SECTION 26 18 00
MEDIUM-VOLTAGE CIRCUIT PROTECTION DEVICES
SICAM

PART 1 - GENERAL

1.1 SCOPE

A. This section defines the Information, Monitoring and Control of the Substation Automation System. The monitoring and control shall be done digitally and from a central location. The substation automation system shall include intelligent electronic devices (IED's) and field devices with local process visualization. The substation automation system shall have communication interfaces to supervisory, control and data acquisition (SCADA) systems. It shall selectively identify and isolate faults. It shall transmit, record and evaluate data.

B. The substation automation system shall gather the data of the substation, plant or field (commands, events, counters and measured values), to process this raw data and to forward the resulting information. The data of the substation shall be gathered by the decentralized substation automation system via connected IEDs and the relevant transmission protocols. It shall be configured to pass relevant information to the applicable observation, monitoring or control centers.

C. The substation automation system shall execute the automation tasks of logical operations and switching sequences. A local human machine interface (HMI) shall be necessary to perform control and monitoring tasks.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section. The substation automation system shall have at least 20 years experience in development, design, engineering and system implementation. A reference list including the details as shown below shall accompany the offer.

1. The reference list shall include 500 installations and experience building multiple IEC 61850 compliant systems. IEC 61850 implemented systems shall be listed and their status and the following information about each:
    a. Customer
    b. Name of Facility
    c. Country
    d. Date
    e. Number of Station Units
    f. Number of Serial Units
    g. HMI
    h. Implementated Communications protocols
    i. IEC 61850 compliance and status
        1.) Not compliant.
        2.) Yes, compliant and in process
        3.) Yes compliant and commissioned
2. The reference list shall indicate the following
    a. Highest Voltage Level
    b. High Voltage Levels worked at
    c. Medium Voltage Levels worked at
    d. Gas, Water, Power and Other Systems Integrated
3. ISO 9001/14001 documentation shall be provided.
4. Capability Maturity Model (CMM) rating shall be included. It shall be certified by an external auditor and shall be attached to the submittal.

B. Hardware Documentation

1. Hardware documentation shall include a circuit manual, central cabinet/field cabinets and device documentation. The device documentation shall be stated in the device manual and has to include the following:
    a. Information on the internal structure and functions (block diagrams) of the device.
    b. Technical data of the devices and their parts, order details, maintenance instructions
    c. Description of the functional scope
    d. Representation of all interfaces
    e. Instructions for commissioning (device-specific setting values) and fault diagnosis
    f. Supply of the device documentation per device type
2. One device manual shall be provided per device type. These are to be handed over according to the agreed upon time schedule.
3. The cabinet documentation is to be stated in the circuit manual, to be generated with a CAD system or other software tools and to be supplied in paper form (DIN A4) and on a data carrier. The circuit manual has to include the following sections:
    a. Covering page, table of contents of drawings
    b. Location diagram (cubicle layout)
    c. Circuit diagram for central, higher-level functions
    d. Circuit diagram per bay/cubicle, divided according to functions
    e. Equipment plan
    f. Terminal diagram (external interface connection)
    g. Assignment of the interface elements (terminal diagram)
    h. Lists of components
4. Circuit diagrams
    a. The circuit diagrams shall include the current paths in a functional-related assignment of the units. Units should be displayed in a detached representation with their connections. The unit's inner circuit paths shall not be displayed. Labeling of the units shall be done in accordance with the plant identification system DIN40719, Part 2. The marking of the break off points and references shall be done in accordance with DIN40719, Part 3. For evaluation purposes, connection points shall only be represented once in the wiring manual.
5. Terminal diagrams
    a. Terminal diagrams shall include the construction of the terminal strip with the used terminal types, terminal accessories, cable types and destination references to connected devices.
6. Cabinet layout
    a. The cabinet views shall display the position of the installed units from the front and the backside. A cross section from the side and the top shall also be provided.
7. Equipment diagram
    a. The equipment diagrams shall display the external connection points of the unit. An equipment diagram should exist for every installed unit. It suffices to display the schematic internal construction of the unit.
8. Components lists
    a. Component lists shall include the technical data, ordering data, equipment names, the place of installation and the amount of units in use inside a cabinet. Component lists should be delivered as an MS-Excel file and included in the cabinet documentation.

C. Number Of Supporting Documents, Time Of Delivery
1. In correspondence with the project schedule the following documents are to be delivered on the set date and time:
2. Preliminary documentation
    a. 1x letter format, perforated, in a binder
    b. A set of cabinet drawings shall be handed to the owner 2 weeks before cabinet construction for approval.
3. Production documentation

a. Changes to the preliminary documentation required by the owner shall be worked into the production documentation. Only the affected drawings shall be replaced and handed over to the tenderee.

4. Work documents during production phase
   a. 1x 11” x 17” format, perforated, in a binder (Construction site)
   b. 1x letter format, perforated, in a binder (Owner)
   c. Delivery after possible changes during the cabinet construction phase and Factory Acceptance Test (FAT) and at the latest before installation on the construction site.
5. Plant documentation after commissioning and revision
   a. 1x 11”x17” format, perforated, in a binder
   b. 2x letter format, perforated, in a binder
   c. 1x data carrier
   d. Delivery of the final set of documentation 6 weeks after possible changes during the commissioning and Site Acceptance Test (SAT).

D. Software Documentation
1. Software documentation shall include the following sections:
   a. Cover page, table of contents
   b. Process signal lists (configuration lists)
   c. Interlocks, automation functions
2. The following work shall be included:
   a. Creation of the documentation with a program that conforms to the procedure.
   b. Documentation and Drawings in English
   c. Delivery of the documentation in letter paper format and as a data file on CD-ROM.
3. If alterations with regard to hardware and software versions occur after acceptance, then they shall be labeled with a hardware/software alteration note, for approval purposes, before implementation. The following specifications shall be included:
   a. Project name, date, old and new hardware/software version
   b. Reason for and type of alteration
4. Process Signal Lists
   a. Process signal/configuration lists shall record all signals that are to be processed by the software. Assignment are unit- or bay-orientated and allocates a specific I/O to a specific signal. A table simultaneously defining which information points are to be routed where:
      1.) Telecontrol-addresses
      2.) Event/Alarm list
      3.) HMI
   b. This list shall be delivered in MS-Excel format.
5. Automatic Functions
   a. Interlocking and automation functions have to be documented using a graphic configuration tool that conforms to IEC 1131 regulations.

