

SECTION 13453

SCADA SOFTWARE AND HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes SCADA software and hardware for control and interface of process and measurement equipment, ancillary systems and metering systems.
- B. Supply head-end servers, visualization node hardware, network hardware, interconnections, communication hardware and connections, interfaces components and connections and programming for a fully functional system.
- C. Supply of all control panels and related components for a fully functional system.
- D. Coordinate instrumentation requirements to insure proper data transfer and compatibility between instrumentation, operator interface terminals, Programmable Logic Controllers and control panels.
- E. Coordinate communication protocols to insure proper data transfer and compatibility between instrumentation, operator interface terminals, Programmable Logic Controllers, modems, radios and control panels.

1.02 SYSTEM TOPOLOGY

- A. Client-Server Network
 - 1. Application Server
 - 2. Configuration Database
 - 3. Historian Database
 - 4. Engineering Station Node
 - 5. Visualization Node (HMI's, OIT's, etc.)
 - 6. Connected system devices (PLC's, instrumentation, RTU's, etc.)
 - 7. SMS Communications
 - 8. Email Based Communications

1.03 RELATED DOCUMENTS

- A. Related Sections:

1. Section 01330 – Submittal Procedures
2. Section 13400 – Electrical Control and Instrumentation
3. Section 16010 – General Electrical Provisions
4. Section 16050 – Basic Electrical material & Methods
5. Section 16123 – Wire and Cable
6. Section 16130 – Raceways and Boxes
7. Section 16195 – Electrical Equipment Identification
8. Section 16798 – Two Way Radio Data Transmission System
9. Section 13451 – PLC

B. References:

1. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems
2. ANSI Y14.1, Y14.2, Y14.3 – Drawing Standards
3. EN61131-2 - Programmable controllers. Equipment requirements and tests
4. IEC 61000-6-2 - electromagnetic compatibility
5. IEEE PC37.1/D1.9 – Standard for SCADA and Automation Systems
6. NFPA 70 (NEC)
7. UL508 - Industrial Control Equipment

1.04 DEFINITIONS

- A. AI: Analog Input
- B. AO: Analog Output
- C. Application Server: Communicates with external devices to poll and retrieve data from devices. The application server functions as the data source for retrieving and archiving of device data. The application server provides application processing services and communicates the configuration database and historian database.
- D. Control Panel Designer: A firm or individual that is responsible for designing the layout of control panels. This entity will select the devices to be included in the panel, will decide on the actual layout and provide a fully functional control panel.

- E. Configuration Database: A SQL database that manages the device configuration data. The configuration database communicates with all nodes to keep them updated on global changes such as security settings, device settings, etc. The configuration database is accessed when the objects within the database are viewed, created, modified, deleted, deployed or uploaded.
- F. CPU: Central Processing Unit
- G. DI: Digital Input
- H. DO: Digital Output
- I. Engineering Station Node: A terminal that runs a commercially available operating system such as Windows. An Engineering Station will execute SCADA configuration software and contain the configuration database. software and allows the operator to view system status, interact with system level devices and modify control system parameters. HMI is used interchangeably with operator interface terminals and are capable accepting input devices, have communication ports, provide a display capable of viewing animations and color images, and capable of viewing text documents.
- J. Historian Database: A SQL database that stores device data for later retrieval. The historian database receives data from the application server. The historian database is accessed when reports, trending and alarms are viewed, created or modified.
- K. Human Machine Interface (HMI): Used interchangeably with Visualization Node to describe a fixed operator interface node for retrieving, setting and viewing connected devices and their associated settings, and to view reports and system objects. An HMI can be a workstation or a panel mounted interface.
- L. I/O: Input and/or Output
- M. Node: A network connection point. Examples include a PLC, Engineering Station, Visualization Node, etc.
- N. Operator Interface Terminal (OIT): Used interchangeably with Visualization Node to describe a fixed operator interface node for retrieving, setting and viewing connected devices and their associated settings, and to view reports and system objects. An OIT can be a workstation or a panel mounted interface.
- O. P&ID: Process and Instrumentation Diagram. Used to describe control action, proportional and integral and derivative.
- P. PLC: Programmable Logic Controller.
- Q. Remote Terminal Unit (RTU): A remotely connected device that collects data, then transmits the data to the SCADA communications network using a common communication protocol. The RTU is used to describe a remote transmitter (e.g. radio, modem, et.) or is used to describe a point of interface within the system.

- R. SCADA: Supervisory Control and Data Acquisition. A SCADA System is a group of computers and servers running software dedicated for SCADA purposes. This SCADA software can collect and exchange data over industrial networks with PLCs, device level controllers, and other industrial devices. The SCADA software will allow for control, trending, graphic display, alarm tracking, historical logging of values in a database and reporting of data.
- S. SCADA System Server: Used interchangeably with Human Machine Interface (HMI) and Operator Interface Terminal (OIT) to describe a combined data acquisition, system reporting, report generation and system access node.
- T. SCADA System Client: Used interchangeably with Human Machine Interface (HMI) to describe a system access node.
- U. SCADA System Supplier and SCADA Integrator: A company that integrates commercially available SCADA software package, and then develops a project-specific application. This company will supply and install the hardware and software to run the project-specific application.
- V. Short Messaging Service (SMS): A communications protocol that facilitates the transmission of short messages between the Application Server and cellular telephones.
- W. Visualization Node: A computer based terminal that runs a commercially available operating system such as Windows with a commercially available SCADA software suite. The visualization node shall execute software that allows the operator to view system status, interact with system level devices, modify control system parameters and communicate with other services on the network. Visualization node is used interchangeably with Human Machine Interface (HMI), Operator Interface Terminals (OIT) and is capable accepting input devices, has communication ports, local data storage, provides a display capable of viewing animations and color images, and capable of viewing text documents. Visualization nodes may provide application processing and data processing. Visualization nodes may be computers that are designed to be embedded in the doors of control panels or user work stations.
- X. Workstation Node: Used interchangeably with Visualization Node to describe a fixed operator interface node for retrieving, setting and viewing connected devices and their associated settings, and to view reports and system objects. A Workstation Node is usually a user workstation.

