PART 17

SPECIFICATION NO.: RSUB-010/2560 (Rev. 1.0)

SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

ADDENDUM

This addendum is made to be a part of **Specification No.: RSUB-010/2560 (Rev. 1.0) SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)**

(1) Clause **4.2 SYSTEM HIERARCHICAL STRUCTURE,** add the following items in **Remarks** (in Page 37 of 389):

5) Network redundancy protocol for each topology shall be Parallel Redundancy Protocol (PRP) and/or High Availability Seamless Redundancy (HSR) protocol for zero-time recovery.

6) Time synchronization shall be accomplished via IEEE 1588 or IRIG-B.

(2) Clause **4.2.2 Bay Level**, replace the typical of Protection relay function (in Page 49 of 389) by the following:

Typical of Protective relay functions can be categorized as:

1) 115 kV Bus Protection (Main 1 and Main 2) 87B, 95B
2) 115 kV Line Protection (Main 1 and Main 2) 21/21N, 67/67N, 25, 27/59, 79, 50BF
3) 115 kV Transformer Protection (Main 1 and Main 2) 87T,87REF, 50/51, 50N/51N, 51GB, 50BF
4) Others 115 kV Protections
5) 22 or 33 kV Feeder Protection 50/51, 50N/51N, 67/67N, 25, 79, 50BF, 81, 27/59, 60
6) Others MV Protections

All protection functions of the protective relay shall be completely programmed from manufacturer's factory.

(3) Clause **4.13 INTERFACING, ADVANCE ANALYTICS AND ARCHIVING FUNCTIONS**, replace the interfacing and archiving functions (in Page 66 of 389) by the following:

The interfacing and archiving functions are performed at the following locations:

1) Station-operator HMI or station level operator interface (SLOI)
2) SCADA gateway for remote interface to PEA SCADA/DMS
3) Prefabricated relay housing screen mimic (If applicable)
4) Engineering workstation
5) Emergency control interface (Backup Mimic)

(4) Clause **4.13 INTERFACING, ADVANCE ANALYTICS AND ARCHIVING FUNCTIONS**, delete the System components: Prefabricated Relay Housing Screen Mimic (If Applicable) and Bay HMI (Bay Control IED Mimic) and their Comments in **Table 4.5 – Interfacing Issues** (in Page 67 and 70 of 389).

(5) Clause **4.14.6 Bay Level Devices Functions,** delete item 7) User Interface and subitem a. – d. (in Page 76 and 77 of 389).

(6) Clause **7.3.1 Communication Network Device – Ethernet Switch**, replace the second paragraph (in Page 150 of 389) by the following:

The main characteristics of the Ethernet Switch shall be designed for continuous operation in a high voltage substation and shall conform to the industrial environment performance, according to IEEE 1613 – class 1 for the Ethernet Switch used in station bus level and IEEE 1613 - class 2 " error free" for Ethernet Switch used in process bus level, for real-time control and EMI immunity and shall pass a type test according to IEC 61850-3. And the requirements stated in **Clause 4.6 System Security**. Ethernet Switch at a station bus level shall be L3 type, and those at a process bus level shall be L2 type.

(7) Clause **7.3.1 Communication Network Device – Ethernet Switch**, replace the Comments of Requirement: Auxiliary Supply in **Table 7.1 (a) – Industrial Ethernet Switch Requirements** (in Page 151 of 389) by the following:

Requirement	Comments
Auxiliary Supply	1) 125 VDC nominal voltage (substation DC system) with minimum range 80-120% of nominal voltage, or 2) 230 VAC nominal voltage with ±10% of nominal voltage

(8) Clause **7.3.1 Communication Network Device – Ethernet Switch**, replace the Comments of Requirement: Network Switch and Time Synchronization in **Table 7.1 (b) – L3 & L2 Switch requirement** (in Page 153 of 389) by the following:

Requirement	Comments
Network Switch and Time Synchronization	Transparent Clock

(9) Clause **8.2.7 User Interface for Protection Device**, replace the Details of Basic Requirement: Human Machine Interface (HMI) in the Table (in Page 173 of 389) by the following:

Basic Requirements	Details
Human Machine Interface (HMI)	Alpha-numeric massage display, Liquid Crystal Display (LCD) to display information.