1.3 SUBMITTALS

A. Submit shop drawings and product information for approval and final documentation in the quantities listed according to the Conditions of the Contract. All transmittals shall be identified by purchaser name, purchaser location and purchaser order number.

B. Documents for Approval
1. General arrangement drawing showing dimensioned elevation and floor plan, side views, foundation details, one-line diagram and system description.
2. Panel arrangement drawing showing layout of devices on the panel doors
3. Three-line diagrams
4. DC Schematics
5. Nameplate engraving drawings
6. Bill of Material
7. Delivery Schedule
8. Reference List and Quality Certificates as described in Section 1.2 above

9. Project Schedule as described in Section 3.6.B and 3.6.C below.
10. Network diagram

C. Final Documents: Record documentation to include:
1. Documents listed in Section 1.2 and 1.3.B above
2. Wiring diagrams
3. Recommended spare parts list for start-up support
4. Instruction manual

D. Failure to submit complete information shall give the engineer the right to exclude the bidder from future projects.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: The bidder shall have at least 20 years experience in manufacturing medium voltage switchgear, breakers and software. The manufacturer of the switchgear and breakers shall also be the manufacturer of the software.

B. Comply with requirements of latest revisions of applicable industry standards, specifically including the following:
1. IEC 61850 Edition 2
2. ISO 9001/ 14001

C. Intelligent archiving processes and versioning for the software of the substation automation system shall be available. It shall be possible for the tender to inspect this at any time.

D. The bidder shall have a worldwide service and a free hotline service, excluding any telecommunication costs. It shall be staffed by qualified people to support customers experiencing problems with the configuration, installation and commissioning. It shall be possible for the tender to inspect this at any time.

1.5 DELIVERY, STORAGE and HANDLING

A. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from potential damage from weather and construction operations. If the circuit protection devices are installed in equipment, store the equipment so condensation will not form on or in it. If necessary, apply temporary heat where required to obtain suitable service conditions.

B. Contractor shall handle and move the all equipment in accordance with manufacturer's recommendations.

1.6 MAINTENANCE

A. Coordinate with Division 1, Section ***[xx xx xx] [01700]*** – Contract Closeout

B. Extra Materials
1. Diagnostic tools shall be delivered with the substation automation system. It shall be possible to perform diagnostic and monitoring functions locally, through the intranet and through the internet, depending on the case in question.
2. The substation automation system shall allow the user a high level of economic efficiency. The following requirements shall be met:
a. Active Technology
1.) Digital devices and systems shall include a watchdog and shall monitor themselves across the network. They shall indicate when an error or invalid state occurs. This shall be done locally by a light emitting diode (LED) indication. It shall be done remotely for the functioning of the applications and system interfaces, so that the system is self monitoring at the station level.
2.) The implementation of the digital substation automation system shall guarantee a reduction of maintenance work and an increase of system availability.

3.) It shall be possible to separate defective components from the system, by switching off the respective communication processes or drivers. The rest of the system will continue to function properly.
4.) Low Maintenance Technology:
   a.) High availability without regular inspections.
   b.) Fan-less operation without a buffer battery and without rotating parts.
5.) Distributed System
   a.) The substation automation system shall be of a distributed nature. It shall make use of a network bus system . This shall result in a performance increase, due to a splitting of the system load and a considerable reduction of faults, expenditures for cabling, mounting and documentation. It shall aid in trouble shooting.

PART 2 - PRODUCTS

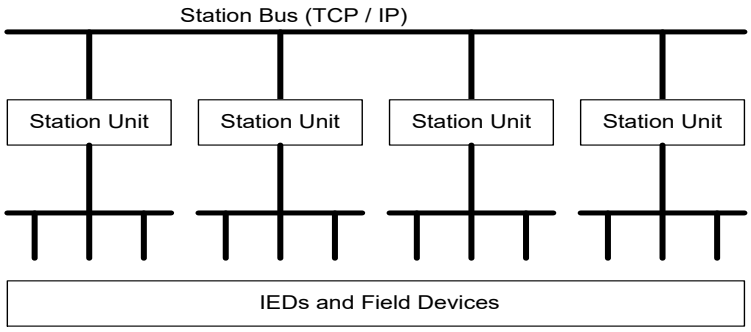
2.1 MANUFACTURERS

A. The metal-clad switchgear assembly shall be as manufactured by Siemens or approved equal. Approved manufacturers are as follows:
   1. SIEMENS
   2. ***[ ]***

2.2 EQUIPMENT

A. The substation automation system shall be a distributed system and fit the distributed plant design. ***[It shall be able to expand according to FUTURE EXPANSION plans, as detailed in Section 2.14.]*** It shall have scalable software and hardware structure. A typical distributed system configuration shall have three levels:
   1. Station Bus (TCP/IP)
   2. ***[Multiple]*** Station Units
   3. ***[Multiple]*** IEDs and Field Devices

