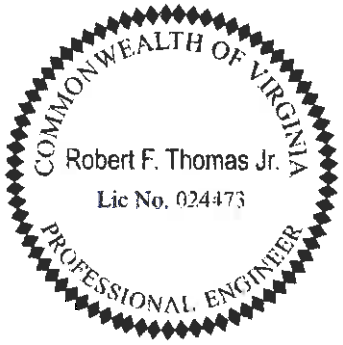
APPENDIX A

Progressive Engineering Consultants, Inc.

SPECIFICATIONS
FOR A
SUPERVISORY CONTROL AND
DATA ACQUISITION SYSTEM

TOWN OF CULPEPER
CULPEPER, VIRGINIA

DOCUMENTS PREPARED BY:



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1. Introduction

1.1 General

This document sets forth equipment and operational requirements for a Supervisory Control and Data Acquisition (SCADA) System.

The vendor's master server shall be required to communicate with the Town's existing QUICS RTU's manufactured by QEI, Inc. currently operating on the Town's existing SCADA System. Should additional hardware and software be required then the Vendor shall include the necessary equipment in the base bid.

The Purchaser does not intend for the selected Vendor to design a new system to these specifications, but rather receive a bid for a system of established and fielded design to replace the existing SCADA System. Minor variances between the Vendor's equipment and the specification may be allowed, but any exceptions not explicitly noted may be cause for the Vendor's bid to be deemed unresponsive. All exceptions and/or clarifications shall be indicated by means of a separate, paragraph-by-paragraph compliance statement which will be included as part of the Vendor's bid.

Vendor shall include a DNP Scan Task in the base quotation for TCP/IP communications to the RTU. RTU is currently running QUICS protocol. Converting the existing database, both at the RTU and Master, for successful communications from the Master to the RTU to DNP over TCPIP, single mode fiber shall be included in the base bid. Any extra hardware necessary for the RTU to communicate with the Master to complete the conversion shall be included in the base bid.

One week of factory training shall be included in the base bid. This could be substituted with one week of site training including travel and living expenses.

Five days of commissioning shall be included in the base price including travel and living expenses. Should commissioning take only a couple of the days then the remaining time shall be spent with the customer to optimize their system. System training shall be done during the following week or at a time to best suited with the customer's schedule.

Five years of attendance at the Vendor's User's Conference shall be included in the base bid for one person.

1.2 Vendor's Responsibilities

The Vendor shall be responsible for:

a. Design, document and deliver a fully integrated SCADA system, with all hardware and software required to meet this specification.

b. Provide the Purchaser with documentation for review and approval including: equipment lists, hardware and software design, system drawings, hardware and software manuals and acceptance test procedures.

c. Provide Purchaser with detailed information on the requirements of the equipment to be supplied: space, cabling, environmental controls, power and communication circuits.

d. Support Purchaser in developing an implementation plan covering installation, testing and startup of the system.

e. Provide training courses covering Master Station database generation, and operation; and remote gateway database configuration and maintenance. Make courses available either at the Vendor's or the Purchaser's facilities.

f. Provide technical support during the Purchaser's construction of the Master Station and/or RTU configuration.

g. Perform a customer-witnessed, ISO 9002:2008 certified, site acceptance test, with all supplied equipment staged into an integrated functioning system.

h. Provide necessary onsite technical assistance as proposed during system start-up and testing.

i. Provide maintenance support and spare parts as proposed throughout the warranty period.

j. The Vendor shall provide with their bid a detailed description of the proposed system's architecture and operational features, as well as five (5) references of installed and operational systems similar to the one proposed, including contact names, phone numbers and email addresses.

1.3 Purchaser's Responsibilities

The Purchaser shall be responsible to:

a. Provide timely technical review of the Vendor's approval submittals: equipment lists, hardware and software designs, drawings, documentation and acceptance test procedures.

b. Develop an implementation plan covering their portion of installation, testing and startup of the system.

c. Provide space, environmental controls, and power and communication circuits sufficient to accommodate the Master Station and Substation equipment supplied by the Vendor.

d. Provide the necessary assistance in order to construct the Master Station database and configure the substation gateway databases. (After receipt of proposed training).

e. Provide all required substation field wiring and equipment external to any remote gateways.

f. Provide assistance to install all Vendors supplied equipment, and connect all substation field wiring from controlled and monitored equipment to the Vendor supplied substation gateway terminations.

g. Performance of onsite acceptance testing with assistance from the Vendor.

1.4 Standards

The Vendor shall apply the following standards, as applicable, in the design and manufacture of the proposed system:

a. NERC - North American Electrical Reliability Council (specifically NERC-CIP)
b. IEEE - Institute of Electrical and Electronics Engineers
c. IEC - International Electrical Code
d. ANSI - American National Standards Institute
e. NEMA - National Electrical Manufacturers Association
f. EPRI - Electrical Power Research Institute

2. Project Overview

Vendor to include system overview drawing specific to vendor's equipment for this project.

Master Station Equipment

2.1 The SCADA Master Station shall consist of central database and communication server(s) which maintain the core SCADA system database and communication software on a secure server platform. The secure SCADA servers shall be industrial quality machines designed for highly reliable 24x7 operations in a demanding and mission-critical computing environment. SCADA servers shall be based on true 64 bit computers capable of providing simultaneous, real-time service to many communication channels and operator workstations. SCADA servers shall utility an operating system widely used by mission critical installations with a high degree of immunity to computer malware and viruses such as LINUX, WINDOWS 8, or approved equal. Operating systems with a history of malware, viruses, worms or those needed frequent patches and antivirus updates will not be considered acceptable for the central SCADA server(s).

The bidder will state in their bid the number of Operating System patches and Antivirus updates experienced by the proposed server during the last calendar year. As the user is interested in meeting NERC-CIP 002-009 requirements, the vendor should address how all operating system updates and antivirus updates will be identified, tested, implemented and documented in the proposed system. In accordance with NERC-CIP guidelines, automatic update of the operating system and antivirus profiles is not allowed or acceptable for the meeting of this requirement. As a minimum, the SCADA system servers shall incorporate the following minimum design features:

③ Demonstrated 24x7 software reliability and high availability, disaster tolerance and performance scalability when running real-time applications.

③ A true 64-bit operating system with a real-time pre-emptive scheduling mechanism and interrupt-driven I/O subsystem designed for minimal latency, and capable of handling complex real-time events with an exceedingly high, sustained I/O throughput.

③ Redundant 10/100 baseT Ethernet LAN/WAN interface with TCP/IP communication using SSL or SSH encryption security.

③ Capable of being configured with up to four (4) fully synchronized SCADA system servers, which support automatic, prioritized, fail-over to standby servers of all gateway/RTU communication, printer driver and operator console services with no manual assistance or intervention.

2.2 Operator Workstation

Two (2) operator workstations shall be provided. The SCADA System Operator Interface shall be pixel resolution graphic display software running on standard Windows PCs with a current MS Windows operating system. All PC Workstations provided by the vendor shall be supplied with IEEE 802.3/Ethernet compliant 100baseT LAN interface, and the SCADA application software shall be capable of supporting multiple operator workstations on industry Windows platforms deployed across the corporate LAN/WAN. Connections between the Windows operator consoles and the central SCADA server shall be via any authorized TCP/IP connection (Ethernet, Internet, etc.). Operator workstation application software shall be designed to optimize performance and minimize network traffic by maintaining a local database on each Windows workstation. The operator HMI will adaptively update only the value of data points that are currently being displayed on that workstation in order to minimize network traffic.

The operator workstation monitors shall be high resolution, 20 inch, LCD flat panel color monitors with 1600 by 1200 minimum resolution and 32 bit colors. Workstations shall include a full alpha numeric keyboard with a minimum of 12 special function keys and a separate numeric key set and a 2 button mouse cursor control device.

Each operator workstation at a minimum shall include 3.2 GHz Dual Core CPU, 2 GB RAM, 320 GB hard drive, 256 MB graphics accelerator, DVD-CDROM, 10/100baseT network interface card, 20" LCD flat panel display, and the current Windows operating system software.