(10) Clause **8.2.7 User Interface for Protection Device**, delete Basic Requirements: Keypad Operation and its Details in the Table (in Page 174 of 389).

(11) Clause **8.2.8 User Interface for Control Device**, replace the first paragraph (in Page 174 of 389) by the following:

The HMI for control device shall be provided as a user or operator interface. The HMI provides device parameter display, device operational record/status display and device interrogation facility.

(12) Clause **8.2.8 User Interface for Control Device**, replace the Details of Basic Requirement: Human Machine Interface (HMI) in the Table (in Page 174 of 389) by the following:

Basic Requirements	Details
Human Machine Interface (HMI)	Alpha-numeric massage display, Liquid Crystal Display (LCD) to display information.

(13) Clause **8.2.8 User Interface for Control Device**, replace the Details of Basic Requirement: View or Display in the Table (in Page 174 of 389) by the following:

Basic Requirements	Details
View or Display	1) View or display device settings and configurations 2) View or monitor service and measurement/metering values 3) View or display event and relevant fault information 4) View or display IED internal events 5) View or display device information/status

(14) Clause **8.2.8 User Interface for Control Device**, delete Basic Requirements: Keypad Operation and its Details in the Table (in 175 of 389).

SPECIFICATION NO.: RSUB-010/2560 (Rev. 1.0)

SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

CONTENTS

1. SCOPE

The intent of this document is to specify the minimum technical requirements for the design, manufacture, testing in the manufacturer's workshop, supply and delivery, transportation to the site(s), construction, installation, site-tests, pre-commissioning, commissioning and training of an Integrated SCPS for PEA (Provincial Electricity Authority) new breed of substation(s), complete in every respect with all the main facilities and system functional requirements for reliable continuous operation. It is expected that the main Contractor (and its partners) is fully experienced in the design and supply of substation automation and protection systems of the type alluded to here and therefore the specifications are not prescriptive but rather give the Contractor leeway to provide the best possible solution at an economical cost. The Contractor is expected to provide a complete Integrated SCPS in its entirety whether or not components or functions are expressively stated in these specifications. SCPS might also be referred to Substation Automation System (SAS).

This specification describes the Integrated SCPS to be offered to PEA, based on the IEC 61850 standard "Communication networks and systems in substations," Edition 2 (unless stated otherwise,) and requirements for relay protection and related equipment of the newly built and updated 115 kV, 22 or 33 kV substations. *Therefore the same specifications can be used to upgrade existing substations as well as being applied to "Greenfield" projects. In case of upgrading existing substations, the upgraded communication systems, which is all-digital based, shall fully comply with Chapter 7 Communication System Requirements of this specification. For project implementation in an existing live substation, maximum safety precaution shall be afforded at site, the Contractor is expected to be thoroughly familiar with PEA electrical safety rules concerning its power networks.*

The scope of work alluded to in this specification describes the minimum requirements for an integrated SCPS. Contractors must comply with all requirements in this specification. The successful bidder shall provide completely integrated, turnkey systems and accept total responsibility for those systems successfully fulfilling the requirements and intent of this specification. The systems will be compliant with the IEC 61850 standard, and afford a complete solution for the control and protection for PEA substation(s). This solution not only includes high technology IEDs (Intelligent Electronic Devices) for Process level, Bay level and Station level performance but also the application software plus other software including interface and tools, SCL (Substation Configuration Language) programming, analysing and data reporting of the whole system. If Contractors believe that alternatives can be suggested without compromising the overall integrity alluding to in the specification, the Contractors are limited to do so providing they state the reasons clearly for offering an alternative and indicating any financial benefits to PEA.

SCPS system equipment shall be furnished and installed by the Contractor. Specifically, the Contractor shall place the equipment on site, interconnect the equipment using Contractor-supplied cables, connect the system equipment to electrical power, and connect cables to external equipment and systems, including the communications channels, networks, and external systems.