1.05 SUBMITTALS

A. General Product Data:

1. The Contractor shall be responsible for the accuracy and completeness of all aspects of the SCADA submittal, including SCADA software detailed herein, and applicable hardware. As a minimum, Contractor shall submit in accordance with Section 01330:
 - a. Hardware Product Information Submittal
 - b. Power Distribution Submittal

- c. Software Product Information Submittal
- d. Connection Diagrams Submittal
- e. Interconnection Diagrams
- f. Panel Fabrication and Layout Drawings
- g. Functional Design Documentation submittal
- h. Functional SCADA Architecture Design Document
- i. System Documentation Submittal
- j. Software Support Materials
- k. Testing Submittals; indicate proposed testing, testing firms biography and contact information.
- l. Training Submittals; outline proposed subjects and any special requirements for training (i.e. facilities, hardware, etc).
- m. Operation and Maintenance Data: Provide documentation detailing routine maintenance requirements (if any) for all hardware as recommended by the manufacturer and industry standards.
- n. All diagrams and drawings shall be provided as standard 11"x17" format at a scale that is readily legible and prepared to ANSI standards.

B. Submittal Format:

1. For each system interface type and software program/software component submittal; provide a separate check sheet acknowledging all specified criteria. The check sheet shall consist of three columns:
 - a. The leftmost column shall indicate the referenced section of the specification.
 - b. The middle column shall indicate rather the indicated specification criteria are met, not met, or has a variance.
 - c. The rightmost column shall be used to describe reasons for variances or not meeting the specified criteria.
 - d. Each row on the check sheet shall be for a dedicated spec section or sub section.

C. SCADA System Submittals:

1. Hardware Product Information Submittal:

- a. Contractor shall submit for review product information for all equipment and material specified in this Section, including all equipment intended to support specified systems.
2. Power Distribution Submittal: Prepare a summary of all SCADA hardware power requirements and provide load calculations that will be used for determining Uninterruptible Power Supply (UPS) loads.
3. Software Product Information Submittal:
 - a. The software documentation shall provide a comprehensive description of all software, necessary for the operation and maintenance of the system. Software documentation shall be furnished for each software or program in the system.
 - b. Warranty information shall be supplied for each software or program in the System.
 - c. Software License information shall be submitted for each software or program in the system, indicating the number of licenses provided for each type of program or software and any annual fees due to maintain licenses.
4. Connection Diagrams:
 - a. Connection diagrams shall show the placement, labeling and wire routing of components within panels, cabinets, and consoles. Wire lists and wireless diagrams shall not be acceptable. Components shall be shown arranged in the physical layout, as it would appear to a person servicing the equipment. Wiring designations, and routing designations, will follow project drawings standards.
5. Interconnection Diagrams:
 - a. Interconnection diagrams shall show the external wiring between terminals of associated equipment, control panels, motor control centers, terminal boxes, field switches, and any other device, panel, or enclosure. Interconnection diagrams shall clearly depict all cable tags. Cable tagging shall conform to project standards.
 - b. Show interconnection diagrams as standard riser diagram / topology format and include communication protocols used, wiring requirements, equipment designations and related information to describe all system interconnections.
6. Panel Fabrication and Layout Drawings (PLFD):
 - a. As a minimum, PLFD shall include front, back, and section views; the locations of all mounted components; drawing scale; nameplate engraving schedule; and structural materials and supports. A bill of material shall also be provided on the drawing, or as a separate document. All drawings shall be scaled. Overall dimensions and minimum clearances shall be shown. Sufficient detail shall be included to demonstrate material choices, outward appearance, construction methods, and seismic force resistance.

- b. Complete shop drawings shall be submitted for all panels, cabinets, and consoles which are fabricated, or modified, for this project. The Owner shall have the right to make modifications to the interior and exterior layouts of panels as part of the shop drawing review. No additional compensation will be provided for changes.
7. Functional design documentation submittal:
- a. Functional Network Design Document: Provide a functional network design document shall contain the following:
 - 1) A complete network system diagram showing the interconnections between hardware subsystems. This shall include network cabling, wireless nodes and all network devices
 - 2) Complete description of switch setup and programming to accomplish configuration shown on the drawings.
 - 3) Complete list of all major system components. This includes existing panels and panels not supplied by the SCADA system supplier. Indicate system interconnections.
 - 4) Assign each component a unique device identifier.
 - 5) Label of all components on block diagrams.
 - 6) Clearly indicate physical locations for all major system components on a scaled floor and site plan.
8. Functional SCADA Architecture Design Document: Provide a Functional SCADA Architecture design document shall contain the following:
- a. A complete system diagram showing the major components and interconnections of the Proposed SCADA system. This shall include all servers, Workstations, Operator Interface Terminals and PLCs at a minimum.
 - b. Indicate transceivers, media converters or other interconnecting equipment.
 - c. Provide complete description of addressing scheme for the proposed system with communications protocol shown.
 - d. Provide complete list of all system components
 - e. Assign each component a unique device identifier
 - f. Label components on all block diagrams
 - g. Provide locations for all system components.
9. Functional Software Design Document (FSDD):

- a. The FSDD shall show the top-level design of the proposed software in a concise manner. The complete description of support, interface, diagnostic, and general I/O software shall also be included. An inventory of major software packages, including third party, provided shall be included. The FSDD shall include a description of the historical data collection subsystem, including table usage and data storage rates. The document shall include, but not be limited to:
 - 1) Polling Process, including anticipated scan rates.
 - 2) Hard Drive Storage space required for each software component indicating anticipated capacity in years of operation.

10. System Documentation Submittal:

- a. Operation and Maintenance (O&M) Manuals:
 - 1) Supply O&M manuals for all equipment and software provided. The manuals shall be developed for a system operator audience. The manuals shall detail preventive and restorative procedures required to keep the equipment in good operating condition and provide step-by-step procedures for data backup and re-imaging. Manuals for OEM equipment shall contain original printed materials, not copies, and may be in the manufacturer's original format.
- b. Instruction Manual:
 - 1) The manual shall contain a detailed analysis of each major component so that maintenance personnel can effectively service, troubleshoot, and repair the equipment. Each manual shall include a Table of Contents, and shall be divided into the following sections:
 - a) Introduction: The purpose of the manual, special tools and equipment, and safety precautions.
 - b) General Information and Specifications: A general description of each equipment item, and its specifications.
 - c) Listings: Include contact information for each product provider, recommended maintenance provider, and local source for replacement parts.
 - d) Theory of Operation: Explain the relationship of all equipment to each other, and its purpose in the overall SCADA network.
 - e) Software: Listing and explanatory text for any software or firmware.
 - f) Operation Procedures: The locations and functional descriptions of all controller indicators, or displays.