2.3 Alarm/Event Loggers

Alarm and event logging printers shall be high speed, 24-pin, impact printers with tractor pull for continuous bottom feed of automatic fan fold paper. Logging printers

shall not be page printers, but shall be capable of immediately printing an individual line as each alarm or event occurs.

As a minimum, the printer shall support print speeds of 3300 cps (draft) and 110 cps (letter quality).

2.4 Laser B&W Printer

Network based laser report printers shall be provided for high resolution printing of scheduled reports.

As a minimum any LaserJet black & white/grayscale printers supplied shall provide:

- 1200 x 1200 dpi resolution
- 32 MB memory
- 30 page per minute print speed
- PostScript 3 emulation
- 10/100baseT Ethernet (RJ45)
- 53 Dba operating noise level

2.5 Color Laser or Color Inkjet Printers

Color laser or Inkjet printers shall be provided for high resolution printing of scheduled reports, graphic displays, and historical data.

As a minimum the color laser printer shall provide:

- 1200 x 1200 dpi resolution
- 128 MB memory
- 24 ppm black & white
- 20 ppm full color
- 10/100baseT Ethernet (RJ45)
- 53 Dba operating noise level

2.6 Communication Server (for serial communications)

The Vendor shall provide fully redundant, multi-port Front End Communication Processors (FEP) capable of supporting multiple polling modes for communications with remote stations including continuous polling, quiescent reporting initiated by the remote devices, dedicated communication circuits, and dialup communication links. The gateway/RTU communication FEPs shall consist of network enabled and

remotely managed multi-port device servers.
As a minimum the RTU communication FEPs shall include the following features:

- Four (4) TCP/IP 10/100Base-T Ethernet LAN Interface
- Downloadable Software Upgrades via FTP, TFTP
- Sixteen (16) Serial Ports: RS-423, RS-232, single and multimode Fiber
- Full Modem Controls - RTS, CTS, DSR, DCD, DTR

The communication server shall support multiple polling modes for communications with remote stations including continuous polling, quiescent reporting initiated by the

remote devices, dedicated communication circuits, and dialup communication links. Communication shall be serial, byte oriented, and asynchronous protocol suitable for interface to standard leased line modems, dialup modems, or other serial communication facilities: such as radio, fiber optic, microwave, CDPD, Frame Relay.

The communication server software shall support multiple remote device protocols with multiple instances of each protocol operating independently on multiple communication lines. As a minimum the scan task software licenses shall be available for the communication server to support the following open remote device protocols: DNP 3, and or Modbus.

2.7 Communications to remote Gateways/or RTUs

Vendor shall be required to interface with the Town's existing RTU currently running QEI Quics protocol. It is the Town's intent to move from the Quics protocol and communicate via DNP 3.0 over TCPIP with single mode, ST, fiber connection. Convertors shall not be allowed for any reason in order to make this transition. Should additional hardware be required then the Vendor shall include the necessary equipment in the bid and list accordingly.

2.8 Environmental

The Master Station servers and operator consoles shall consist of standard products designed to operate in a normal, indoor, office environment with no special air conditioning requirements.

- Operating Temperature: 10° to 40°C
- Humidity: 10% to 90%
- Voltage: 88 to 130 VAC
- Frequency: 47 to 63 Hz

2.9 System Capacity

At a minimum the SCADA system software shall be capable of accommodating the following:

- 50,000 status and analog points
- 1,000 remote stations
- 64 operator consoles
- 16 printers
- 64 RTU communication lines

3.1 Secure SCADA Server & Windows (PC) Operator Consoles

The SCADA system software shall support a client/server system architecture.

While standard Windows PCs are to be used for all system HMI (dispatch, editing, system management, etc.), the central SCADA database and communication functions shall reside on a secure server utilizing an operating system designed for demanding

and mission-critical computing. The SCADA server will be safe from the security, update and malware vulnerabilities inherent in the Windows operating systems.

The SCADA display application software shall support multiple operator console windows, which can be moved, re-sized, tiled, cascaded and shrunk into icons, and an intuitive system of quick, mouse-oriented, pull-down menus and dialog boxes to execute all operator functions.

The operator workstation application software shall be designed to optimize performance and minimize network traffic by maintaining a local database on each workstation that adaptively updates only the value of data points that are currently being displayed on that workstation.

3.2 Communication

3.2.1 Gateway/RTU Communication Protocols and Features

The communication server software shall support multiple Gateway/RTU protocols (serial or TCP/IP based) with multiple instances of each protocol operating independently on multiple communication lines. As a minimum communication software licenses shall be available to support the following remote device protocols: DNP 3.0, and Modbus. Vendor shall list other protocols being supplied with the proposal package.

As a minimum communication protocol functions shall include:

③ Secure select-check back-execute controls with variable execution durations
③ "fast scan" of controlled points until execution is confirmed.
③ Rapid polling for data changes only
③ Detect and report multiple changes of state between pole cycles
③ Interleaving of multiple priority messages
③ Master to remote acknowledgement of message receipt
③ Freeze and read KWH pulse accumulator poles at user-defined intervals
③ Time synchronization of remote device clocks (and those of their subordinate IEDs) at defined intervals
③ Sequence of Events monitoring and reporting
③ Ability to support unsolicited communications

3.2.2 Communication Monitoring

The system shall maintain statistical communication values for each remote gateway which can be displayed, alarmed, printed in reports and stored as historical data. The

system shall raise alarms distinguishing between failure of individual remote devices, entire communication lines, remotely interrogated IEDs, and failover to a backup communication line. A communication monitoring facility shall detect and document communication errors with date time stamps and a text message description, which can be scrolled to the terminal screen, spooled to a printer, or written to a hard disk file.

3.3 Interfaces to Other Systems

The SCADA Master Station shall incorporate an "open system" architecture with demonstrated inter-operability with other hardware and software platforms.

3.3.1 Internet Web Reports for Live SCADA System Data

The Vendor shall quote a Web Report facility which displays live SCADA data on user PCs connected to the network using standard Internet Browser such as Internet Explorer or Firefox. Web Alarm and Event Reports shall be chronological lists of point names and alarm details. Web Analog and Status Reports shall list point names and parameters. Web History Reports shall create graphs or tables over a user-selected time range. Operators shall be able to actively filter the points displayed in a Web Report using pull-down menus to select time range, point and station names, zones of responsibility, alarm priority, state of acknowledgement, tagged state, alarm blocked, off-normal state.

It shall be possible to export Web reports in HTML, Excel, Web archive, Acrobat PDF file, TIFF file, CSV (comma delimited), and XML file formats. It shall be possible to save, print, or email historical data graphs for a fixed point in time as a .PNG file.

3.3.2 DNP3 or Modbus Master Station Server Interface

The Vendor shall quote software for a fully bidirectional DNP3 and/or Modbus server communications ports, (e.g. Master Station status, analog and control points can be present in a port which looks like a DNP3 or Modbus RTU to an external Master Station).

3.4 SCADA System Security Features

3.4.1 Synchronized Dual or Quad Server Redundancy

The system shall be configured with redundant SCADA servers which are fully synchronized to include live RTU data, calculations, closed loop control algorithms, historical data, alarms, reports, and database changes. Peripheral and communications equipment shall be automatically transferred between SCADA servers with no operator assistance or intervention. The system shall be capable of using up to four servers for redundant SCADA database servers. These servers may be located at the primary master server or use offsite separate location(s).

3.4.2 Operator Passwords and Zones of Responsibility

It shall be possible to assign up to 128 zones of responsibility to user-defined operator passwords to restrict different operators' ability to execute controls, impose tags, or acknowledge alarm on different devices. These zone assignments will be possible down to the point level (e.g. a water point would not be controllable by an electrical operator as they are assigned to different zones, etc.). These zones shall also filter alarm annunciation on the operator's console and alarm summary displays and alarm logging on printers.

