the employ of the respective manufacturer.

C. Within 60 days of receipt of Notice to Proceed, the CSP shall submit a training plan which contains, as a minimum, course outlines and schedules for training to be provided at the CSP’s facility.

D. **DH Preparatory Training:** A series of preparatory training courses shall be conducted at the Department Headquarters prior to commencement of any ORT. The training shall be control system familiarization courses for project management personnel, engineers and key operating/maintenance personnel. The course content shall include, but not be limited to a description of: DCS philosophy; all major hardware components utilized in the system; Historian system software functions; control strategies associated with WS; system operating modes and procedures and Hardware and software maintenance practices.

E. **DH Configuration Training:** Control system configuration and operating courses shall be provided. The level of training shall be sufficient to familiarize the OWNER's personnel with all control loops associated with the control center, with the generation and application of control/data acquisition programs, and with all essential system operating procedures associated with the control room WSs.

F. **DH Operators Training:** The level of training shall be sufficient to familiarize the OWNER's personnel with the operators interface to all available monitoring and control functions.

G. **DH Programming Training:** Computer system programming and operating courses shall be provided for persons each who typically have prior programming experience. The level of programmer training shall be sufficient to:

1. Familiarize the OWNER's personnel with enough details of the system programs to enable them to use and modify the programs, as desired, during plant operation.

2. Enable the OWNER's personnel to compose and generate all required CRT-based process graphics and report/log formats. All work performed by the OWNER's personnel shall be done at Department Headquarters. The CSP shall implement all graphics required for this project.

3. Enable OWNER personnel to write, edit, file, delete, and apply C Language and high level process control language programs, as necessary to implement all control system and process information functions. The use of assembly language programming shall be covered only where specific assembly language statements are required to implement or maintain control system and/or process information system activities.

4. Familiarize OWNER personnel in the function and use of support and application software.

H. **DH System Maintenance Training**: The level of system maintenance training shall be sufficient to familiarize OWNER's personnel with all DCS preventative and corrective maintenance procedures. All students shall be instructed in the meaning and extent of system diagnostics, board level replacement, calibration and DCS "house keeping" procedures.

I. **OS Operator/Maintenance Training:** A series of training courses shall be conducted at the plant prior to the startup of processes associated with the DCS system equipment.

1. Operator training courses for the computer system to provide instruction in DCS equipment operation, both individually and collectively as an operating system, shall be conducted by the CSP. All procedures required to operate and manipulate each process from the WS shall be described. Normal, as well as abnormal, startup and shutdown operating conditions shall be covered, including the response to failure occurrences and system alarms. All Operator/control system interactions shall be described and demonstrated in conjunction with the use of all process information system functions. The CSP shall coordinate training sessions with operations personnel 30 days prior to conducting any classes.

J. In addition to providing classroom instruction, the CSP shall furnish each training course in electronic format including VHS and video disk. The content of the electronic training shall be identical to that used in the classroom.

3.9 MAINTENANCE REQUIREMENTS AND CONTRACT

A. **General:** The CSP shall maintain in complete operation the DCS furnished under this contract for a period of 2 years from the date of the successful completion of the final 90 day performance test. All hardware required in the first year of this maintenance contract shall be covered by system warranty provisions. Maintenance personnel provided by the CSP shall instruct the OWNER's personnel in the operation, adjustment, calibration and repair of equipment being serviced.

B. Independent of this agreement, the CSP shall maintain and permit OWNER utilization of various DCS components which have successfully completed 90 day performance tests until the entire DCS has been successfully tested and accepted with each component in service being applied to its respective full intended usage. During this interim period between component utilization and system acceptance, (i.e., from the time of the completion of the

System overall DCS (test) the CSP shall maintain the utilized components in conformance with the requirements herein.

C. Corrective hardware maintenance shall be performed by factory-trained service technician(s) specifically trained for the digital equipment to be serviced. Technician(s) possessing suitable training and experience shall be provided to perform corrective maintenance on all other equipment. The hardware service technician(s) shall be on-site within 4 hours after notification by the OWNER. The service technician(s) shall be available for call 8 hours per day, 7 days per week.

D. Corrective system software maintenance shall be performed for all software provided by the CSP and incorporated into the system prior to system acceptance. Software service programmers shall be available for call 8 hours per day, 7 days per week and on-site within 12 hours after notification by the OWNER. All preventative and corrective maintenance activities shall be performed at no extra cost to the OWNER and shall be documented with service reports which identify the equipment (or program) being serviced, condition of the equipment, description of all work performed, listing of all materials used, and the name and signature of the OWNER's representative attesting to the accuracy of the report. A copy of all service reports shall be delivered to the OWNER on the day work is performed.