- g) Troubleshooting: A tabular list of all symptoms, probable causes of malfunction or improper operation, and probable remedies to each specific malfunction, down to field replaceable components.
- c. Preventive Maintenance Instructions:
- 1) These instructions shall include all applicable visual examinations, hardware testing, diagnostic hardware/software routines and data backup and retrieval instructions. Instructions on how to load and use any test and diagnostic programs and any special or standard test equipment shall be an integral part of these procedures.
- d. Corrective Maintenance Specific Instructions:
- 1) These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction. These guides shall explain how to use on-line test and diagnostic programs for all devices and any special test equipment, if applicable. The corrective maintenance specific instructions shall include:
 - a) Explanations for the repair, adjustment, or replacement of all equipment items.
 - b) Schematic diagrams of electrical, mechanical, and parts location, illustrations, photographs, and sectional details as necessary to facilitate repair or replacement.
 - c) Mechanical items requiring field repair, shall have the following:
 - 1. Information on tolerances, clearances, wear limits, and maximum bolt-down torques
 - 2. Information on the loading and use of special off-line diagnostic programs, tools, and test equipment
 - 3. Cautions or warnings, which must be observed to protect personnel and equipment.
 - 4. A list of test equipment and special tools required.
 - 5. A list of recommended spare parts necessary to maintain and repair SCADA components. The list shall identify the specific part or model number, description, manufacturer's name and address, commercial equivalents, and recommended quantity to be stored. The spare parts list shall indicate which components (by model and serial number) have been provided with the delivered system as part of the spares inventory.
- e. System Operator's Manuals:

1) The System Operator's Manuals shall describe the configuration and all functions for the systems and equipment provided. Functional descriptions shall include algorithms necessary to fully understand the functions. The manuals shall be organized for quick access to each detailed description of the operator's procedure. The manuals shall be limited only to description of procedures for functions that are performed by the operator. The System Operator's Manuals shall serve as a complete instruction to the system and equipment and shall describe in detail the operator interfaces and operator procedures. In addition to the Operator interaction sequences, the following shall be provided in a matrix format, as a minimum:

- a) Summary description of all major functions
- b) Presentation of data on displays.
- c) Description of how the system and equipment react to situations such as heavy alarming, loss of communication links, heavy operator interaction, and loss of power and restoration of power.
- d) Description of all programmed messages and alarms that the system is programmed to output, with an explanation of what the message indicates and what action the system operator should take. Provide descriptions in tabulated format.

f. System Administrator Guide:

1) The System Administrator Guide shall be a user's manual for all the corresponding systems programs. It shall include information on system restoration from file backups, starting and bootstrapping the system, editing and expansion techniques (including display/report compiler, database, and applications edit), batch mode operation of software utilities, and troubleshooting to be used in conjunction with the system dumps, error and abort messages. User instructions with all administrative passwords shall be provided for each of the peripherals and for all Software procedures shall be in the guide.

11. Software Support Materials:

a. Program Media:

1) Furnish complete sets of program media documentation. These documents shall include source of all programs written specifically for the proposed system, including RTU and PLC programs, HMI scripting related applications and programmed objects of all programs necessary for the operation and maintenance of the systems programs. If any changes are made to programs during system test and acceptance, provide within 10 days, corrected copies of source, object and system media.

b. Program Listings:

- 1) Each program listing shall include the system component that it belongs to. Each time a change is made in the listing, its revision level shall be documented by the party making the change. Program listings will include all in-program comments and documentation, and must be clearly understandable by programmers familiar with the language used. Undocumented code is not acceptable.

c. Programmer Manuals:

- 1) The purpose of these manuals will be to enable systems and applications programmers, to maintain, modify, and expand the capacity and functionality of the system. These manuals shall comprise the standard manuals furnished by the computer system manufacturer covering the Operating System, Utilities, and Diagnostics, and High Level Language(s) supplied, together with furnished manuals that are specific to the system. The manuals shall include descriptions of the procedures to be used for:
 - a) Default system level access logins and passwords.
 - b) Modifying and expanding the system databases and testing revised versions.
 - c) Defining, linking to the database, and testing revised and new displays, logs, reports, data acquisition, process control, and data processing procedures including the addition of communication links, RTUs, PLCs, and input/output points.
 - d) System operational troubleshooting including error descriptions.
 - e) Instructions for configuring and rebuilding servers and workstations as if starting a new system, as well as rebuilding from backups (this will apply to peripherals applicable to the system as a whole, including network items).
 - f) Provide effective procedures/techniques for creating, expanding, and editing SCADA and PLC applications. Include useful backup procedures required for system recovery.

d. System Configuration Inventory List:

- 1) An inventory list shall be furnished for all contract material, software, software serial numbers, documentation, spare parts, and test equipment. Hardware identification of each unique module by serial number and each software unique module shall be included on the list. The inventory list shall include, but not be limited to, the following information:
 - a) Manufacturer's name, part number, and serial number.
 - b) Quantity of units supplied with the deliverable System/subsystem.
 - c) Software modules supplied.
 - d) Operating system software provided for all CPUs/microprocessors.

- e) Operating systems enhancements and upgrades applied and provided during the installation.
 - f) System documentation supplied.
- 2) The inventory list, be subdivided by hardware, software, test equipment, spares, documentation, and training courses. Each of these major divisions shall be further subdivided to the individual deliverable item level. Each item must be defined in sufficient detail to permit identification in shipping documents and inventory checks. The organization of the inventory list shall include provision for annotating each item with forecast and actual dates for:
- a) Review (Documentation)
 - b) Shipping and Delivery (All items Except Documentation)
 - c) System Testing (Hardware and Software)
 - d) Site Demonstration Tests (Hardware and Software)
 - e) Final Acceptance (Spares, Documentation, etc.)
 - f) Delivery (Training Courses)

12. Binders and Electronic Copies:

- a. Each manual shall be bound in 8 1/2" x 11 inch 3-ring side binders with commercial quality hardback, cleanable plastic covers. Final versions of the manuals shall also be provided as separate Adobe Acrobat pdf files on CD-ROM. The manuals shall be subdivided with permanent page dividers with tab titling clearly printed under reinforced laminated plastic tabs. Each volume shall have a Table of Contents, with each product or system description identified.