B. A typical diagram of a distributed system configuration is shown below:

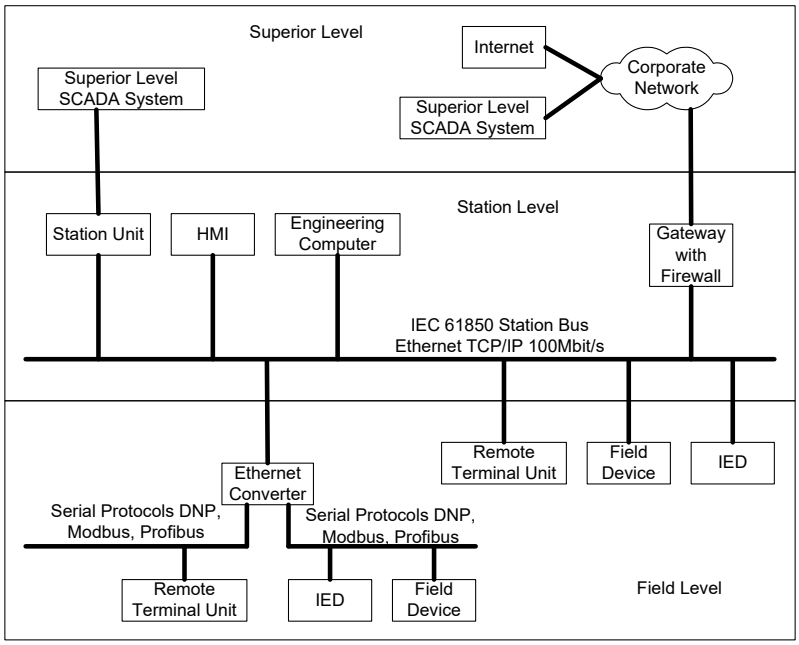


C. The monitoring and control functions (HMI) as specified in ***[Section 2.8]*** shall be part of the substation automation system.
D. The specific functions of the substation automation system shall be combined with those of a programmable logic controller system and equipped with the communication possibilities of the information technology world of today.
E. It shall be possible to integrate the substation automation system into existing stations by using standard communication protocols as listed in this specification.
F. The system shall include:
   1. Cabinet(s)
   2. Station unit(s)
   3. Automation functions
   4. Licenses
   5. A local process visualization system

6. Time synchronization by means of an external time signal receiver via ***[GPS] [Ethernet SNTP] [RTU protocol]***
7. connections to SCADA centers
8. IEDs and field devices

G. The serial, decentralized process interface shall be implemented with autonomous IEDs and field devices using the corresponding communication protocols. Connection to the switchgear is carried out directly from each bay, without requiring additional isolation (measuring transducers, coupling relays).

H. Proposed conceptual functional system architecture is diagrammatically given below:



2.3 FUNCTIONS OF THE SUBSTATION AUTOMATION SYSTEM

A. The substation automation system shall serve as a control and monitoring device for operating the switchgear. The operator shall detect the substation status and carry out switching commands from an HMI. The HMI shall be connected to the station unit via the TCP / IP station bus. The substation automation system shall record and processes all switchgear events. Each event shall be accompanied by a real time - time stamp. The origin of this time stamp shall be in the device which acquired the event.

B. The tasks of the substation automation system shall be distributed logically according to:
1. Field devices
2. Station units
3. Process visualization systems

C. All measured and metered values and all events shall be captured by the field devices which are connected to the substation automation system either in a radial or in a bus structure. The substation automation system is connected to a SCADA system, using a point to point or wide area network telecontrol interface.

D. The substation automation system shall fulfill the following functions:
1. IEC 61850 Edition 2
2. Telecommunication
3. Monitoring
4. Automation (Soft PLC functionality)
5. Online configuration
6. Local and remote control / control with switchgear interlocking / switching sequences

7. Serial connection of IEDs and field devices
8. Connection to a local HMI
9. Archiving and logging of operation and disturbance data
10. Open communication channel using OPC client / server mechanisms

E. Interlocking for Breaker Operation
1. Bay interlocks shall be implemented locally in the respective IEDs. The system shall be capable to do this centrally in the station unit.
2. High ranking station interlocking shall be done by using a generic object oriented substation event (GOOSE) mechanisms between IEC 61850 IEDs.
3. For non-IEC 61850 devices high ranking station interlocking shall be done centrally in station unit.
4. Breaker position shall be set to local or remote at the station unit ***[as shown on the diagrams]***. The command form the remote control center shall be rejected or executed based on the setting.
5. IED shall be set to local or remote via a keyed switch ***[as shown on the diagrams]***. The command form the HMI shall be rejected or executed based on the setting of the keyed switch in the IED.

F. Bay and Telecontrol Blocking
1. Bay and telecontrol blocking shall be implemented in the substation automation system.
2. When bay blockage is ON for maintenance or test work in a bay, the information flow between the IEDs and the substation automation system shall be blocked in the monitoring and control directions. Bay blockage shall be set device orientated.
3. If the telecontrol blockage is set, the information flow between the substation automation system to the control center shall be suppressed. Telecontrol blockage shall be set device oriented and set channel specifically. It shall be possible to select particular control centers.

G. Switching Authority between SCADA Systems and Local HMI
1. The switching authority shall be implemented in the substation automation system.
2. The switching authority defines which level (field, station or SCADA) is authorized for switching operation. In addition to the local / remote switch on the IED, it shall also be possible to switch between local (HMI) and remote (SCADA) control at the station level. The switching authority shall also be configured to be channel specific, e.g. control center 2 is authorized for switching operation and the other control centers and the local control are not.

H. System Security
1. The electronic components of the substation automation system shall be electromagnetic compatibility.
2. Safety functions shall ensure prompt error or fault signals. Hardware self test and the general interrogation shall be performed at:
   a. Start up
   b. Cyclically in the background during system operation.
3. The substation automation system shall not contain no buffer batteries, rotating parts, fans or hard disks.

I. Interruption of Power Supply
1. All parameters shall be securely stored in a real time database. All applications shall start as services. After a power failure, the substation automation system shall automatically start up again and continue its operation.

J. Communication
1. Faults in the data transmission caused by electromagnetic influences, earth potential differences, aging of components, noise sources on the transmission channels or other disturbances, shall be reliably detected and transmitted.
2. The safety procedures of the protocols shall detect:
   a. Bit and message errors

b. Loss of information or repetition
c. Faulty information items
d. Separation or corruption of contiguous information items.

K. Priority Controlled Message Preparation
1. Messages activated by events shall be prioritized and made available to the system according to their status. The following transmission lists or procedures shall be used:
a. Scan list
b. Initiation buffer
c. Basic cycle list
d. Telegram buffer with time tag
e. Telegram buffer without time tag
f. Counter-controlled list
g. Time- controlled list

L. Grouped Messages
1. It shall be possible to collect several single alarms in a single grouped alarm indication. This shall be done with via the graphical interface. One grouped alarm message shall be sent to the control center.