3.4.3 Control Point Operator Interface and Select-Checkback Security

A control dialog box shall appear when a point is selected presenting graphic and text indications of the status of the device and labeled pushbuttons for execution of the device's control functions (Open/Close, Tag/Untag, Activate/Deactivate, Manually Set, Acknowledge Alarms/Block Alarming). Only one operator shall be able to select a point at a time, and that selection shall expire automatically is no commands are completed within a definable length of time. Controls shall execute with secure, multi-step handshaking between the master and remote gateway/RTU. The sequence shall be: point selection, "check-back" to Master, control execution, acknowledgement of execution. RTUs or remote gateways shall be automatically polled in accelerated (fast scan) mode after a control action until the expected status change (or multiple user-scan) mode after a control action until the expected status change (or multiple user-defined changes) indicate the operation is complete. Control execution alarms shall distinguish between failure of the remote gateway or RTU to acknowledge a control, and failure of expected status change(s) to occur.

3.4.4 Secure Multi Level and Group Tagging

Tags for up to eight separate departments or individual shall inhibit control devices, without affecting the tags that another department has entered on the same device until all tags are removed. Tagging activities shall be automatically logged with date/time stamp and synchronized to all backup SCADA servers. A Tag dialog box shall display tags currently applied to a device with pushbuttons and fields to enter operator comments and to add, modify or remove tags. A Group Tag function shall apply a tag to multiple points by simply clicking on the desired devices in the SCADA system graphic display.

3.5 Windows Based PC Database Editors

All the editors used to define the SCADA system database and consequent dispatch shall run on standard Windows PC Workstations. These editors will use familiar Windows features such as pull down menus, drag-and-drop, file operations and configuration selections. The editor windows themselves will be conventionally configurable on the PC desktop in such matters as dragging between screens, re-sizing, tiling, cascading, as it's customary with the graphical and user interface capabilities inherent in Microsoft Windows.

3.5.1 Display Generation Editors

All the editors used to define the SCADA system database and consequent dispatch shall run on standard Windows PC Workstations. These editors will use familiar Windows features such as pull down menus, drag-and-drop, file operations and configuration selections. The editor windows themselves will be conventionally configurable on the PC desktop in such matters as dragging between screens, re-sizing, tiling, cascading, as it's customary with the graphical and user interface capabilities inherent in Microsoft Windows.

3.5.2 Communication Line Editors

Communication line editors shall define the protocol, and communication characteristics of LAN/WAN IP nodes or serial communication ports, and the remote gateways assigned to each node or port.

3.5.3 Control & Indication Point Editors

Control and indication point editors shall define the gateway/RTU/IED address and characteristics of each point: point name, description, address, type, zones of responsibility, normal state, control execute duration, control completion time, alarm severity, alarm annunciation delay and so forth. Control and indication point editors must be capable of export and import to MS Excel such that mass editing of database points is possible.

3.5.4 Analog Point Editors

Analog point editors shall define the address and functional characteristics of each point to include point name, description, address, type, zones of responsibility, scale and offset factors, engineering units, clamp to zero, 3 high and 3 low level alarm limited (dead bands, severity codes) and rate of change alarm limit (dead bands, severity code). Analog point editors must be capable of export and import to MS Excel such that mass editing of database points is possible.

3.5.5 RTU Configuration File Import

The Vendor's remote gateway or RTU configuration files shall be structured to allow direct importation into the SCADA Master Station database editor, eliminating the need to repeat database entry at the Master Station. Importation of the gateway/RTU configuration file will automatically create those points in the Master Station database to include associated housekeeping points, such as, percent communications, time-out values, security error counts, number of polls, etc.

3.5.6 Calculation and Control Sequence Editors

The system shall include a feature to define calculations and logical process control algorithms in a self-documenting editor format. The system shall include a library of electrical power calculation functions that only require the user to name the data source points and the calculation result destination point names. Control sequences shall be securely synchronized to the backup SCADA server and continue execution after a failover.

A complete library math/logic functions shall be provided including temporary variables, arithmetic (*,/,+,-), logical operators (AND, OR), magnitude comparison (>,<,=), square root, trigonometric (SIN, COS, TAN, ASIN, ACOS, ATAN), exponential, logarithmic, time/date, table look-up, AGA-3, 7 and 8 gas compressibility and flow, electric power calculation functions, conditional (if-then-else) branching decisions.

3.6 SCADA System Full-Graphics Operator Interface

The operator's graphical user interface (GUI) shall run on PC Workstations and display multiple windows that can be re-sized, moved, or shrunk to an icon, and can execute all operator functions with mouse point-click-drag functions, pull-down menus, and interactive dialog boxes. Performance shall be maximized and network traffic minimized by maintaining a local database on each Workstation which adaptively update from the SCADA server only those points that are being actively displayed on the operators' screen at any point in time. It shall be possible to run the map display software on remote workstations over any TCP/IP link to the SCADA server.

Graphic display editors shall support importation of .DXF format files of detailed vector-based, geographic images of the actual system and territory being monitored from CAD map sources such as AM/FM, GIS, and AUTOCAD systems. It shall be possible to incorporate these geographic images into layers of the SCADA system map displays to serve as backdrops onto which can be overlaid live SCADA status and control targets.

Full-graphic map displays shall display monitored equipment and territory in a large scale, continuous map display, which the operator can view through a movable window. These operator windows can pan in any direction and zoom in or out to view a smaller or larger area of that complete map display. Multiple maps can be used on the same operator console or different consoles without restrictions. This display system shall support multiple users, and departments with different responsibilities, by displaying a compilation of layers (like a stack of color transparencies), which can be turned on and off to display different aspects, equipment, or subsystems of the complete control system. Different display layers shall turn on and off manually by using pull-down menus or automatically as the operator zooms in and zooms out of the complete World Map display. Pull-down menus shall allow the operator to quickly select pre-defined views at specific map locations, levels of zoom, and selection of display layers.

Pixel-resolution, graphic elements in the displays shall be linked to live points in the SCADA system database and depict the current digital state or analog value of monitored devices such as RTUs, Gateways or IEDs. Telemetered, calculated or manually entered status, accumulator and analog points shall be displayed through user-defined graphic shapes, colors and text indications of the value, state and data quality of each point. Accumulator and analog values shall be displayed with numerical values or expanding horizontal or vertical bars that are colored to indicate 3 levels of high and 3 levels of low limit alarming for each point. Colored letters shall annunciate each point's condition (Tagged, Manually Set, Alarm Blocked, Telemetry Failed). It shall also be possible to annunciate field conditions using lines or whole areas of the world map display which dynamically changes color or flashing state of database points. The system shall store a library of user-defined graphic symbols and text labels for use in developing displays and/or they may be imported from user CAD systems.

Historical data trend graphs shall appear on map displays as miniature, labeled graph icons. When selected, these icons shall expand into a pixel resolution trend graph window, which plots color-coded variables against time. Displayed graphs will be user configurable in terms of graph type, colors, graphed data values, and other parameters. The graphed values and the trend graphics themselves will be able to be cut-and-pasted to popular Microsoft applications such as Excel, Word and Access.

Control of points shall be initiated by clicking on a user-defined target area within or around a point's graphic display element (they needn't necessarily correspond). Selecting a point shall open an interactive dialog box with which the operator can execute controls (Open/Close, Trip/Close, Raise/Lower etc.), add or remove tags, set group tags, acknowledge or block alarms, manually set the state or value, activate/deactivate a point or enter a user definable note.

3.6.1 IED Templates

The operator HMI shall include the capability to create, edit, cut, paste, and save (as a library entity) an IED template for use by an operator in visuali8zing the data collected from IEDs in the substations and for the operation of these devices. Furthermore, such IED templates (the IED faceplate plus the associated monitoring and control points) once defined, will reside in a library for use in creating further instances of that IED. This will serve as a rapid graphical user interface (GUI) development tool to build IEDs onto the system/substation map. The IED template will operate in a similar fashion and display the same information as if the operator was standing directly in front of the device in the substation.

Bitmapped image files (*.bmp, *.jpg, *.gif, animated*.gif) will be useable for the creation of IED templates along with the status, analog, accumulator and control points associated with that IED or the overall system.
The bidder will describe their library of IED templates provided with the proposed system.