13. Testing Documentation Submittals

- a. System Commissioning Plan: Prepare and submit for review a System Commissioning Plan that includes contact information, planned dates, special procedures and considerations, and planned testing procedures.
- b. Test Reports: Prepare and submit for review a Sample Test Report indicating results of system commissioning indicating deficiencies, corrective measures and recommendations.

1.06 SYSTEM DESCRIPTION

A. SCADA SYSTEM SERVER:

- 1. The following paragraphs discuss the specific requirements for the SCADA System Server:

- a. General Requirements: The SCADA System Server shall interface to networked devices, connected RTUs, PLCs, and/or remotely connected RTUs and PLCs via radio and/or networked connections as outlined in the project documents. The SCADA System Server shall gather, log, store and display available SCADA data and reports, and enable modification of data points.
- b. SCADA System Server Hardware Requirements:
 - 1) Pentium class CPU: Sized for 150% minimum software requirements.
 - 2) Physical Memory (RAM): Capacity of 200% minimum software requirements.
 - 3) Hard Disk (SATA): 500GB, minimum
 - 4) External Storage: DVD R/W, Compact Disc Combination
 - 5) Chassis: Rack Mount (2U)
 - 6) Interface Ports: (1)Serial,(1)Video,(1)RJ45
 - 7) Operating System: Microsoft Server 2003, SP2
 - 8) 20" Widescreen LCD Flat Panel with cable of sufficient length to connect to wall mounted enclosure
 - 9) Rack Mount UPS, sized to operate server for 30 minutes without external power.
- c. SCADA System Server Software Requirements:
 - 1) The Visualization Node shall have the SCADA System Server, SCADA System Client and Database Software loaded and configured.

B. SCADA SYSTEM CLIENT:

1. The following paragraphs discuss the specific requirements for the SCADA System Client:
 - a. SCADA System Server Hardware Requirements:
 - 1) Pentium class CPU: 2.8GHZ (min)
 - 2) Physical Memory (RAM): 4GB
 - 3) Hard Disk (SATA): 300GB, minimum
 - 4) External Storage: DVD R/W, Compact Disc Combination
 - 5) Chassis Style: Desk Top

- 6) Interface Ports: (1)Serial,(1)Video,(1)RJ45
 - 7) Operating System: Microsoft XP, SP2
 - 8) 20" Widescreen LCD Flat Panel with cable
- b. General Requirements: The SCADA System Client shall interface to networked devices, connected RTUs, PLCs, and/or remotely connected RTUs and PLCs via radio and/or networked connections as outlined in the project documents. The SCADA System Client shall gather and display available SCADA data and reports, and enable modification of local data points.
- c. SCADA System Client Software Requirements:
- 1) The HMI shall have the SCADA System Client Software loaded and configured.

C. SWITCHES:

1. The following paragraphs discuss the specific requirements for Ethernet based SCADA communications:
 - a. The system shall utilize switches for network control. Hubs shall not be accepted. At a minimum, each control panel shall be provided with a switch with ports equal to the devices connected.
 - b. Basis of Design: N-TRON 9000 Series.
 - c. General:
 - 1) Copper Cable Ports shall be as specified below unless otherwise noted:
 - a) 10 BASE-T/100 BASE-T communications.
 - d. Shielded Twisted Pair Category 6 cable
 - 1) Maximum total cable length: 100 meters.
2. Unmanaged Switch:
 - a. 24 VDC SELV suitable for P1 and P2 redundant power supplies.
 - b. Minimum 0-60 degree C. operating temperature.
 - c. Multimode or single mode optical fiber.
 - d. Switches shall be configured for project conditions. If a switch is not available with the proper configuration, then switch cascading shall be permitted.

D. UNINTERRUPTIBLE POWER SUPPLIES:

1. Uninterruptible Power Supplies (UPS) shall be provided for the SCADA System Server, HMIs, PLCs and switches. As a general rule, provide a dedicated UPS for each cabinet and each major SCADA component location. Sharing of UPS's is allowed as long as a single point of UPS failure cannot disable the system. The UPS system shall be able to run on Utility or generator power without any disruption in service. UPS's will be sized according to the following:
 - a. 89 to 151 VAC Input with automatic 50/60 Hz detection, 127 joules total energy dissipation surge suppression, data line protection, and user resettable circuit breaker.
 - b. Continuous battery recharging, even if the power button is set to OFF. The UPS shall have a battery replacement indicator, and shall allow batteries to be replaced via the front panel.
 - c. The UPS shall have a minimum of 4 NEMA 5-15R plugs.
 - d. The UPS shall be approved by UL, and cUL. The UPS shall carry the CE logo, and shall comply with EN 50 091, and IEC 62 040.
 - e. The UPS shall have a set of discreet contacts for connection to the PLC. The UPS shall have a power management software package suitable for Windows.
 - f. Basis of design: Basis of design will be the MGE UPS Systems Nova AVR by Schneider Electric.
 - g. Run time shall be based on a 45 minute outage with alarm contact closure for low battery and general alarm.

1.07 SCADA SOFTWARE

A. GENERAL

1. Description: The SCADA software package shall be part of a complete SCADA system. This system shall include all required networked hardware.
2. Core SCADA Functionality: All core SCADA functionality offered, such as communications drivers, graphics capabilities, reporting, historical storage, trend and alarm displays and the development environment are offered as a single integrated software package or suite of packages. The software shall be designed with the ability to make changes to the graphics while the system is running. Shutting down the system for graphic changes is not acceptable.
3. Additionally, software will be supplied to augment, or replace functionality of the software package:
 - a. Additional Operator and HMI Pages including; Graphics, I/O representation and report generation.