Furthermore the Contractor shall include all necessary hardware/software required for integrating the SCPS to the Distribution Management System (SCADA/DMS) Mater Station located at each Area Distribution Dispatching Centre (ADDC) which shall be expandable to meet future system requirements, i.e., more units, different product interfacing; use of communication profiles based on international standards, considering the Ethernet network and the use of the TCP/IP; the use of LAN technology as local network of the substation offers a common physical level with a greater bandwidth.

All engineering conceptual and detailed design drawings and submissions shall be approved by the PEA prior to equipment/product procurement and manufacturing. However, approval of the drawings and submission shall not exonerate the Contractor from any responsibility to make good any connection, wiring, scheme, drawings, etc. associated with the scope of works, as may be found during the later stage of testing and site inspections. The engineering & configuration tools shall be supplied to PEA during engineering review stage.

The conceptual design submissions include:

1) System products - devices and components list
2) General – drawing legend, standard symbols and naming conventions
3) Overview Diagram – substation single line diagram, system configuration, IEC 61850 system architecture, and control building layout
4) Block Diagram (Station & Bay Level) – primary, control and protection block diagram
5) Logic Function Diagram (Control & Protection) – command control logic & interlocking scheme, monitoring points & measurement scheme, protection logic function & scheme, device terminal function diagram
6) Panel Drawings – control & protection panel arrangement, construction, layout assembly, and parts lists
7) Technical calculations – instrument transformer burden & rating calculations, auxiliary DC system battery & charger ampacity and ratings, optical fibre power budget calculations, etc.
8) IEC 61850 SCL configuration files - .ssd, .scd, .icd, .cid files (if applicable)
9) Conformance statements – MICS, PICS, and PIXIT
10) Client-Server Reporting data sets and control blocks
11) GOOSE messaging data sets and control blocks
12) Data Exchange Diagram (DED)

The detailed design submissions include:

1) Schematic or Circuit Drawings (Station & Bay Level) – AC and DC distribution, instrument transformer & power circuit, measuring & instrumentation circuit, communication network, switching device tripping & closing circuits, protection circuits, manual synchronizing, alarm monitoring, system drawing, terminal function diagram, etc.
2) Cable and wiring schedules including cable route, fiber route etc.

The scope of work shall include the preparation and maintenance of as-built database and control applications, including documentation of all data points within the substation, and the preparation of an Integrated SCPS detailed design documents for approval by PEA prior to commencement of system production.

The Contractor shall provide Simulation Test Tools for testing all IED Protective relays and BCU according to the IEC 61850 communications standard for the informative interface protection equipment. Training shall be also provided.

1.1 GENERAL REQUIREMENTS

The SCPS system shall be of current production from industry recognized component manufacturers and shall reflect state-of-the-art, mainstream engineering for continuous-duty service in the substation environment, shall be built of all new material of the best industrial grade with proven reliability, and shall be designed to provide reliable service subject to reasonable maintenance and replacement of consumable parts.

The Contractor must comply with the requirements in this specification. The successful bidder shall provide completely integrated, turnkey systems and accept total responsibility for those systems successfully fulfilling the requirements and intent of this specification. The systems will be compliant with the IEC 61850 standard, and afford a complete solution for the control, protection and automation of a PEA substation. This solution not only includes high technology IEDs for Process Bus, Bay and Substation Level performance but also the application software plus other software including interface and tools, SCL programming, analysing and data reporting of the whole system.

All SCPS equipment shall be of the manufacturer's standard design, and shall be manufactured, fabricated, assembled, finished, and documented with workmanship of the highest production quality and shall conform to all applicable quality control standards of the original manufacturer and the Contractor. All goods and materials shall be new, unused, and of the current model. The Integrated SCPS equipment shall be the latest version and shall incorporate all recent improvements in design, software and materials.

The Contractor shall supply full documentation on all components at the time of tender. Materials that are not specifically designed for a tropical climate, may promote the growth of fungus or are susceptible to corrosion, and thus shall not be used. All features of the proposed equipment described in the Bid and in the Bid's supporting reference materials shall be fully representative of the equipment to be supplied.