3.6.2 Full Graphics Editing

A password protected, online, full graphics editor shall be provided for database generation and display at all local and remote consoles.

The system displays maps will exist on each workstation console, such that only dynamic data such as point values and alarms need be retrieved from the host server. This will minimize network traffic even for the largest of dynamic system maps. When editing is accomplished on a system console, the changes will then be published back to the system SCADA server(s) from where changes will be published to other consoles. Publishing of changes to all consoles can be manually initiated or automatic (as chosen by the system manager).

Importation of the underlying system map will allow any number of map layers. The layers of the original map will be maintained and additional layers may be added to

the map for SCADA purposes. As an operator zooms, the display will automatically de-clutter or enrich (turn on and off layers) depending upon the level of zoom and these de-clutter levels will be user definable.

The editor provided shall contain easy-to-use tools for layering, coloring and styling of text as well as duplication of elements (copy/cut and paste), stretching and re-sizing.

Connectivity information for the system map will be able to be stored in the SCADA system database to show dynamic topological data. (E.g. a breaker tripping will de-energize the feeder within the substation down that feeder on the system map to the end of the line. Entry of topological connectivity data will be through easy-to-use editors.

3.6.3 Data Quality

The quality of the telemetered points shall be available to the system for display and capture. The following data quality indications shall be present:

a. Point is failed
b. Point is manually set
c. Point is calculated from manually set data
d. Alarm is blocked
e. Value is out-of-range
f. Point is tagged

3.6.4 Integration with Windows PC Operation

The SCADA system editors will operate using a "Windows PC style".

The database editor shall provide a graphical tree-like representation of the complete database and shall support easy navigation throughout the database to items to be edited. Database items to be edited in this way shall include Stations, Communication Lines, Communication Channels, RTUs, IEDs, as well as all the individual database points (analog values, status indications, accumulators, etc.). These database editors shall be able to run on any computer that is connected to the host server via the network. With this arrangement, it shall be possible to manage the database maintenance from any suitably configured PC on the network without it being at the Master Station server(s) itself.

The database editors shall include features which will make it easy to create and modify the database such as:

1. Cloning an entire station or group of points through a straightforward copy and paste approach.
2. Copying, cutting and pasting of display elements (symbols, dynamic symbols, IEDs, entire stations or map sections, etc.) in a Windows environment.
3. using this cut and paste capability to create points and other database elements that are based on previously created ones;

4. Using a Station Rename feature to copy a portion of an existing display, and to reassign all those dynamic points to points to a different station. Convenient pull down boxes will be used to identify the source and destination station names.
5. Exporting, editing or modifying and re-importing the SCADA database to/from an MS Excel spreadsheet to speed "mass editing" and duplication of points.
6. Master Station import of gateway/RTU configuration files directly, so as to eliminate the need to define the same point multiple times in the system.
7. Windows based applications will be directly callable from the operator's screen. (e.g. a system manager can place a target on any full graphic screen which launches a non-SCADA application such as an Excel spreadsheet or a browser).

All editing will be accomplished in an online manner (e.g., the real-time SCADA system need not be taken offline in order to complete or publish any editing function).

3.7 System Generated Displays

3.7.1 Fully Functional and Automatically Generated Tabular Displays

The SCADA system shall automatically generate text displays data for status and analog points for each station defined in the Master Station database. For each point these displays shall provide a line of color-coded text concisely listing all the point's relevant information, including current status, value, tagged and alarm conditions. These text displays shall be capable of serving as a fully functional operator interface for the SCADA system. Operators shall be able to select points on these displays to control points, manage alarms, and adjust point attributes. Pull-down menus shall allow selection of the points to be listed by station, stations, tagged points, points in off-normal or points in alarm condition.

3.7.2 Operator Scratchpad and Message Log

An operator message facility shall allow operators to transmit messages to a dedicated message display window on a specific operator workstation or to all Workstations. This facility shall maintain and display a chronological log of messages including time/date, and the operators sent to or received from. Multiple notes areas within the SCADA Worldview displays shall provide scratchpads where operators can enter text notes. All entries shall be logged with a date/time stamp on the event logger and maintained in the display database until deleted.

3.8 Alarm Processing

3.8.1 Alarm Communication and Processing

Alarm processing shall proceed in a timely, secure and traceable manner. Gateways or RTUs shall be rapidly polled for changes only, and shall retain all changes until the Master has acknowledges receipt of the changes. Each gateway/RTU shall buffer and report to the Master a minimum of 7 changes of state for occurring between polls each status point. The system shall provide visible indication when the value of any point is not being updated because of gateway/RTU or communication line failure. Points calculated from telemetry failed points shall also be visibly flagged.

Alarms shall be time stamped immediately upon receipt oat the Master, and alarms shall update on all displays in less than 2 seconds. Alarms shall be processed at a continuous rate of at least 60 per second, and excess alarms shall accumulate in a queue capable of buffering a minimum of 4,000 alarm events without loss. All processing of alarm shall be continuously synchronized in real time on the standby SCADA system server.

3.8.2 Alarm Definition and Priority

There shall be 5 alarm priority levels, assignable on a per point basis, with distinguishable annunciation characteristic. Alarm priority shall be included in logged alarm messages, and identified by color coding on the system generated displays. A separate alarm priority shall be assignable for each direction of a status point change of state. Separate alarm priorities shall be assignable to an analog value's 3 high alarm level limits, 3 low level limits, and a rate of change limit.

Higher priority alarms shall require acknowledgement and shall sound audio alarm signals. The audio alarm signals shall consist of operator console WAV files that can be assigned to each priority. All alarms shall be logged regardless of priority to at least three destinations: alarm summary displays, event printers and operator log files.

For each status point, it shall be possible to define which state (0 or 1) is abnormal and to assign a separate alarm priority to each state. When either the select or execute check-back fails, the system shall generate a check-back failure alarm. If the check-back is successful, but the expected status change does not occur within a timeout period that is user-definable for each control, the system shall generate a control failure alarm.

The system shall provide the operator with a visible "telemetry failure" indication when the value of any displayed point is not currently being updated by the system because of an RTU or communication line failure. Any points that are calculated using as inputs the values of failed telemetry points shall also be marked as telemetry failed.

3.8.3 Alarm Summary Displays

Automatically generated alarm summary displays shall list alarm events, in reverse chronological order, with color and flashing indication of alarm priorities and acknowledged/unacknowledged state. Alarm summaries shall list the point names, description of alarm condition and data and time of each alarm occurrence, and allow the operator to select points on to acknowledge or block alarms. The system shall automatically filter the alarms listed on these displays according to the zones of responsibility assigned to the workstation or the logged on under operator's password.

The following alarm summary displays shall be automatically generated by the system:

③ Alarm/Event History Display of all alarms and events.

③ A list of all alarms grouped by priority.
③ A list of all alarms from which the operator an manually remove any alarm.
③ A list of all alarms and events for each Station.
③ A list of all unacknowledged alarms.
③ A list of acknowledged alarms that have not returned to their normal state.
③ A list of all points for which alarming is currently blocked.

3.8.4 Configure Alarm Viewer

In addition to those alarm views automatically generated by the system, an editor function shall be provided which allows operators to choose criteria for alarms that will be listed in new views. The operator shall also be able to configure these views with different alarm selection criteria and save them for future use.

The operator shall easily be able to select criterion using the operator interface. Possible criterion will include: chronological or reverse chronological presentation order, zones of responsibility, alarm priorities, blocked alarms, selected station(s), acknowledged and/or unacknowledged alarm(s) status, currently active status, currently cleared alarm status.

3.8.5 Zones of Responsibility

Up to 128 *zones* of responsibility shall be assignable to each point and to each user-defined operator password to control the annunciation of alarms on Workstation sand to limit each operator's ability to control and manage alarms for different areas of the system. After a user-definable timeout period with no keyboard or mouse activity, workstations shall automatically revert from the zones assigned to the logged on operator's password to the default set of *zones* assigned to the workstation.