- b. SMS software for remote annunciation of alarms.
 - c. Email software for emailing of alarms.
4. Application size: The SCADA software and engineering configuration shall be based on the total number of device points being measured and derived plus a 20% spare capacity.
5. Customized Application Programming: Additional SCADA software programming shall include:
- a. Configured Graphics Pages: The Owner shall be provided with 8 graphics pages to be used at the SCADA System Server and SCADA System client to access devices.
 - b. Alarms: The Owner shall be provided with device level alarming for each connected device and 4 customized general alarm pages to be used at the SCADA System Server and SCADA System client to access devices.
 - c. Trends: The project shall be provided with customizable trends tables indicating trends by device. Values shall be scaled per device and quantity measured.
 - d. Historical Reporting: The Owner shall be provided with customizable reports historical reports for each device connected indicating trend values, min/max values, totals and device specific information.
 - e. Development: The Contractor shall coordinate with the Owner for specific design requirements prior to commencing work. The SCADA Contractor shall provide a 50% and 100% design meeting after initial coordination meeting with Owner. Final 100% design meeting shall occur within 60 calendar days of successful review of HMI and PLC submittals.

B. CONNECTIVITY:

- 1. Description: The SCADA software shall employ an I/O client to manage the reading and writing of data from PLCs, RTUs, and system components. The I/O client shall provide the data on request to any SCADA System Client in the network.

C. COMMUNICATIONS

- 1. Description: The SCADA software shall be capable of communicating to PLCs connected to the network, remote PLCs, I/O clients, and other devices on the network.
- 2. Communication failure at any node shall not render that node or any attached nodes inoperable. Each node shall function independently using a locally stored program.
- 3. General communication capabilities. The SCADA software shall have the following communications capabilities:

- a. Support for redundant communication paths to field controllers, and provision for automatic changeover to the standby path in the event of a communications failure.
 - b. Built in diagnostic alarms shall be provided with the system that will automatically notify the operator of the failure of any communications path both locally and remotely.
 - c. A package of communication drivers that shall include the following as a minimum:
 - 1) Modbus Driver
 - 2) Ethernet/IP Driver
4. Communication re-establishment:
- a. Upon re-establishment of communications after a failure all historical alarm, event and trend data archived by the remote field device (RTU) shall be automatically backfilled into the SCADA System Server and Client alarm and trend history files.

D. SECURITY

1. Description: Security features shall be fully integrated to allow only users with appropriate security levels access to individual parts of the system.
2. Security Capabilities: The SCADA software shall have the following:
 - a. Encrypted passwords that are verified at each node and at the server side.
 - b. Passwords shall be hidden in both the configuration and runtime environments to ensure that personnel cannot access another account without authorization.
 - c. Monitoring and logging of each Operator Interface and of each user. This shall include all operator control actions where inputs or outputs are forced, modifications are made and system log in and log out with time and date stamps. The sequence of actions shall be viewable within the SCADA package and also stored in an external open file format (e.g. txt, csv, dbf, sql) for later analysis.
 - d. Automatically log out a user after an adjustable time period. Logging out a user will only cause the system to revert to a view only security status. Logging out will not shutdown any node or interface.
 - e. A minimum of 6 privilege levels shall be available for each user. The software shall ensure that a user has access to all tasks for his privilege level. If the user does not have the correct privilege for a task a message will indicate insufficient privilege and log the attempt at the SCADA System Server.

- f. Assign each graphic object at each plant area, define the privilege level, define whether operator input is enabled or disabled, and if the object will be visible or not based on the operator's current privilege levels within the plant area.
- g. A mechanism to restrict access to different areas of the plant for each individual user or group of users.

E. GRAPHICAL DISPLAYS

1. Description: Graphical displays are windows that are used to represent part or all of a process in a graphical manner.
2. General Graphical Display Capabilities: The SCADA software shall have the following graphical display features:
 - a. Unlimited number of graphical displays.
 - b. Capable of a minimum of 2000 analog variables, with real time updates of less than 500ms (for all data to appear or change on the page)
 - c. Capable of automatically re-sizing to match the screen resolution of the computer on the network, irrespective of the resolution the pages were developed in or configured for, and irrespective of whether vector or bitmap graphics are used on the page, without shutting down the SCADA software, without recompiling, and without having multiple copies of graphic pages for different resolutions.
 - d. Support a screen resolution of up to 1280 x 1280 pixels.
 - e. Support full 32 bit graphics, and capable of displaying images from third party packages for use within the SCADA displays, including animating and vector graphic images.
 - f. Capable of pop-up windows for trends, loops, device status, and device control by clicking on hot spots or objects on the main graphics page. Simultaneous opened popup display windows shall be supported by the graphics display system.
 - g. Inclusion of page name, current time and date together with details of the last 6 alarms that have occurred on all graphical displays.
 - h. Ability to allow the user to navigate around the graphics system utilizing a variety of navigation methods.
 - i. Ability to have Hot Key links to specific graphics pages from the keyboard.
 - j. Windows style navigation menus allowing access to any configured page in the system from any other page.
 - k. Configured with "hot spots", where as a user can click on the area and drill down into a detailed view (if available) of the plant area.

- l. Ability to display communication loss for a particular I/O point wherever that data is displayed in the software.
 - m. Touch screen friendly icons for HMIs employing touch screen capabilities. The area to be 'clicked' shall be large enough for a standard finger and designed to prevent accidental 'clicking' of adjacent areas.
3. Dynamic Objects: Dynamic objects are symbols that visually change when a property, tag or expression changes. Dynamic objects shall include:
- a. Support the following graphical dynamic objects as a minimum:
 - 1) freehand lines
 - 2) straight lines
 - 3) poly-lines
 - 4) rectangles (including the latest curved corner style)
 - 5) ellipses
 - 6) pie slices
 - 7) text
 - 8) buttons (of the latest WinXP style)
 - 9) Bitmaps
4. Dynamic objects shall have a series of properties that can be used independently or concurrently. Each dynamic object shall have the following properties:
- a. Horizontal, Vertical and Rotational movement
 - b. Up, Down, Left or Right Level Fill
 - c. Gradient Level Fill
 - d. On-Off, Multi-State, Integer, Threshold or Gradient Color Change
 - e. Horizontal and Vertical Size
 - f. Visibility
 - g. Keyboard Input
 - h. Touch (Mouse Up, Down, While Down) input

- i. Horizontal and Vertical or Rotational Slider
 - j. Ability to disable the object based on security levels.
 - k. Popup information in a “tool tip” form by rolling the mouse over the object
5. ActiveX: The SCADA software will be an ActiveX container and allow for insertion of ActiveX objects into standard graphics pages. ActiveX components include Adobe Flash, JavaScript enabled routines, etc. The SCADA software shall interact with ActiveX objects in the following ways:
- a. Dynamically change properties of an ActiveX object via a Tag from an I/O Device
 - b. Dynamically change properties from SCADA software high level language.
 - c. ActiveX object to trigger actions in the SCADA software based on events in the ActiveX Object.
 - d. ActiveX property values can be read by the SCADA software.