The Integrated SCPS shall be designed as part of new substation projects to provide the following functions:

1) Control (substation control) – both manual and automatic
2) Protection (substation / network protection) largely automatic

3) Interfacing, advanced analytics and archiving
4) Measurement
5) Monitoring

The Integrated SCPS shall be designed:

1) To accommodate future substation upgrades, modifications, extension and expansion
2) To achieve the objectives of IEC 61850 standard, i.e. interoperability, simple configuration & allocation of functions, and be future proof
3) To ensure high reliability, performance and availability to minimize the interruption of service and functions
4) To ensure that single failure at station level or one bay will not affect the operation and functions of other bays
5) To maximize the utilization of substation information for supporting decision processes, engineering, operation & maintenance, fault investigation & diagnostics, and asset management
6) To optimize the application of devices, panels, cabling and substation space
7) To provide safe, secure and reliable operation of the substation throughout its total life cycle
8) To withstand harsh operational substation environment such as the impact of electromagnetic interference and adverse environmental conditions.

The Contractor shall design and implement the Integrated SCPS to facilitate:

1) A distributed architecture using distributed station and bay intelligent devices, functions and applications
2) Full system integration via substation communication network
3) Fully automated functions
4) The separation of substation operator interface and engineering interface
5) The station level operator interface and SCADA gateway to perform station/supervisory monitoring and control operation of the substation
6) To support engineering workstations to manage the SCPS, communication network and substation information, and to provide applications utilizing the substation information
7) To support the application of Ethernet Technology and Information Communication Technology (ICT) such as Client-Server communication, Peer-to-Peer communication, web-based application, SCL, MMS (Manufacturer Message Specification), TCP/IP and Ethernet
8) IEC 61850 enabled technology including IEC 61850 conformant multifunction intelligent devices
9) Self-monitoring, condition-based monitoring (optional) and management of intelligent devices, communication network and substation equipment. The Contractor shall propose condition-based monitoring as an option, together with a separate quotation, for PEA approval.
10) The integration of intelligent devices in single panel

11) The interoperability of IEDs from several different manufacturers to exchange information and use the information for their own functions.
12) The maximum utilization of information from IEDs.

1.2 OBJECT MODELLING

The Contractor shall perform the following typical tasks as part of the scope to abstractly model the substation data before mapping to mainstream communication protocols:

1) Analyse PEA requirements, substation single line diagram, constraints and functions as specified in the specifications
2) Define the abstract model data and communication services model (i.e., Abstract Communication Service Interface, ACSI) based on the functions, SCADA points and requirements
3) Determine the functions allocation and the Logical Nodes (Refer to IEC 61850-7-4, 61850-7-410, and 61850-7-420 for the complete list of all IEC 61850 Logical Nodes as a reference)
4) Map the required functions to the Logical Node and their data
5) Determine the object modelling including the Logical Device modelling
6) Determine the information flows, and data exchanges within the substation
7) Create PEA SCL files (.icd., and .scd files) for the specific substation configuration based on .ssd file provided by PEA
8) Generate .cid file from .scd file and configured all the IEDs used for the substation
9) Determine the data sets and control blocks of the IEDs based on the above modelling

The figure below illustrates the above configuration process.