3.8.6 Operator's Alarm Dialog Box

Selecting a telemetered point shall open a dialog box displaying the point's value and containing labeled pushbuttons to manage the points operation and alarm functions:

③ Tag/Untag a Point
③ Activate/Deactivate a Point
③ Manually Set a Point Value
③ Acknowledge Alarms or Block Alarming of that Point
③ Set Point Alarm Limits (if analog)

A Manual Set function and a Set limits function shall allow operators to adjust a

point's manually set value or an analog point's three set of high or low limits by entering numeric values or by clicking and dragging lines on bar graphs that represent the manually entered value or the alarm limits.

3.8.7 Master Slave Alarm Suppression

Master-Slave alarm suppression shall be provided which can automatically suppress cascades of multiple secondary alarms that are known to result from a primary alarm condition. (e.g. suppress downstream low voltage alarms if a breaker trips and locks

out). This user-definable function shall be able to either automatically acknowledge or block alarming for sets of points for definable time duration, or indefinitely, after a primary point goes into an alarm condition. Alarm suppression shall be definable in multiple levels to produce a hierarchal tree of master/slave alarm suppression.

3.8.8 Alarm Logging

Alarms shall be logged to system or user defined alarm views, to files on the SCADA server hard disk, to hard copy printers, and these loggings filtered by priorities and zones of responsibility assigned to the points in alarm. English language alarm messages shall be generated by the system based on the skeleton message formats defined by the utility. The user shall be able to define automatically those generated alarm messages to include these message elements in any desired sequence (name of point in alarm, station name of point in alarm, alarm priority level, point value or status, point's engineering units, point's description, strings of fixed text).

3.8.9 E-Mail and Text Alarm Annunciation

E-mails and cell phone text messages annunciating alarms shall be automatically sent to recipients when requested for specific times of day, days of the week, and holidays. Email recipients shall be able to select from pre-defined sets of email alarm groups which filter alarms based on lists of points or stations, alarm severity and zones of responsibility.

3.8.10 Group Alarm Acknowledgement

Capability will be provided for group generation and group acknowledgement of alarms. The bidder will explain their method for accomplishing this feature.

3.9 Historical Data Collection

The system shall include a historical data collection facility, which allows the user to capture, store, edit, display and archive data collected by the SCADA Master Station and to enhance the data collected by the system with calculated averages, maximums, minimums and the time of max/min occurrence. It shall be possible to create derived (after the fact) historical data sets, which extract information from previously stored historical data sets. Editors shall allow the user to repair erroneous or missing historical data and any values that are manually entered in this manner shall be flagged as manually entered data.

In addition to scheduled, periodic data capture, the SCADA system shall allow definition of disturbance events that will trigger automatic collection of pre-defined sets of historical data both before and after the event. The events defined to trigger disturbance data collection shall be changes in multiple status points and/or multiple analog values exceeding predefined hi/lo limit levels. As a minimum, the utility shall have the ability to define the frequency and duration of data collection both before and after the triggering event, the time a "trigger" condition must exist to initiate a disturbance event, and the time after a disturbance event that the "trigger" condition will be ignored.

3.10 Report Generation and Scheduling

An automatic report generation facility shall provide flexible scheduling and formatting of the reports, including format of the report, selection criteria for points included in the report and information to be listed for the points. Point selection criteria shall include as a minimum: point type, station group, zone(s) of responsibility, communication line, manually set points and analog values in over-range, tagged points and points in alarm. Point data that can be included in a report format shall include: (point name, type, description, current value or status, daily min/max values and the time of occurrence, 3 high and 3 low level alarm limits, rate of change limit, dead bands, scaling factor, engineering unit label, zones of responsibility, point transition count, calculated averages, sums, maximums, minimums and the time of occurrence).

A report schedule display shall allow users to view and modify the print schedule for all reports. Information listed on the report schedule display shall include report name and description, logging device(s) on which the report will print, report's automatic scheduling parameters, reports last and next scheduled generation time, how long the report takes to generate. It shall be possible to designate a backup printer to which reports will be re-directed in the case of a printer failure. Any reports which cannot reach a functioning printer shall be spooled to hard disk files which can be retrieved and printed at a later time.

This automated report generation capability will be separate and in addition to report generation available under the relational database publishing capability.

3.10.1 Operator Event Log & Summary Display

Operation and Outage event files will be maintained for specified points recording all status changes, control actions, breaker outages, and three phase power values saved in a snap-shot file for 5 seconds before the breaker opened. The system shall maintain a count of open and close operations and outages (stored as an analog database value for open operations only) for specified devices, raising alarm when the count exceeds a defined limit.

Operations Reports for each device will list:

- Point name, description and normal state
- Time and date of last operation
- Number of operations - caused by operator or caused by protective relaying
- Operation count limit
- Percent of limit reached by actual operations
- Status of alarm: Ok, Warning, Exceeded

Outage Reports for a specified duration of time will list the following for each outage:

- Name and description of the device
- Time, date and duration of the outage
- The three (3) phase currents for 5 seconds before the outage

③ A summary of the accumulated total outage time for all devices

3.10.2 Sequence of Events & Event (SOE) Data Recording

Thirty (30) day event files shall be maintained for all status point change, all operator control actions, selected analog points, and SOE data for gateway/RTUs/IEDs equipped with sequence of events. Event data will be time-stamped to the nearest second; SOE data will be stamped to the nearest 1 millisecond.

3.10.3 Data Trending

The proposed system shall provide the ability to store and view any data value from the database in a trend graphical format. The system shall bring up pixel-resolution trend graphs of historical data. Sample rates as low as one (1) second must be supported. Trend graphs shall be displayed in separate windows that can be moved, re-sized minimized to an icon. The trend graph window shall include tools that allow the user to configure and customize the graph display.

A trend graph window shall have the ability to plot at least five points from the historical database. The trend graph displays shall be interactive allowing the operator to quickly adjust the time frame, duration and resolution of the graph.

It shall be possible to scroll backward or forward in time by selecting time parameters and it shall be possible to cut and past the numeric values and the trend graphs themselves directly into MS office products such as Excel or MS-Word.

This trending function is separate from the one provided for by export to the external relational database or historian.

3.11 Load Management Software

3.11.1 Direct Load Control

The system shall be capable of automating direct load shedding and voltage reduction to defer power consumption from peak to non-peak usage periods. The system shall be capable of automatically distributing the requested load shed percentages equally among the devices in different load classes, and shall permit the user to define alternate load shedding strategies to be implemented on different days of the week and on designated holidays.

The utility shall have the ability to define peak load shedding in a variety of operating modes:

③ Time Mode: shed load % for fixed time intervals on weekdays, holidays or weekends.

③ Threshold Mode: shed load to maintain the total load below a defined threshold limit.

③ External Mode: initiate/control shedding scenarios based on signals from another system.

③ Advisory Mode: recommend the next level of load shedding to the operator.

3.11.2 Automatic Power Factor Control

Power Factor Control software shall be capable of tracking all changes in the power distribution system's connectivity and maintaining an inventory of capacitor bank values associated with each feeder line. Using KWATT and KVAR measurements to calculate power factor values for each feeder line, the program shall trigger corrective action based on upper and lower power factor limits. Corrective controls shall be issued sequentially based on the feeder lines with the worst power factor and available capacitors on each feeder line.

3.12 Special Function Applications

3.12.1 System Connectivity

A System Connectivity Program shall display the power distribution system connectivity, which has been calculated from the current state of breakers, switches and transformers. The program shall re-calculate connectivity whenever an interconnecting device changes state and shall annunciate whether power line sections are de-energized, energized, energized in parallel, energized in a loop or part of a de-energized loop. Appearance of new dead line, parallel fed, or looped line sections shall raise alarms identifying the exact switching event that caused the change. An automatic trace feature shall determine and highlight the connectivity path of any power line section selected by the operator back to its power source.

This function will permit live system maps and displays (e.g. when a breaker trips, a feeder and all connected elements will be de-energized and therefore change color).