2.4 FUNCTIONAL CAPACITY REQUIREMENTS FOR THE SUBSTATION AUTOMATION SYSTEM

A. This capacity shall be available should future expansions demand it.

B. The modularly designed substation automation system shall meet the information processing requirements during normal operating conditions and during fault operating conditions. This includes:
1. Processing of up to 10,000 master and 20,000 slave datapoints of information
2. Connection for up to 150 field devices with one unit
3. Connection for up to 6 additional station units in a distributed system for a total of 350 field devices
4. Hot-Hot redundant configuration as a standard function

2.5 INTERFACE REQUIREMENTS

A. The station unit shall provide the telecommunication functionalities of an RTU and provide communication to SCADA systems. Additional RTU shall not be required. It shall be possible to connect up to 5 independent SCADA systems to the substation automation system.

B. The variability and expandability of the substation automation system depends mainly on its external interfaces. The system shall support the following protocols to ensure optimal and open system operation and planning:
1. Control Center Protocols
a. DNP V3.00 Level 2
b. Telegyr 8979
2. IED and satellite RTU protocols
a. IEC 61850
b. DNP V3.00 Level 2
c. Profinet, Profibus DP (IEC 61158 / EN 50170)
d. MODBUS (RTU format and ASCII)
3. Open Gateways
a. OPC server and client

C. All the decentralized station units of the substation automation system shall communicate with each other via an Ethernet TCP / IP station bus. The linking up of the IEDs shall be done in a ***[point-to-point] [bus structure] [via the Ethernet TCP/IP station bus].***

2.6 TIME SYNCHRONIZATION

A. The substation automation system shall be the clock time master in the system and shall cyclically synchronize all connected HMIs connected via Ethernet, IEDs and satellite RTUs when used with protocols that support this functionality.

B. The station unit shall be synchronized via a:
   1. Internal GPS clock connection
   2. Master clock connected to the TCP/IP station bus
   3. Telecommunication protocol (that supports Time Synchronization).

C. The time stamp for all process events shall be given by the IEDs. This shall be transferred through the substation automation system as an integral part of the event information. The real time - time stamp shall have a resolution of 1ms.

2.7 STATION UNIT

A. The station unit of the substation automation system shall fulfill the following requirements:
   1. General:
      a. Embedded operating system on non-rotating silicon disk
      b. Self-diagnostic and supervisory functionality
      c. Fanless operation
   2. CPU:
      a. Modern processors
      b. High fault tolerance (MTBF of 100,000 hours)
      c. Shall have LEDs for the indication of the operating state.

2.8 HMI

A. A fully graphical process visualization system forms the interface between the operator and the substation automation system. All information shall be handled and displayed in real time. The station status shall be exactly displayed and recorded. The HMI shall contain a library with predefined symbols used for substation automation. The system shall use the library of symbols for substation automation.

B. The information originating in the substation automation system and required in the HMI shall be created from the Wizard. Manual input of variables shall not be allowed. A plausibility check shall ensure the actual substation system matches the HMI configuration. The plausibility check shall ensure data consistency.

C. It shall be possible to make configuration changes during system operation. The HMI system shall be based on an SQL database allowing on-line changes. It shall not be necessary to recompile or load the new code.

D. The status of all data points shall be clearly visible in the HMI switched objects and in a dialog box:
   1. HMI ok/not ok
   2. Not Topical
   3. Bay blocked
   4. Telecontrol Blocked
   5. Substituted

E. The different states for all switched devices shall be transferred as a double indication and displayed in different colors, which shall be selectable (open, closed, disturbed 00, disturbed 11).

F. Essential indications, measured and metered values shall be archived in chart or table form for future analysis. The original values and the archive with the original data shall be used.

G. The original real time - time stamps with 1ms resolution originating in the connected IEDs shall be logged in the event and alarm lists of the HMI. Process feedback indications and command indications shall be logged in the event and alarm lists. This shall include the acknowledgement of events in the alarm list. The information telegram shall contain information indicating cause and source of the command feedback
   1. The cause:
      a. Spontaneous
      b. Control

2. The source
    a. Near
    b. Local
    c. Remote
    d. Other

H. The HMI shall be an integral part of the substation automation system. It shall be a modular. It shall be modifiable if the system expands. It shall be used on both small scale applications and complex client server configurations. It shall function in a distributed architecture using several servers. Access to HMI pictures or a subset thereof, depending on the purpose, shall be available via the ***[intranet] [internet]*** to perform monitoring and control functions.

I. The HMI shall guide the operator through the multi-level switching procedure and command execution cycle phases:
1. Initialization
2. Confirmation
3. Execution or cancellation

J. Synchronized switching operations shall be performed directly from the HMI with a procedure guiding the operator. IED's shall have a setting to inhibit synchronized switching operations. The HMI shall evaluate the synchro-check conditions. The command and related feedback shall be seen in unity. The whole command cycle shall be logged in the event list. The log shall show one of the following (4) four results:
1. Command cycle triggered
    a. Executed. In this case a feedback shall be supplied:
        1.) Command was executed
        2.) Failure. A time out indication shall be supplied
    b. Not executed. In this case the reason shall be supplied:
        1.) Failure - Interlock blocking
        2.) Failure - Switching authority not permitted

K. A plausibility check shall be implemented. The status information of a switched device shall automatically be checked in the system. It shall be checked whether the switched device is already in the state which is to be switched to or if a malfunction occurred.