F. ALARMS

1. Description: Alarms are meant to alert and operator of an abnormal condition. They are logged, and require operator intervention.
2. General Alarm functionality: The alarm functionality shall have the following:
 - a. No software limit on the number of alarms supported
 - b. Acknowledgement on one operator interface terminal shall be globally acknowledged and as such shown as Acknowledged on all operator interface terminal s. This shall be configured as one common database, with no other programming necessary to enable global acknowledgment of alarms from any node in the network.
 - c. Alarm pop up displays shall expire upon alarm event being cleared at any of the nodes within the network.
3. Alarm Types: The SCADA software shall monitor analog and discrete variables and calculated conditions, and determine if the variable is in an alarm condition. The SCADA software shall perform the following:
 - a. All analog alarm conditions shall have adjustable dead bands and delay timers to minimize nuisance alarms. All analog alarm properties shall be adjustable without the need to shut the system down. For each Analog Tag, an alarm for each of the following conditions shall be assignable:
 - 1) LOW,

- 2) HI,
 - 3) Deviation LO
 - 4) Deviation HI
 - 5) Rate of Change
 - 6) Device Fail
 - 7) Device Level Assignable Alarm
 - 8) Communications Loss
- b. Discrete alarms shall have an assignable alarm for each of the following:
- 1) Variable ON
 - 2) Variable OFF
- c. Multi-Digital Alarms based on a combination of discrete tags. Any combination of states of the discrete tags may be configured to be an alarm. Furthermore, a new alarm signal shall be initiated whenever a new alarm state is encountered.
- d. All alarm processing shall use time and date stamping based on origin of alarm and clearing of alarm.
4. Alarm Display: Alarm display shall have the following:
- a. Depending on user's log-in privileges, it shall be possible to display or acknowledge any alarm and/or the most recent alarm on any page.
 - b. Alarm shall be configurable in multiple levels. The color of the text of the alarm message shall indicate priority. Text color shall be determined in initial design review meeting.
 - c. Sound indication for each alarm category shall be configurable. This must be possible at each node via internal or external speaker. The sound indication shall support the playing of any standard .WAV and .MP3 file.
 - d. Provided with a standard alarm user modifiable display page. The alarm page shall allow for scrolling of alarms, and acknowledgment of individual alarms or all alarms on the page.
 - e. Possibility to display the following information for each alarm as it appears on an alarm display page:
 - 1) Alarm Tag Name

- 2) Alarm Description
 - 3) Value of the Variable
 - 4) Alarm Status - Disabled, Acknowledged, Unacknowledged
 - 5) Alarm Category or Priority
 - 6) Time & Date
 - 7) Value of associated tags, devices or results of associated calculations.
 - 8) User comments, where alarm is to be locked out by authorized user.
- f. Based on user's privileges, it shall be possible to disable alarms on individual basis, by page or by alarm category or all alarms. A disabled alarm page shall indicate to every user which alarms have been disabled and which user disabled the alarm with user incorporated comments, including area for description of lockout purpose.
 - g. Based on user's privileges, it shall be possible for user comments to be attached to any alarm. These comments shall either be displayed with the alarm or by clicking on the alarm.
 - h. Possibility to automatically display any graphic display when an alarm occurs or to dynamically change the appearance of any graphical object based on whether an alarm is On, Off, Acknowledged, Communications Error or Disabled.
 - i. A mechanism for operators to dynamically define filtering of alarms by alarm name, tag name, date/time range, state or type.
5. Alarm Logging: The following alarm functionality shall be provided:
- a. Alarms that are logged to disk shall be viewable while the system is online or offline without interrupting data collection. The software shall not limit the number of alarms logged to disk. The alarm logging shall be capable of logging an instantaneous burst of alarms without losing any single alarm notification.

G. TRENDS

1. Description: Trends are a collection of data points over time. When viewed over time, the trends will indicate general progression of the data.
2. General Trend Functionality: The software shall have the following functionality.
 - a. The number of trends collected shall not be limited by the software.
 - b. The software shall be capable of logging historical trend information at configurable sample periods from 1 Millisecond to 24 Hours.

- c. Trend data shall be stored in a file system with the sample period, file location, privilege, owner and area being user definable individually for each trend. File names and paths shall support file names up to 255 characters in length.
 - d. Every tag defined in the system configuration shall be trended. Each trend shall contain a minimum of 2 years historical data at a 10 minute sample rate. The trends shall be maintained online for operator call back without the need to backup or restore history files.
3. Trend Display: The software shall have the following in its native functionality:
- a. Each operator and login shall be able to view fully customized trend pages. These pages shall be customizable on line by each user in a drop down menu fashion. Any setting available to be made in a configuration environment shall be available to the user to modify the trend graphs in run time. These include the color, scaling, pen selection as examples.
 - b. Line graphs with time on a linear, continuous horizontal or vertical axis and the trended variable on the vertical or horizontal axis. Resolution of each graph shall be to within 0.1% of full scale.
 - c. Where more than one variable is displayed on the same graph, the pen color of each variable and associated information shall be displayed in a different color.
 - d. Each trend graph shall be capable of displaying a minimum of 12 trend pens with adjustable time base to one second samples and shall be capable of viewing the entire archived trend history.
 - e. Each pen shall display individual ranges and engineering units. Each pen shall be scalable for display purposes independent to each other pen displayed on a page.
 - f. Include the capability to pan backward and forward within a selected time range to read the exact value of any displayed variable, by selecting a point on the graph or chart. The system shall display historical information as far back in time as desired, with all information being displayed within 1 second.
 - g. The software shall provide "zoom" and "pan" facilities for both the trended variable range and the time axis range. The "zoom" facility shall allow an operator to compress or expand the axis range whilst the "pan" facility shall allow an operator to shift the origin of the axis. The software shall allow a user to define any zoom area by dragging a mouse across the trend.
 - h. The software shall make available trending data from a historical database for export to disk files or external databases. It shall be possible to define the section of the trend to be exported by clicking and dragging the mouse across the trend. Data shall be portable to csv, dbf or txt formatted files. It shall also be possible to export any portion of the historical trend database via ODBC, DDE, dbf, CSV and TXT formats.