3.12.2 Load Forecasting

A Load Forecast program will be provided which produces a short term (24 hour) and long term (7 day) demand forecast by comparing recent demand-weather trends and weather forecasts with similar historical weather-demand trends (a "best match" type program). It shall also be possible to apply correction factors to adjust the demand forecast to account for annual growth in the base system load, current temperature, humidity, wind chill factor and cloud cover.

The program shall account for holidays both in the historical data and in the forecasted demand period, such as excluding holidays from the comparison of the present and historical data and injecting a holiday demand schedule into a 7-day forecast using the nearest historical holiday or Sunday demand trends.

4. Remote Gateways and/or Remote Terminal Units

4.1 General Description

The substation gateways/Remote Terminal Units (RTUs) shall be microprocessor based units capable of secure-select-check-back controls, exception-reporting of status and analog changes, pulse accumulation and TCP/IP and serial port communication with SCADA Master Stations and Intelligent Electronic Devices

(IEDs). The gateways/remote terminal units shall have a flexible modular architecture consisting of a central processor module with all logic and communication functions, expandable I/O (status, analog, control) card cage modules and modular I/O communication boards.

The gateways/RTU proposed shall support, as a minimum, the following features:

- Execute highly secure select-checkback controls with programmable execute durations
- Monitor contact status inputs with momentary change-of-state detection
- 1 millisecond Sequence of Event (SOE) time tagging
- Monitor analog inputs with programmable exception reporting dead bands
- Execute secure analog set-point controls
- Have discrete I/O hardware which meets IEEE Surge Withstand Capability test C37.90.1-2000
- Programmable user defined local calculations and closed loop control capabilities
- Ability to communicate over serial ports or TCP/IP based links with substation
- Intelligent Electronic Devices (IEDs) using industry standard protocols
- Ability to communicate with multiple Master Stations over serial data ports or TCP/IP based links.
- Windows based configuration software which generates customizable gateway/RTU configuration files that can be accepted into the SCADA Master Station database editor
- IRIG-B interface capability for local gateway time sync
- Web page hosting for presentation of user defined status/analog to a conventional browser (Internet Explorer, Mozilla)

4.2 Gateway/RTU Central Processor

The gateway/RTU central processor shall be based on a robust, 32-bit, microprocessor architecture capable of supporting traditional discrete I/O hardware, executing secure SCADA monitoring and control functions and acting as a communication node between the multiple SCADA Master Stations and industry standard Intelligent Electronic Devices (IEDs). At a minimum, the gateway/RTU central processor shall

include: Erasable, Programmable, Read-Only-Memory (EPROM) to store executable programs; Random Access Memory (RAM) to store acquired data from local I/O and IEDs; and EEPROM memory to store RTU configuration files and downloaded information. The gateway/RTU central processor shall be capable of performing protocol conversions and of mapping data values between Master Station *Server* and IED *Client* communication interfaces, through an application specific Embedded Real-Time Operating System (ERTOS) which provides a high rate of data transfer with minimum latency.

Communication options shall be available for the gateway/RTU central processor to support a minimum of the following:

③ Ethernet LAN/WAN 10/100baseT Interface
③ Expandable RS232 or RS485 serial data ports (up to 40)
③ Single or redundant channels with automatic failover

The gateway/RTU TCP/IP interface hardware and software shall support communication with Master Stations over a supplied IP WAN, Web Browser access to data in the gateway/RTU and remove diagnostics and configuration of the gateway/RTU central processor over the utility IP WAN. As a minimum, the gateway/RTU network interface option shall include the following:

③ embedded 32-bit communication processor
③ 10baseT (RJ45) or 10baseAUI
③ 100baseTX or 100base FX (multi-mode or single mode)
③ communicate over TCP/IP or UDP/IP
③ Support FTP, Telnet and WEB server

Support all byte oriented protocols offered on the gateway/RTU central processor.

4.3 Master & IED Communication and Data Concentrator Functions

The gateway/RTU Central Processor software shall be capable of selectively concentrating data from multiple Intelligent Electronic Devices (IEDs) and local discreet I/O panels (status, accumulators, analog, controls) into communication channels with one or more SCADA Master Stations.

Server software licenses shall be available to support gateway/RTU communication with Master Stations from a selectable list of communication protocols, such as DNP 3.0, and Modbus. Vendors shall indicate in their bid what Master Station communication protocols are supported.

Client software licenses shall be available to support gateway/RTU communication with IEDs from a selectable list of communication protocols. Vendors shall indicate in their bid what IED communication protocols are supported.

4.4 Status Inputs

The gateway/RTU shall be equipped with modularly expandable cards and termination panels to monitor status input contacts. The gateway/RTU shall respond to *exception* polls by sending only the status values that have changed, and shall reset change-of-state flags only when the Master Station has acknowledged receipt of the

gateway/RTUs *exception* message. An RTU change-of-state (COS) memory shall store up to seven (7) changes of state occurring between polls, reporting each as independent changes in response to *exception* polls from the Master Station. Status inputs designated as Sequence of Events (SOE) points shall report changes with a

resolution of 1 millisecond using the standard status input circuitry. SOE data from IEDs will be transferred to the Master Station as well (if present).

All status inputs shall be optically isolated and require less than 10 mA of drive current. The remote station shall include a 24-volt dc wetting supply to power the status inputs from dry contact inputs provided by the owner. Input panels shall also be available with 12-volt, 24-volt, 48-volt and 129-volt dc inputs.

Status point input optical coupling shall meet the IEEE Surge Withstand Capability test C37.90.1.

4.5 Accumulator Inputs

Status inputs designated as accumulator points shall accept form "A" or "C" KWH pulse inputs at a rate of up to 15 pulses per second. The gateway/RTU shall filter contact bounce and maintain a running count of pulses up to 32,768 (15 bits). The Master Station and gateway/RTUs shall synchronize accumulator counts into a freeze buffer, allowing the active gateway/RTU accumulator to continue counting while the Master Station polls the accumulators' values from the freeze buffers in each gateway/RTU.

4.6 Analog Inputs (from user supplied transducers)

The gateway/RTU shall be equipped with modularly expandable cards and termination panels to monitor differential analog inputs. The RTU shall respond to *exception* polls from the Master Station by sending only the analog values that have changed more than a defined dead bank percentage.

The gateway/RTU A/D converter shall have a resolution of 16 bits for an input range of +/-5 Vdc. The modular analog input panels shall include field wiring screw terminations; high accuracy scaling resistors for 0 to 1 ma, or 4 to 20 ma inputs; a solid state analog multiplexer and ribbon cable connection to the central processor board. The overall system conversion accuracy shall be 0.1% and noise rejection shall be 60 dB at 60 Hz common mode and differential mode.

All analog inputs shall meet the IEEE Surge Withstand Capability Test C37.90.1.

4.7 Control Outputs

The gateway/RTU shall be equipped with modularly expandable control relays and circuitry to execute fail-safe, select-check-before-operation control operations. Following receipt of a "select" message, the gateway/RTU shall respond with a "check-back" message verifying the address of the selected point, enabling the Master Station to send an "execute" message. The gateway/RTU shall also employ an over current detection circuit which deactivates relay power (prior to completion of the control) if more than one relay is energized due to a hardware malfunction. The execute duration of momentary control relays shall be programmable on a per point basis at the Master Station.

Controls shall be configurable as momentary relay pairs or dual coil latched relays. Control out puts shall consist of 2 sets of form "C" contacts per relay, rated at a minimum of 10 amps at 28 Vdc or 240 Vac.

All control outputs shall meet the IEEE Surge Withstand Capability Test C37.90.1.

4.8 Power Requirements

The gateway/RTU shall accept ac or dc power from a single source and generate all necessary power to support the gateway/RTU communications, logic, control relay coils and status contact wetting. The power supply shall provide complete galvanic isolation from the power source and be equipped to withstand the IEEE Surge Withstand Capability Test C37.90.1. Gateway/RTUs with 120 Vac power source shall be equipped with a battery backup sufficient to power the gateway/RTU for a minimum of 8 hours.