L. A user administration function shall be implemented. This shall ensure that the authorized users only have the rights to operate the switch gear. Others shall only be able to perform monitoring functions. It shall be possible to configure different user groups with different functionalities. It shall be possible to create:
1. 128 User Groups
2. 128 Users
3. 999 Rights

M. The system shall be scalable and shall be able to expand according to future plans for the substations and demands of the owner:
1. Single HMI system
2. Multi HMI system with 2 or more autonomic HMI systems
3. Multi HMI system using client/server architecture
4. Multi HMI system using client/server architecture with redundant server

N. **OPTION:** ***[Obtain an application for analysis of historical data. This application shall use the original data as a basis for further calculations or analysis. It shall visualize variables in a user-friendly graphical format. It shall have the functionality to export this data into a comma separated value (csv) file format for analysis in Excel. These functions shall be performed on-line and off-line.]***

O. ***[An application shall be provided for fault record analysis. It shall allow the automatic collecting of fault records of the connected protection devices (for IEC 61850, Profibus FMS, IEC 60870-5-103) into a local archive of the related station unit.]***

P. ***[Automatically collect all the fault records of the distributed substation automation system [and approved substation automation systems], in a central archive. The collection of fault records shall be stored [in the HMI computer] [in a separate computer]. It shall be possible to collect the data from a remote computer, connected to the TCP/IP Ethernet station bus.]***

Q. Original records shall ***[not be deleted after transmission] [be deleted after transmission, in order to prevent the disc from filling up.]***

R. A user friendly tool for the analysis of these fault records shall be provided. The tool shall be able to provide a technical and topological explorer type of view. New fault records should arrive in a separate folder and in their associated device/topological folder. A pop-up window shall announce the arrival of newly downloaded records. After an operator acknowledges the new fault records, they shall disappear from the separate folder for new fault records. The fault records in the central archive shall be saved in the comtrade format.

2.9 IEDS

A. All IEDs shall have a distinctive uniform design and shall be configurable for protection and control functions with a single user-friendly tool. The automation, protection and control shall be products manufactured by a sole source, the bidder. The digital/numerical devices shall also meet control and monitoring tasks. They shall be flexible in functionality. These protection and field devices shall have the following functions:

1. A graphical display and keyboard with at least 10 numerical keys and cursor keys for user friendly local operation
2. At least 16 LEDs which can be mapped with two status LEDs
3. Uniform look and feel and a uniform and transparent design
4. All operations are secured using access permissions
5. All operating actions such as readout of information or switching can be done within the bay using the bay panel and/or the key switch.
6. Fast, simple and flexible mounting
7. An integrated key switch for switch jurisdiction shall be available
8. An integrated key switch for non-interlocked local control shall be available

2.10 CONFIGURATION

A. Specific software and programming knowledge shall not be required for configuring and operating the standard functions of the substation automation system. The parameters required for operations and system management shall be displayed in a user-friendly and operator-prompted dialog mode based on Microsoft Windows windowing technique.

B. A user interface for changing data and descriptions on-line shall be available for the configuration of system data. The configuration system shall support technology and operation oriented data views. It shall allow for fast and straightforward configuration.

C. The extent of configuration shall be minimized by the use of copy functions at all levels, selection possibilities out of predefined hardware catalogs, symbol libraries and operating aids by drag and drop. Data consistency shall be ensured by employing bottom up data exchange (xml, dbf and SCD for IEC 61850 devices) between the connected IEDs, field devices, the station unit and the connected HMI system. Data that has entered already shall not be allowed to enter again. The SCD file with the GOOSE linking shall be read by the configuration tools. Data available in the SCD file shall be used by the vendors engineering tool. All data shall be read out of the SCD file and linked or mapped to the designation.

D. Structuring and sorting the information shall be in correspondence to the plant topology. For example:

1. Tree topology of voltage levels and
2. Hierarchic sorting criterion for fields

E. Drag & drop and Wizards shall be available for easier engineering.

F. The configured data shall be checked on-line for consistency. Errors as a result of plain text messages have to be displayed in the online dialog. Color markings of a fault shall differ from that of the error-free parameters. Errors have to be displayed as hyperlinks which lead directly to the related parameter. An extensive help system shall support context sensitive and detailed questions online.

G. The substation automation system shall be an open system. The automation functions shall be configurable. They include command processing, configuration of operating sequences, interlocks and generation of derived information. A graphic configuration system, in compliance with IEC 61131-3, shall be available and operational. A Wizard shall be integrated with system tested function blocks for power automation specific functions.

H. Modern service and diagnostic tools shall be 'on board'. No separate generation and loading of code shall be necessary. It shall be possible to switch on-line between both applications. An adaptation or extension done in the configuration mode shall be visible in the operation mode. It shall be enabled without first compiling the modification and loading the procedure. Diagnoses and engineering of the system do not require a separate programming interface.

2.11 CENTRAL CABINET

A. All connection, display and control elements of the substation automation system components shall be accessible from the front. Neither a door on the backside of the cabinet nor a swing frame shall be necessary.

B. Definition of the project specific cabinet identification shall be done by the owner. Cabinet labeling is done by the cabinet vendor.

C. All units and components shall contain at least the following labeling:
1. Type designation (also recognizable when installed) with serial/identification number and year of manufacture
2. Company name
3. Equipment identifier (e.g. F204) on the front and back of the device as well as on the place of installation

D. The station unit is to be installed in a standard cabinet with an IP54 degree of protection. No fan shall be required for operation.
1. Cabinet dimensions: 2200mm H x 900mm W x 600mm D
2. Material: 1.5 mm sheet steel, mounting plate and rear panel 2 mm sheet steel
3. Color: RAL7032 (Silica grey) trim: rail SN617 (Petrol)
4. Cable entry: bottom (Floor pan 3 parts)
5. Door lockage: Espagnolette lock and double bit key

E. Cabinets that are placed in a row shall have full length side panels (necessary for compartmentalization). All cabinets shall be equipped with transportation eyes.

F. All units and component cabinets shall be in an ambient temperature between 0°C and +40°C. Units and components installed in areas where temperature are outside of the range shall have forced ventilation or heaters to maintain proper operation temperature.

G. Connection to an AC power supply requires the following:
1. 1 Main Molded Case Breaker, 1-pole
2. Molded Case Breaker with auxiliary contacts and wiring to a monitoring circuit

H. Connection to a DC power supply requires the following:
1. 1 Main Molded Case Breaker, 2-pole
2. Molded Case Breaker with auxiliary contacts and wiring to a monitoring circuit

I. The connection system shall be implemented via:
1. Power supply and PE terminals (6 mm^2)

J. All components shall be properly isolated against touch voltages.

K. The applied units and components shall withstand the high voltage tests without executing any unwanted or failed functions (high and impulse voltage tests; interference immunity test).