H. DEVELOPMENT ENVIRONMENT

1. Description: The development environment is the area that allows generation of graphic screens, alarms screens, tag database, trend screens etc.
2. General Development Environment Functionality: The SCADA software shall include a development environment with the following:
 - a. An integrated development package utilizing menu driven, fill in forms style configuration to develop the runtime system.
 - b. All development functions shall be available at the SCADA System Server node.
 - c. A utility to back-up or restore an entire database including all graphic displays, configuration data and source code, as well as online configuration (such as menu navigation, trend groups and alarm groups), via a simple point and click method shall be provided. The backup/restore utility shall prompt the user prior to over writing any existing files. The utility shall employ automatic file compression and decompression.
 - d. Ability to import field controller tag definitions shall be included as a standard feature. Automatic updating upon a change of a definition in the I/O device tag names, addresses, ranges etc will automatically be imported into the SCADA software database. In addition it shall be possible to manually initiate the import of tag definitions at any time. The Tag import function shall be user configurable such that a user can specifically define which definition fields must not be overwritten or define how the import will operate. The import function shall support generic OPC data sources and CSV file imports in conjunction to native field controller programming software database imports.

I. GRAPHIC BUILDER

1. Description: The graphic builder allows for development of graphic screens.
2. General Graphic Builder functionality: The graphics builder shall be interactive and menu-driven, requiring no programming. It shall consist of the following:
 - a. Directly import graphics and text in the following file formats:
 - 1) AutoCAD DXF
 - 2) Windows BMP
 - 3) Windows Meta File WMF
 - 4) JPG
 - 5) GIF
 - 6) TIF

- b. The graphics builder shall be capable of creating screens composed of both static and dynamic objects. To create these objects, the software shall provide sample screens and a set of standard shapes in a library. The developer shall be able to include these symbols by reference, or create new symbols/objects.
3. ActiveX: The graphics builder shall have an assignable ActiveX container. ActiveX objects shall be capable of being inserted and edited in a visually interactive manner. It shall be possible to connect ActiveX properties to tags, allowing read/write between properties and tags without the need for script or code. ActiveX objects must have the same security as native graphics objects and ActiveX objects shall be visible or hidden based on the users' privilege level.

J. CUSTOM SCRIPTING LANGUAGE

1. Description: The scripting language shall be used to develop custom routines, and algorithms not supplied as part of the standard package.
2. General Custom Scripting Functionality: The SCADA software's scripting functionality shall include the following.
 - a. An integrated high level language specifically designed for SCADA applications that shall be inherently multi-tasking and multi-threading.
 - b. Fully integrated and multi-threaded Visual Basic (VB) scripting.
 - c. Access to all field tags, alarms, graphics displays, database and ASCII files. The languages shall include functions with clear and precise syntax. The languages shall support user written functions and function libraries supported by the computer's operating system. The language shall have the capability to export or import data from other applications.
 - d. Creation of calculated (inferred) variables based upon formulae including constants, measured variables and other calculated variables. All facilities available for logging, reporting, trending, monitoring, controlling, alarming and displaying measured variables shall also be available for calculated variables.
3. Support of mathematical and Boolean operators.
4. Support for mathematical functions.
5. Prevention of any functions from interfering with proper SCADA functionality.
6. Permit users to create their own functions and integrate them. All functions shall be reusable. It shall be possible to call the same function multiple times from different locations, with different parameters simultaneously.

7. Provisions to run functions automatically on start up, on page entry, on page exit, while a page is open, on button down, while button down, embedded in reports, alarm on, alarm off, on any keystroke, any keyboard entry on any mouse button click, etc.

1.08 QUALITY ASSURANCE

A. Installer Qualifications:

1. A qualified installer shall have, within 200 miles of Project site; a facility, capable of providing parts, service and coordination of emergency maintenance and repairs.

B. Source Limitations:

1. All SCADA HMI Software shall be from a single manufacturer.

C. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

E. SCADA System Availability Requirements:

1. A fundamental objective of the SCADA System Supplier's proposed system design shall be to ensure that no single equipment failure or temporary error condition can disable the systems overall operation or generate any spurious control commands to the system equipment. This requirement is not intended to specify a hot backup installation, but to provide a modular system that when a site is in error or has failed; will not disrupt the whole of the SCADA system or prevent another site or terminal at another site within the SCADA system from functioning as designed.

F. Single Point of Failure:

1. The SCADA equipment configuration shall prevent any single hardware or software failure from causing loss of any system function or from causing overall system malfunction. Single hardware failures may cause loss of specific communication channels temporarily until failed equipment is replaced. This requirement is not intended to specify a hot backup installation, but to provide a modular system that when a component is in error or has failed; will not disrupt the whole of the SCADA system or prevent the site from functioning as designed in manual mode.

G. SCADA Operational Checks:

1. The SCADA System Supplier's proposed system shall continually poll each component in the system for operation, alarm I/O, and report the malfunction. Upon detecting a malfunction, the failed operation shall be attempted a number of times (programmable) in order to determine

whether the malfunction is temporary or permanent. Permanent malfunctions shall be alarmed and logged. Temporary malfunctions shall be logged for maintenance purposes. Communication delays shall not be logged as a device specific alarm.

H. System Availability:

1. During the System Availability Demonstration, the SCADA system shall achieve an average availability rate for all functions of at least 99.95 percent. This is equivalent to a total downtime of approximately 4 hours per year for the System. The system Availability Demonstration shall be part of the warranty guarantee.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Store SCADA software in a secured location and in binders. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. Protect SCADA software from theft, loss, exposure to dirt, fumes, water, corrosive substances and physical damage. The Contractor shall retain responsibility to deliver all documents and hardware to the Owner as part of the project close-out procedures.

1.10 WARRANTY:

A. System Warranty Overview:

1. The system warranty shall consist of a full scope, in-place warranty, consistent with the provisions of the Terms and Conditions in the project documents. The warranty duration shall be 36 months. All hardware components and system programming that is a part of the completed system shall be covered by the warranty. The Contractor shall not provide third party warranties.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Software Manufacturer: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but not limited to:

1. Invensys Wonderware InTouch
2. Invensys Wonderware Historian
3. Invensys Wonderware SCADAAlarm
4. Invensys Wonderware Information Server

B. PLC Programming Software:

1. PLC programming software compatible with installed system.

- a. Provide 1 License, program for use with Microsoft Windows XP/Vista operating system and related cables required to connect to PLC. Coordinate with Owner for system installation and configuration requirements.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive SCADA System and associated control panels for compliance with requirements, installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

- A. Select SCADA Software based on application type, tag count, type of node. It is recommended that a manufacturer's representative be consulted during the selection.