The power supplies shall be designed to function properly over the following ranges:

③ Nominal Range
③ 120 VAC102 - 132 VRMS; 58 - 62 Hz
③ 129 VDC109 - 135 VDC
③ 48 VDC42 - 52 VDC
③ 24 VDC21 - 27 VDC
③ 12 VDC10.5 - 15 VDC

5. Gateway/RTU Test & Configuration Software (if required)

The Vendor's Windows-based PC application software shall provide drag & drop menus to prompt a technician through configuration of the gateway/RTU processor's communication ports, IED communication *Clients*, Master Station communication *Servers*, and selectively route data points between the IED *Client* databases and Master Station *Server* databases. The Vendor's gateway/RTU configuration files shall be structured to allow direct uploading of the gateway/RTU configuration file into the SCADA Master Station database editor thus eliminating the need to repeat database entry at the Master Station.

As a minimum the gateway/RTU configuration software shall support the following functions:

③ Configure gateway/RTU communication port parameters.

③ Define local discrete I/O status, accumulator, analog and control points.

③ Select Master Station and IED communication protocols

③ Selectively map data points between IED and Master Station communication ports.

③ Defaults Parameters sufficient for the initial operation of most systems.

③ Online Tool Tips that appear when the cursor is placed over buttons or data entry points.

③ A "View Components" window to examine configuration data and print the results.

③ Importation and/or generation of vendor supplied or user generated IED templates.

- ③ Library actions (store, retrieve, etc.) of vendor supplied or user generated IED templates.
- ③ Facility to export gateway/RTU configuration files to word processor or spreadsheet applications.
- ③ Ability to directly import gateway/RTU configuration files into the Master Station database.

6. Spreadsheet Calculation & Control Algorithm Editor

The gateway/RTU shall support programming of calculations and local control algorithms, which can be edited and documented using a standard Excel spreadsheet editor.

As a minimum, the calculation and control algorithms shall support:

- ③ Access to all local gateway/RTU status input, analog input and IED data points.
- ③ Ability to execute local closed loop control algorithms.
- ③ Arithmetic, Logarithmic, Trigonometric, Logic and time/date functions.
- ③ Branching, conditionals, if-then-else programming capabilities.
- ③ PID control loops and AGA gas calculation and compressibility calculations.

7. Spare Parts

The Vendors shall propose a list of spare modules sufficient for the owner to maintain the remote station equipment on a module replacement basis.

8. Project Management

8.1 Implementation Plan & Schedule

The Vendor shall submit, as part of the bid, a project implementation plan and schedule that will ensure timely and coordinated integration, testing and delivery of a working system. The project implementation plan must include a detailed project schedule demonstrating how the proposed delivery will be met and identify any critical responses required of the owner to maintain the schedule.

As a minimum the project Schedule shall identify the following phases of the project:

- ③ Initial project definition meeting
- ③ Approval submittals
- ③ Design and procurement schedule
- ③ Database generation and entry
- ③ Staging and testing of the system
- ③ Training schedule
- ③ Delivery of documentation
- ③ Factory acceptance

test
③ Delivery and start-up
③ Final acceptance

8.2 Submittal Drawings

Prior to purchasing equipment and assembling the system the Vendor shall submit drawings and documentation for the Purchaser's review and approval.

Documentation submitted for approval shall include:

a. System drawings showing physical layout, interconnection cables and Purchaser connection points for all equipment.

b. Parts lists and specification for all hardware and software products.

c. Detailed requirements of the equipment to be supplied: space, cabling, environmental controls, power and communication circuits.

d. Hardware, software and operation manuals for all hardware and software products.

e. A training schedule and training course syllabuses.

f. Vendor's factory acceptance test procedures.

8.3 Database Generation

The Vendor shall be responsible for converting the Purchaser's existing database and shall be included as part of the bid. It is the owner's intent to be able to generate and enter the system database points and single line diagram after receipt of the necessary training from vendor instructors. Training shall be scheduled at an appropriate time in the delivery cycle. Final acceptance of the system shall be basedon a test database, entered by the Vendor, which shall be configured to demonstrate that all delivered equipment, all equipment interconnections and all remote station communication lines are functioning. The Vendor's maintenance contract shall clearly define the level of support that will be offered to the owner during entry and testing of the owner's database.

9. Documentation

The Vendor shall provide documentation that completely and accurately describes all hardware and software components that comprise the delivered SCADA system.

The Vendor shall provide a System Manual showing all major hardware and software components of the SCADA system including a block diagram in sufficient detail to show the interrelationship and interconnection of all system components. The system manual shall clearly identify all deliverable hardware, software and documentation.

9.1 Hardware Documentation

9.1.1 Master Station Hardware Drawings and Manuals

Master Station drawings shall consist of:

③ A block diagram showing the interrelationship of all components.

③ Equipment mechanical layout drawings.

- ③ Interconnection drawings showing all cables, connections and power terminations.
- ③ A Master Station Configuration Specification documenting all the software licenses and configurations inherent in the Master Station hardware components including:
  - o layered software products
  - o SCADA software configuration
  - o LAN nodes
  - o port designations

③ Original manufacturer's manual for all equipment not manufactured by the SCADA vendor.

9.1.2 Gateway/Remote Station Hardware Drawings and Manuals

The Vendor shall provide drawings for each gateway/RTU which clearly show the mechanical layout of the equipment, details of all component module interconnection and external connections for all communication connections, power terminations and discrete I/O terminations (status, accumulator, analog, control points, client and server communications ports, etc.).

The Vendor shall provide gateway/RTU hardware manuals, which include installation and startup instructions, instructions for expansion of the gateway/RTU, maintenance and trouble-shooting guidelines, a functional block diagram, modular theory of operation and terminations of each gateway/RTU module.

9.2 Software Documentation

The software documentation shall consist of the computer manufacturer's complete operating system software documentation on CD-ROM, and detailed manuals covering the functional application of the SCADA system software products.

9.2.1 SCADA Master Station Database Manual

The Vendor shall provide database generation manuals for the SCADA system software, and any layered software products, which clearly describe the structure of the SCADA system database and contain detailed information on all of the editors used to configure and maintain the SCADA system database.
The topics covered shall include as a minimum:

- ③ Database structure and organization of the editor system
- ③ Definition of communication line, remote stations, status/analog/control points
- ③ Creation of calculations and process control sequences
- ③ Structure and Generation of Graphic Displays
- ③ Integration of DXF file maps and Live Data Points in Displays

③ Definition of historical data collection sets & creation of historical graph displays

③ Format and scheduling of reports, event logs and alarm messages

9.2.2 SCADA Master Station Operator's Manual

The Vendor shall provide operator manuals for the SCADA system software and any layered software products which clearly describe the use of the SCADA system from the perspective of an operator.

The topics covered shall include as a minimum:

- Overview of SCADA System Database Structure and database editors
- SCADA system screens and keyboard functions
- Display Access and use of graphic displays, menus and dialog boxes
- Use of system generated Data Point and Alarm Summary Displays
- Report Formatting and Scheduling
- System start-up and power fail recovery
- Database backup/restore and historical data archiving

9.2.3 Gateway/Remote Terminal Unit Configuration Software Manual

The Vendor shall provide Gateway/RTU configuration software manuals, which clearly describe use of the Vendor's configuration software to define:

- gateway/RTU communication ports
- local status, analog and control points
- IED Clients
- point mapping between gateway/RTU points and Master Station Server(s)
- Importation of IED point definitions from appropriate Excel spreadsheets
- Export of gateway/RTU Configuration Files as an ASCII file.

10. Training

Training shall be at the owner's facilities or at Vendor's facilities, at the option of the owner. If training at the owner's facilities is elected, the bid price shall reflect all training costs: the cost of instruction, students' manuals, instructor's travel and living expenses. Training shall be conducted by employees of the Vendor who are experienced trainers and engaged full time in technical training on the products proposed in the Vendor's offering. Course syllabuses shall be included in the Vendor's offering.

10.1 Master Station Operator Training Course

Operator training shall be a hands-on course using an online operator console on the owner's system. If the operator training course is conducted at the Vendor's facilities,

each student shall be trained using an online operator workstation with a SCADA system server running the same version of the software as will be provided to the Purchaser.