L. A double shell coiled cable shall be used for installing optical fiber connections.

M. Less than 80% of internal and external cable channels shall be assigned so changes can be executed..

N. The metallic surfaces used for grounding shall be non-corrosive and shall possess good electrical conductivity. Painting and non-conductive surface treatment shall not be allowed.

O. The units shall be connected using grounding strips. Strip length shall be as short as practical. Cabinet grounding shall be done using a grounding bar. The bar shall be connected to the plant's ground.

P. The central cabinet and all components required shall be installed, tested and wired. These include, among other things:
1. Station Unit
2. HMI server computer including Ethernet components
3. Serial connections ***[if needed]***
   a. ***[Serial interfaces for the connection of the network control centers]***
   b. ***[Serial interfaces for the connection of IEDs and field devices]***
4. Time signal receiver complete with antenna, lightning protection and antenna cable.

2.12 CONFIGURATION

A. The owner's engineer shall provide check lists for each configurable device. The HMI screens shall be illustrated in detail explaining both look and functionality. After the owner's approval, these lists shall be the official basis for the configuration of the system. The configuration phase must include the following items:
1. Making of configuration lists, signal lists and HMI screens
2. Configuration of IEDs and field devices
3. Exporting of the data of the IEDs and field devices in to the substation automation system
4. Configuration of the substation automation system
5. Configuration of the HMI(s)
6. Typical testing of the configuration (communication, each data object in both directions)
7. Delivery of all relevant configurations on a CD

B. ***[See Appendix XXX for the configuration check lists.]***

2.13 GENERAL REQUIREMENTS

A. Climatic and Ambient Conditions

Factor	Operation	Transport and Storage
Ambient temperature 795 hPa to 1080 hPa 1) 660 hPa to 1080	0 °C to 55 °C	–40 °C to 70 °C
relative humidity (RH)	10 % to 90 %	10 % to 90 %
acceptable air pressure	795 hPa to 1080 hPa 1)	660 hPa to 1080 hPa
acceptable temperature changes	0.5 K/min, no condensation (but not to exceed 10 K in 30 minutes)	

1. At higher altitudes (i.e. > 2000 m), reduced ventilation may make it necessary to reduce the maximum operating temperature and use a fan.

B. Physical Requirements

Factor	Operation	Transportation and Storage
Oscillation stress in acc. w. IEC 60068-2-6	Fc test, 20 cycles on 3 axes: 10 to 61 Hz: 0.2 mm amplitude 61 to 500 Hz: 19.6 m/s2	10 cycles on 3 axes: 5 to 9 Hz: 3.5 mm amplitude 9 to 500 Hz: 9.8 m/s2
Shock stress in acc. w. IEC 60068-2-27	Ea test, half-sine, 3 each per axis in both directions: 300 m/s2, 11 ms	
Shock stress in acc. w. IEC 60068-2-29		Half-sine, 1000 shocks per axis: 250 m/s2, 6 ms

C. Electromagnetic Compatibility

Specification	Testing in Accordance with
Interference immunity against discharge of static electricity (ESD) • Discharge through the air • Discharge on contact	EN 61000-4-2:1995 8 kV 1) 4 kV 1)
Interference immunity against fast transient interference (bursts) • Power supply cables for 120/230 V AC • Signal cables (input/output and bus cables)	EN 61000-4-4:1995 2 kV 2 kV 2)
Interference immunity against surge voltages 3) • Power supply cables for 120/230 V AC • Power supply cables for 24 V DC	EN 61000-4-5:1995 1 kV symmetrical 4) 2 kV unsymmetrical 4) 0,5 kV symmetrical /unsymmetrical 3)
Interference immunity against electro-magnetic fields • Amplitude-modulated HF, 80 to 1000 MHz 1)	EN 61000-4-3:1996 10 V/m 5) 80% AM (1 kHz)

Interference immunity against electro-magnetic fields • Pulse-modulated HF, 900 MHz 1)	EN 61000-4-3:1996 & ENV 50204:1995 10 V/m 5) 50% ED, 200 Hz repetition frequency
Interference immunity against cable-conducted interference, induced by high-frequency fields • 0.15 to 80 MHz	EN 61000-4-6:1996 10 V 5) 80% AM (1 kHz) source impedance 150 W
Interference emission1) • Emission via the field • Interference emission via power cable	EN 55011:1991, Group 1 (CISPR11:1997+A1:1999) limit value class A limit value class A

1. Installed on IMC system frame
2. Signal cables which are not used for process control (e.g., cables to external printers): 1 kV
3. The interference immunity on DC power cables and data/signal cables must be ensured by appropriate external measures.
4. Only applies to components with 120/230 V power (e.g., power supply boards)
5. For permissible deviation of analogue input and output variables during interference input, see EG statement of conformity.

D. Requirements at the System Level

Factor	Requirement	Validity
EN 60950	Protection class I, with protective conductor	For boards with power supplies
Protection against foreign bodies and water in acc. w. EN 60 529	Protection against foreign bodes: IP 2X Protection against water: IP X0	When installed
	Protection against foreign bodes: IP 1X Protection against water: IP X0	Board level
Air and creepage paths in acc. w. IEC 1131	Over voltage category II	For all boards
	Degree of soil 2 PCB material III a	For all boards
Isolation test in acc. w. EN 60950	500 V DC	For boards with nominal voltages up to a max. of

		50 V
	1,2 x (2UN + 1000 V) x 1,414 DC	For boards with nominal voltages up to max. of 50 V
Fire resistance for open-type controllers in acc. w. IEC 1131-2	At least UL94 HB	For housing parts
	At least UL94 V-2	For holders for voltage carrying parts
	At least UL94 V-1	For PCB material
Manufacturing material in acc. w. SN 36350	• Environmentally compatible disposal of used devices • Avoidance of environmentally endangering substances and materials • Increased repairs due to easy disassembly • No materials emitting silicon or teflon	

E. Signal list for IEDs and Field Devices

1. The scope of information to be recorded from the IEDs and field devices is described in the signal lists as stated below:

Station name	**Voltage level**	**Field type (name)**	**Field type (number)**	**Functions – Short description**		
				Protection function (ANSI no.)	**Switchgear (number)**	**Alarm indications (number)**
[Name]	***[XXX kV]***	Overhead line (OHL)				
		Cable				
		Transformer [XXX kV]				
		Coupling				
		General				
	[XXX kV]	***Transformer [XXX kV]***				
		Cable				
		Transformer [XXX kV]				

		Coupling				
		General				
	[XXX kV]	***Transformer [XXX kV]***				
		Cable				
		[Auxiliary system transformer XXX kV/kv]				
		Coupling				
		General				

F. Scope of Supply **[Example items to be modified for your job]**

Pos	**No.**	**Description**
Pos.1		**Operator Station (OS)**
	1	Workstation
	1	Event Printer
Pos. 2		**Operator-Station LAN**
	1 Set	Ethernet LAN System from ***[XXX]*** to ***[XXX]***
Pos. 3	1	**Station Unit (SU)**
	1	Station Unit
Pos. 4		**Station LAN**
	1 Set	LAN System (Station Unit to IEDs /field devices)
Pos. 5		**Bay Level**
5.1		**High Voltage Switchgear *[XXX kV]***
5.2		**High Voltage Switchgear *[XXX kV]***
5.3		**Medium Voltage Switchgear *[XXX kV]***
Pos. 6		**Service**
6.1	1 Lot	Engineering and Configuration - Engineering and Configuration of Substation Control Level and HMI - Engineering and Configuration of Field Level
6.2	1 Lot	Commissioning
6.3	1 Lot	FAT
6.4	1 Lot	SAT
Pos. 7		**Training**
	1 Lot	Training Courses
Pos. 8		**Options**

2.14 FUTURE ADDITIONS

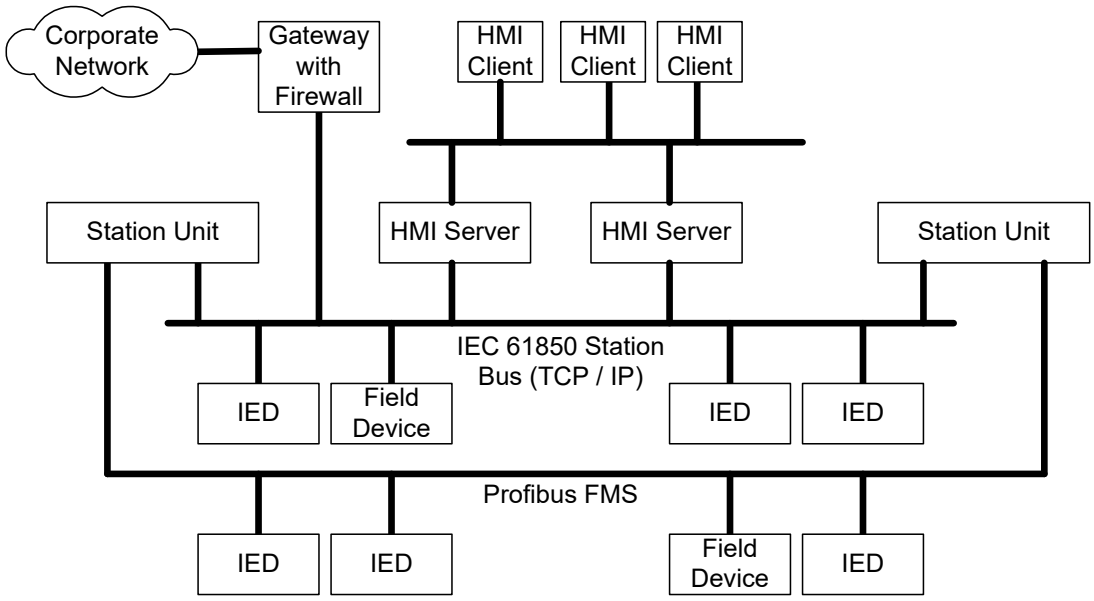
A. It shall be possible to change the substation automation system. The substation shall be able to modify software and components. Physical expansions and operating logic shall be able to change. This shall be possible by extending the system with additional station units, IEDs or interface modules.

B. It shall be possible to change configuration during system operation. The integration and activation of applications and protocols shall be able to be modified while in operation. The substation automation system shall be based on an SQL database, allowing online changes. It shall not be necessary to recompile and to load the new code.

C. The IEC 61850 standard shall be part of the system for the connection to the IEDs.

D. ***[During the evaluation, vendors shall demonstrate their engineering tools are able to integrate their own as well as 3rd party IEDs.]***

E. For future expansions it shall be possible to implement a hot-hot redundancy system. This is diagrammatically shown below:



PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation should include the following services:
1. Installation of all cabinets (distribution cabinet, central cabinet, field cabinets)
2. Placement and grounding to existing grounding cables
3. Connection of all auxiliary, signaling, and control voltages
4. Installation and connection of components required for time synchronization
5. Installation of the control lines in the existing cable channels and connection inside the cabinets
6. Installation of the optical fiber cables in the existing cable channels, splicing and connecting
7. Installation of relevant network components and cables.
8. Assembly work shall be executed by ***[the manufacturer's personnel] [by the direction of the manufacturer]***.

9. Transferring work to subcontractors ***[is not allowed] [shall be stated in the bid and can only be executed if the owner approves the proposal]***.

3.2 ADJUSTMENTS AND CLEANING

A. Remove debris from switchgear and wipe dust and dirt from all components.

B. Repaint marred and scratched surfaces with touch up paint to match original finish.

3.3 TESTING

A. The system shall include integrated test and diagnosis functions.

B. It shall be possible to view all data coming or leaving the station unit with their respective values. It shall be possible to execute commands for test purposes during the commissioning stage from here.

C. A suitable diagnostic tool shall be available for checking system and/or process information connected to the substation automation system. It shall be possible to call up the information on site via a network connection and dial up connection. Internet Explorer shall allow visualization of the diagnostic and monitoring data without any special software installation for the web clients. It shall be done ***[directly at the diagnostics server] [with a web client connected to the server via [the Internet] [an Intranet] [a long distance data transmission]] network***. The ***[owner] [contractor]*** shall provide secure communication from the back-office to the substation.