3.03 INSTALLATION

- A. Fasten control panels, and other devices.
- B. Ventilation slots shall not be blocked, or obstructed by any means.

3.04 IDENTIFICATION

- A. Identify components, and wiring according to all applicable codes, standards and contract document sections.

3.05 FIELD QUALITY CONTROL

- A. Field Service:
 1. The Contractor shall provide a qualified service representative to perform the following:
 - a. Inspect wiring, components, connections and equipment installation for conformance.
 - b. Test and calibrate instrumentation and equipment.
 - c. Provide software programming, loading and debugging.
 - d. Install and test SCADA applications.
 - e. Report results in writing.
- B. Installation and Start-Up:

1. Develop a specific plan for the startup and commissioning of the SCADA system and for any required cutover. No startup or cutover activities shall be performed until the plan has been successfully approved by the Owner and Engineer.

C. Site Acceptance Test:

1. A Site Demonstration Test of the functions, software, and performance shall be conducted after all system elements have been installed and the I/O point checkout has been completed. The system site demonstration tests shall be performed to verify complete operation of the system, requiring a repeat of much of the comprehensive system tests but with the equipment installed at the permanent sites, and shall include additional tests required to verify field installed equipment. The I/O point checkout shall include, but not be limited to:
 - a. Verify all the facility installations.
 - b. Demonstrate each functional requirement identified by the specification.
 - c. Demonstrate all equipment control functions, including the operation of automatic control strategies. Actuation of field devices shall be closely coordinated with facility operations.
 - d. Verify system performance parameters and system responses under field operational conditions.
 - e. Verify accuracy of documentation, especially operator's manuals, software documentation, and general system operating instructions.
2. Provide the appropriate technical representatives for the execution of the Site Demonstration Test. Test support personnel shall be qualified to resolve and correct problems encountered with the system during the tests. In addition to test support personnel, provide all test instruments and equipment necessary to troubleshoot any of the proposed system problems encountered. The Owner reserves the right to increase the requirements for test support personnel if support is inadequate.

D. Demonstration

1. Provide a qualified service representative to train Owner personnel to adjust, operate, and maintain SCADA system as detailed below.
2. Site Availability Demonstration:
 - a. Test Requirements:
 - 1) At the completion of Site Acceptance Test (SAT), the Integrator shall conduct a Site Availability Demonstration test utilizing all equipment, software, and services provided under this Contract. During the test the system shall meet the availability criteria defined below and shall meet the performance requirements stated in the specification. Owner personnel may elect participate in any and all parts of this demonstration as observers at the discretion of Owner.

b. Scope of Test:

- 1) All equipment and software delivered with the system shall be subject to the availability measurements.

c. Test Equipment:

- 1) The Site Availability Demonstration shall be performed under field operating conditions. All functional and performance requirements specified in this document shall be met during the SAT.

d. Length of Test:

- 1) The system shall be subjected to Site Availability Demonstration evaluation for a period of not less than 60 days (1440 hours). If at the end of the 60 days, the system availability is determined to be less than that required, the test shall continue on a day-by-day basis, dropping off the oldest day's test results. This sliding window concept shall continue until the system passes the test or until 120 days time has passed.

e. Preventive Maintenance:

- 1) During the Site Availability Demonstration period, perform preventive maintenance of the type and the frequency of service defined in the SCADA maintenance manuals. Supply a recommended maintenance plan prior to start of the test.

f. Test Prerequisites:

- 1) Prerequisites to starting the SAT are successful completion of the Comprehensive System Test and the Site Demonstration Test and resolution of all outstanding Discrepancy Reports.
 - a) Final copies of O&M manuals
 - b) Final copies of System Operator's manuals
 - c) Final copies of System Administrator manuals
 - d) Final Record Documents.

g. Progress Reports:

- 1) Maintain the official record of operating time, recorded incidents and disposition, maintenance action, and calculated availability. At the completion of system availability demonstration, prepare a separately bound test report for Engineer to evaluate and approve.

h. Letter of System Acceptance:

- 1) Upon review and approval of SAT, the Owner shall provide a letter documenting that the SAT has been completed.

E. Training:

1. Training Overview:

- a. Provide A comprehensive training program covering the operation and maintenance of all elements of the proposed system.
- b. For training sessions conducted on-site, the Owner will provide the necessary workstations.
- c. All training classes shall be completed prior to the start of the Site Acceptance Test.
- d. Training shall not be combined with other activities such as system configuration or startup.

2. Required Training Sessions:

- a. Sufficient sessions shall be presented to satisfy session size restrictions and conflicts in facility personnel scheduling. If the standard training curriculum includes applicable information in addition to those discussed below, the Contractor shall also provide these courses. The categories of training to be provided shall be:

1) Operator Training:

- a) Training sessions shall be presented that instruct the system operators in the efficient operation of all aspects of the SCADA. The course material shall include the general operation of the SCADA system, and the operation of the specific system features incorporated in the SCADA system. In particular, the operator training shall include instruction on the use of all operational functionality.

2) Software Maintenance Training:

- a) Training sessions shall be presented that will enable facilities staff to develop and maintain all aspects of the system software. Separate sessions shall be presented that deal with the following topics:
 1. Process database replication, backup and restoration
 2. Process display development and modification
 3. Supervisory Control strategy development and modification
 4. Report development and modification

5. General software maintenance, including system backup, restoration and archiving.
 6. Calculation additions, alarm and event logging additions, Graphic display, report and trend additions
 7. Network training for adding additional equipment (printers, workstations, etc) or additional PLCs / RTUs and I/O from the SCADA Network
 8. Adding, editing, transporting and testing of data sent to historical database system
 9. Any Third party tools for accessing data from any database.
3. Training sessions shall address the procedures for the standard SCADA system software, plus material explaining the specific conventions and procedures used by the Contractor in developing the SCADA applications. The sessions shall also provide instruction in techniques for developing and maintaining current, comprehensive documentation for all applications.

END OF SECTION