E. Preventative hardware and software maintenance shall be performed at scheduled intervals to provide a dependable and operational system. A copy of all service reports shall be delivered to the OWNER on the day the work was performed.

F. As part of the Maintenance Contract, the CSP shall provide Remote Diagnostic Support Service for on-line system performance analysis. The CSP shall provide all required hardware to electronically connect the DCS to the CSP’s main factory and local service facility, herein referred to at the CSP’s service facilities, to enable the CSP’s service specialists to assist in diagnosing application and system malfunctions. A quarterly report detailing the performance of the system, generated by the CSP’s G7 Remote Diagnostic software, shall be delivered to the OWNER in conjunction with scheduled preventive maintenance visits.

G. Prior to final acceptance of the work, the CSP shall submit a separate proposed maintenance agreement to the OWNER incorporating the following features:

1. Extension of preventative hardware maintenance services (as previously described) for a period of up to 5 years from the expiration of the two year maintenance period.

2. Provisions for corrective hardware/software maintenance work (as previously described) on a will-call basis for a period of up to 5 years from the expiration of the maintenance period.

3. All labor and material costs associated with preventive and corrective maintenance shall be based on future unit prices stipulated in the Contract.

3.10 SPARES, TOOLS AND TEST EQUIPMENT

A. **General:** The CSP shall furnish all spare parts, tools and test equipment required to repair and calibrate the DCS and maintain it in good operating condition.

B. The test equipment shall include but not be limited to, signal generating and signal tracing equipment, and equipment to erase and re-program any programmable read only memory chips in the system. Where extension boards or modules are required, at least 2 of each type shall be furnished.

C. The CSP shall provide the following spare parts and supplies in a quantity sufficient enough to maintain the DCS for a period of 2 years. Actual spare part requirements shall be based on each component published MTBF. As a minimum, spare parts and supplies shall include:

1. One of each type of processor board associated with PCM's, WS's, and peripheral devices.

2. One spare I/O card of each type at each PCM.

3. One of each type of communication board.

4. Three of each type power supplies.

5. One box of ribbon for each of the printers.

6. Ten floppy disks if used in system.

3.11 SOFTWARE DOCUMENTATION

A. Software documentation shall be delivered to the OWNER prior to the final acceptance at which time all programs shall have been tested, delivered, and fully operational. The Owner retains all rights to programming and software configurations developed, performed, and implemented under this project. The CSP must obtain the Owner's consent prior to reuse of project software. Each set of documentation shall include, but not be limited to, the following:

1. General description of the overall purpose of each program with any assumptions or restrictions fully explained. Format for any input and/or output messages shall be included.

2. Abstracts describing the operational objectives of each major program section together with an explanation of its relationship to other major program sections.

3. A complete listing all of hardware devices which comprise the DCS. The listing shall include manufacturer, model number, physical location and hardware address.

4. A complete listing of all of the tag numbers in the DCS along with associated description information and hardware addresses.

5. A complete listing of all specialized interface functions that are associated with each system function, tag, or operator function.

6. Complete documentation on all system and process displays including a graphical depiction of the hierarchy with

7. Complete copy of system data base organized by PCM.

8. Complete set of all software configurations implemented for data acquisition, control, and alarming purposes. Data shall include both text and graphic depictions.

** END OF SECTION **

APPENDIX A
FACILITY-SPECIFIC REQUIREMENTS

TABLE A-1 DCS COMPONENT QUANTITIES

Item	Reference	Quantity	Locations	Other Requirement
Workstations	2.5			
PCM	2.2		See Table A-2	
Historian	2.8			
PC-MMS	2.6			
Area Control Room Consoles	2.11			
Log/Report Printers	2.9			
WS Custom Graphic Screens	2.24		N/A	
Workstation (Ws) Process Tutorial Displays	2.25	30	N/A	
Operator Assistance Displays	2.25	20		
Video Projection Systems	2.13		Control Room	
Portable Telephones	2.4.K	5		
Laptop Computers	2.4.K	5		

Table A-2 PCM LOCATIONS AND I/O

PCM NO.	Location	AI	AO	DI	DO	Other (Note)

Note: I/O Points for Data Links not included above. See Table A-3

TABLE A-3 DATA LINK I/O

Data Link No.	Data Link Description	PCM No.	QLC Card No.	AI	AO	DI	DO	Other (Note)

TABLE A-4 TRAINING - SECTION 3.8

Item	No. of Sessions	Length, Days	No. of persons	Other Requirement
DH Preparatory Training	3	3	5	
DH Configuration Training	3	15	4	
DH Operators Training	3	5	4	
DH Programming Training	3	20	2	
DH System Maintenance Training	3	15	4	
OS Operator/Maintenance Training	9	5	12	