D. The diagnostics tool shall allow control of all switching devices connected to the station unit(s) for testing purposes. There shall be a password question before users are allowed to send out commands. It shall also allow access to an event list where system and process information are contained in plain text.

E. Configuration of the diagnostic system shall be done by importing the existing variables from the existing database. Additional configuration of the diagnostic system shall not be necessary.

F. The following information from the substation automation system shall be displayed, when configured in the substation automation system:
1. Event list with system and process information
   a. ***[Shall represent a data archive, up to 5000 entries shall be record (cyclical buffer).]***
   b. ***[Shall have the data archive initially off with an option to turn on and enable continuous archiving.]***
   c. ***[Shall update automatically when new events occur.]***
2. Bay units (connected via the substation automation system) with
   a. Status information
   b. Process information
   c. Control information
3. General system messages such as:
   a. State of time synchronization
   b. Partner disturbance
   c. Configuration fault
   d. Transmission error
   e. Command not configured
4. It shall be possible to protect the diagnostic system against unauthorized access using a password. The password shall only be stored on the server and shall only be changed by administrators.

G. Factory Acceptance Testing (FAT)

1. An acceptance test for substation automation is required. The test of the units and components shall be done at the corresponding manufacturing plant prior to the delivery of the substation automation system to the construction site. All devices used in the substation automation system shall be functionally tested during their construction. An

acceptance test of the units and cabinets shall be done according to the agreed upon time schedule. The duration of the test shall be 3 days.

a. Prerequisites for the factory acceptance test are the following:
   1.) Presentation of complete documentation (circuit manual, unit documentation)
   2.) All components are fully equipped and previously tested by the manufacturer.
   3.) All components have been operationally connected for a system test and the required auxiliary powers are applied
   4.) System inputs have been emulated for the components to be tested
   5.) Inspection protocols with regard to insulation test, impulse voltage test and manufacturers function test have been presented
   6.) A competent (professionally and commercially) contact person for the system test is to be named for the manufacturer.
   7.) The inspection program is to be presented for acceptance prior to the FAT and the entire configuration is to be implemented. The entire software configuration shall be completed before commencing with the FAT.

b. Execution
   1.) The manufacturer shall be responsible for the report of the FAT. The basis is the FAT test procedure which has been previously determined by both parties.
   2.) Detected deficiencies and remarks shall be recorded during FAT meetings. Deficiencies shall be corrected prior to delivery.
   3.) Signals are to be simulated and their function is to be tested throughout the system. Meters and displays are to be used to show binary quantities and values.
   4.) Inspection acceptance of the FAT shall be done in writing.

H. Site Acceptance Testing (SAT)
   1. The substation automation system shall undergo Site Acceptance Testing (SAT), upon completion of the commissioning. The acceptance of the entire inspected substation automation system shall depend upon meeting the criteria outlined herein. SAT shall include testing units, cabinets and functions in accordance with the specified scope of delivery and services.
   2. All test and inspection papers shall be handed to the owner. The SAT shall commence once the owner's approval.
   3. Conclusion of this project phase shall be confirmed in writing by the owner via a Certificate of the Site Acceptance Test – SAT. This shall begin the warranty.
   4. Possible remaining open points shall be recorded and confirmed in writing by both parties. A date for their completion shall be set by both parties.
   5. Final acceptance of the system by the owner shall be done in writing (Final Acceptance Certificate – FAC).
   6. For a Final Acceptance Certificate – FAC, the following is required:
      a. SAT with certificate
      b. Completion of the open points with confirmation by the manufacturer.
      c. Successful trial operation
      d. Delivery of final revised documentation with confirmation by the owner.

3.4 WARRANTY

A. Replacement Obligation
   1. All substation automation system components shall be guaranteed for at least 1 year from the commissioning date.

3.5 START-UP SERVICES – PROJECT MANAGEMENT

A. The manufacturer must appoint an experienced project supervisor (PS) with greater than 5 years of professional experience for the implementation of these projects.

B. A project schedule must be attached to the submittal, with the expected project course or schedule and project phases and the milestones to be reached.

C. Project reviews shall take place at fixed intervals and in case of special requirements. Regular project reviews shall be outlined in the project schedule. The participation of the project supervisor (PS) appointed by the manufacturer is mandatory. The manufacturer's (PS) shall record the minutes during these reviews and, within 5 work days, presents it in draft form to the contractor and owner for revision. After revision, the official review minutes will be distributed by the manufacturer's (PS) within the following 5 working days. In every project review the previous minutes are discussed and open or unfinished items are included in the newly written minutes.

D. The following documents must be drawn up for individual project phases in accordance with the schedule:
   1. Circuit manuals
   2. Process signal lists (configuration check lists)
   3. Detailed time schedule
   4. Test programs

E. The ***[contractor] [owner]*** shall reserve the right to inspect the production state at the manufacturing plant during the production period. The cost of the trip and any related expenses shall be by the ***[contractor] [owner].***

3.6 COMMISSIONING

A. After commissioning, the delivered substation automation system shall be functional. Commissioning of the substation automation system begins once installation of the primary and secondary facilities has been completed and the primary system is ready for operation.

B. Commissioning includes bit-tests of the substation automation system and all its connected components and will be done by ***[the contractor] [the manufacturer] [a third party]***.

C. During the commissioning, customer personnel should be trained accordingly for later operation and maintenance. Training shall be carried out on the construction site as defined in Section 3.7 TRAINING.

3.7 TRAINING

A. The manufacturer shall have a training center with regularly scheduled training courses. A current catalog of training courses shall accompany the offer.

B. Owner's personnel shall be trained for ***[1] [2] [3]*** days so that the following tasks can be executed:
   1. Knowledge of the structure of the substation automation system and its components
   2. Configuration and operation of the substation automation system
   3. Maintenance of the facility including trouble-shooting and error correction

C. The operations and maintenance personnel shall participate in an on site introduction of the facility during commissioning or SAT.

END OF SECTION