The topics covered shall include as a minimum:

③ Overview of SCADA System Database Structure and database editors
③ Methods of Display Access & keyboard functions
③ Use of graphic displays, menus and dialog boxes
③ Use of system generated Data Point and Alarm Summary Displays
③ Report Formatting and Scheduling

③ System start-up and power fail recovery
③ Database backup/restore and historical data archiving

10.2 Master Station Database Training Course

Database training shall be a hands-on course using an online operator console on the owner's system. If the database training course is conducted at the Vendor's facilities, each student shall be trained using an online operator workstation with a SCADA system server running the same version of the software as will be provided to the Purchaser.

The topics covered shall include as a minimum:

③ Database structure and organization of the editor system
③ Definition of communication line, remote stations, status/analog/control points
③ Creation of calculations and process control sequences
③ Structure and Generation of Graphic Displays
③ Integration of DXF file maps and Live Data Points into Displays
③ Definition of historical data collection sets and creation of historical graph displays
③ Format and scheduling of reports, event logs and alarm messages
③ Importation of vendor supplied or user generated IED templates
③ Library actions (store, retrieve, etc.) of vendor supplied or user generated IED templates

10.3 Gateway/RTU Configuration and Maintenance Training Course

Remote Station training course shall provide hands-on instruction covering Gateway/RTU Theory of Operation; RTU trouble shooting and repair on a board-swap level basis; configuration of the central processor point database and communication servers; and clients using the Vendor's PC configuration software.

As a minimum, the course shall cover the following topics and activities:

③ Gateway/RTU Theory of Operation
③ Card Level Trouble Shooting & Repair
③ Use of Gateway/RTU Configuration Software
③ Communication Port Configuration

③ Server Database Configuration
③ Client Database Configuration
③ Client/Server Point Mapping
③ Importation of vendor supplied or user generated IED templates
③ Library actions (store, retrieve, etc.) of vendor supplied or user generated IED templates.

11. Inspection & Testing

11.1 General Requirements

All aspects of the Vendor's manufacturing process, from system design to material procurement, production, product assembly, testing and shipping shall be performed under the guidelines of a certified ISO 9002:2008 Quality Management procedure designed for early detection of any deficiencies and effective corrective action. The complete process shall result in documented test report, which confirm that all system components and functions are thoroughly tested in a methodical and organized manner in accordance with a written test procedure.

All equipment and work performed shall be subject to inspection and testing to confirm that it is in compliance with this specification. Any items found not to be in compliance with the specification will be replaced, repaired or upgraded as necessary to correct the noted deficiencies. After correction of a deficiency, the items shall be retested as necessary to ensure compliance with the specification. No deliverables shall be shipped until all inspections and testing have been completed, any deficiencies have been corrected and the Purchaser has approved all software and hardware items for shipment.

11.2 Factory Acceptance Tests

A Factory Acceptance Test (FAT) shall be performed by the Vendor, prior to shipping, to demonstrate the operation of the complete integrated system is in accordance with a written test specification approved by the Purchaser. The FAT shall be performed under the guidelines of a certified ISO 9002:2008 procedure. The Vendor shall perform the FAT and Purchaser representatives, if so desire, shall witness the FAT and perform hands on tests as desired to ensure conformance with this specification. Complete records of all factory acceptance tests, keyed to the test procedures, shall be maintained by the Vendor and delivered to the Purchaser. Each time a variance from this specification is detected, the Vendor shall generate a variance report documenting the date, variance and protective action to be taken.

As a minimum, the Factory Acceptance Test procedures shall include the following:

- ③ Visual inspection and inventory of all equipment for conformance to the specification and to the system documentation.

- ③ Demonstration of all Master Station client and server communication interfaces and protocols, using hardware to be provided under this contract, test units provided by the Purchaser or certified simulation devices.

- ③ Demonstration of the proper function of all Master Station operator consoles, printers, LAN/WAN equipment and communication hardware.

- ③ Demonstration of failover to the redundant Master Station server.

③ Simulations to verify the systems reaction to communication failures, hardware failures and power failures.

③ Simulation of system rollovers associated with daylight savings time, new year and leap year.

③ Installation and demonstration of a Master Station test SCADA database or the database generated by the Purchaser.

③ Demonstration of the proper functioning of all functional features of the SCADA system software operator interface and database generation editors using a written SCADA software test procedures and check-off list.

③ Verification of all hardware and software documentation.

11.3 Field Acceptance Tests

Following installation of the system, the Purchaser shall perform a Field Acceptance Test to confirm operation of the basic system functions such as communication with gateways/RTUs and other subsystems, data acquisition and processing, operator interface displays, report generation, data archiving and diagnostic routines.

Following the initial Field Acceptance Tests, the Purchaser will perform a complete test of the system including communication with IEDs that were simulated in the factory, point-to-point verification of RTU functions from the field terminations to the Master Station database and operator interface displays.

11.4 Installation and Start-up Technical Support

The Vendor shall provide a knowledgeable field service engineer as required to support the Purchaser with onsite technical assistance during the installation and startup of the SCADA system.

12. INSERT DESCRIPTION OF SPECIFIC, ADDITIONAL INSTALLATION AND STARTUP SERVICES, IF REQUIRED.

13. Warranty & Support

The SCADA Vendor's Customer Service Department shall be the Owner's single point of contact for all system maintenance and shall follow an ISO 9001:2008 certified procedure to maintain the highest level of service quality. All customer contacts shall be entered into a computerized tracking system which is closely managed and monitored for quick and effective responsiveness. The Vendor shall offer maintenance contract options including both hardware and software maintenance agreements with telephone/TCP/IP link based technical support, on-site technical assistance and printed circuit board repair.

13.1 Master Station Server Hardware Maintenance Contract

The Master Station SCADA hardware shall carry a five-year, (not including the first year) renewable maintenance contract to be executed by the SCADA Vendor. The

Master Station server hardware shall consist of "open system" architecture with all hardware and operating system software manufactured by a nationally recognized computer supplier who can support the system with factory trained product specialist providing next day, on-site response from a local service center. The Vendor shall state the terms of the maintenance contract included in the master price and provide the address and telephone number of the nearest service center. Warranty upgrades shall be available to provide same day 4-hour response or 24-hour/day, 7-days-a-week.

As a minimum, the SCADA Master Station Server hardware maintenance contract shall include the following services:

- A single point of contact to coordinate all repair services.
- On-site repairs provided by the server manufacturer's factory trained product specialists.
- Response within 24 hours, Monday through Friday, 8 a.m. to 5 p.m.
- Warranty upgrades shall be available to provide same day, 4-hour response, or 24-hour/day, 7-days-a-week.

13.2 Master Station SCADA Software Maintenance Contract

The Master Station SCADA software shall carry a five-year, (not including the first year) renewable maintenance contract to be executed by the SCADA Vendor. Third party maintenance contracts for Master Station software products will not be considered. The proposed Master Station shall include a secured, diagnostic connection which allows the Vendor's service technicians full access to the SCADA system to perform monitoring, diagnostic and system configuration services and to install and/or update SCADA software modules. The SCADA Vendor shall maintain a full time customer service staff capable of providing same day technical assistance. The Vendor shall submit, with the technical bid, a description of the software capability of the company including resumes of the customer service and software development personnel that will be associated with this project.

As a minimum, the Master Station software maintenance contract proposed shall include the following:

- Minimum of four (4) hour response.
- Unlimited telephone support and correction of any SCADA software problems.
- SCADA software Bug-fixes and upgrades as required.
- Technical assistance in the use of the SCADA system database editors.
- System restoration services, if required, following a hardware repair.
- A discounted rate for any required site-technical services.

③ Maintenance agreement upgrades shall be available to provide same day, 4-hour response or 24 hour/day, 7-day-a-week response.

14. Website Services

The Vendor shall maintain a website which provides access to all product documentation and manuals, a means for the Vendor and customers to exchange application notes, communication with the Vendor's Customer Service Department and company contact information.