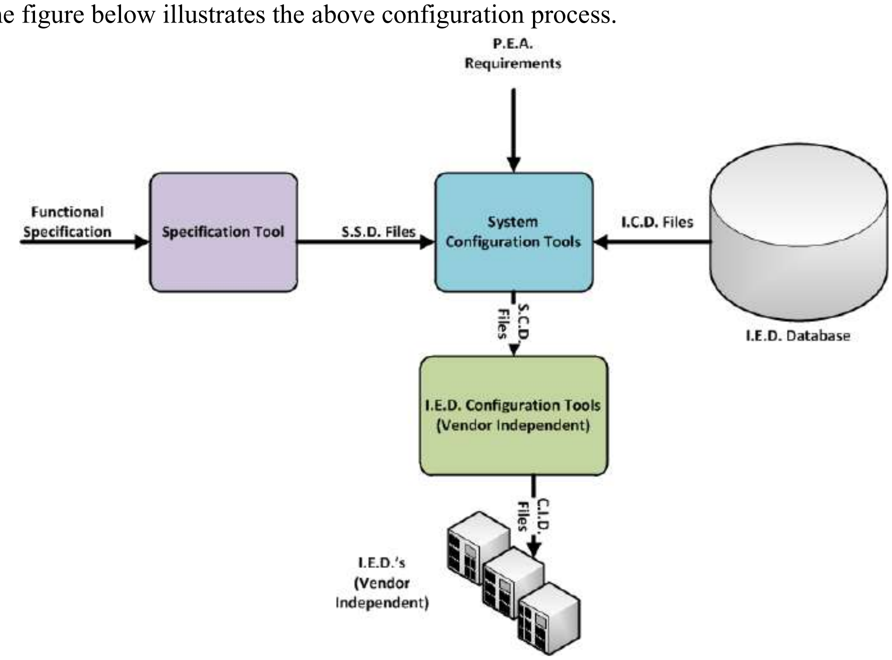

Figure 1.1 – Configuration Process

1.3 ENVIRONMENTAL CONSTRAINTS AND ELECTROMAGNETIC COMPATIBILITY

1.3.1 Environmental Data

1.3.1.1 All the equipment supplied in the scope of this project shall be compliant with the environment constraints listed in this paragraph**.** Temperature requirements**:**

Category	I		II		III	
Rated operation range 1(1)	T1: +5°C	T2: +40°C	T1: -10°C	T2: +55°C	T1: -25°C	T2: +70°C
Maximum operation limits (2)	T3: +5°C	T4: +40°C	T3: -10°C	T4: +55°C	TI: -25°C	T2: +70°C
Relative humidity At +23°C	75%		80%		90%	
Storage and transport conditions (3)	-40°C	+70°C	-40°C	+70°C	-40°C	+70°C
Operation location example	Air conditioned room		Non-air conditioned room		Outdoor Equipment	

The three above definitions are extracted from IEC 60359.

1.3.1.2 Class of Equipment

The following description gives the class definition used in the next paragraphs (except the temperature related paragraph):

CLASS 1: Low-level electromagnetic radiation environment, such as levels typical of local radio/television stations located at more than 1 km and levels typical of low power transceivers.

CLASS 2: Moderate electromagnetic radiation environments, such as portable transceivers that can be relatively close to the equipment but not closer than 1 m.

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(1) Operational range:
Range of values that can take an influence quantity when the prescriptions regarding the error determined in rated operating conditions are fulfilled.

(2) Maximum operation limits:
Range of values that can take an influence quantity beyond the rated range of operation, in which an equipment can still work without deterioration or degradation of its operating qualities when it works again at its rated conditions of operation.

(3) Storage:
Set of climatic conditions to which the equipment can be submitted, when not operating, without deterioration or degradation of its operating qualities when works again in its rated conditions of operation.

CLASS 3: Severe electromagnetic radiation environments, such as levels typical of high power transceivers in close proximity of the control equipment.

CLASS 4: Open class for situations involving very severe electromagnetic radiation environments. The level is subject to negotiation between the user and the manufacturer or as defined by the manufacturer.

According to these figures, the equipment to be supplied shall be compliant with tropical constraints.

TEST	METHOD	CLASS	SEVERITY
Cold	IEC 60068-2-1	-	-25°C / 96 h (storage) +5°C / 96 h (in operation)
Dry heat	IEC 60068-2-2	-	+70°C / 96 h (storage) +70°C / 96 h (in operation)
Damp heat	IEC 60068-2-78	-	+55°C / 95% / 96 h (storage) +40°C / 93% / 96 h (in operation)

ELECTROMAGNETIC ENVIRONMENTAL STANDARDS

Isolation tests: voltage withstand

TEST	METHOD	CLASS	SEVERITY
Rated insulation voltage	IEC 60255-27	-	500 VDC
Insulation impedance	IEC 60255-27	-	100 MΩ

ISOLATION TESTS: DIELECTRIC WITHSTAND

TEST	METHOD	CLASS	SEVERITY
Rated insulation voltage	IEC 60255-27	-	2 kV / 50 Hz / 1 mn

Isolation tests: impulse voltage withstand

TEST	METHOD	CLASS	SEVERITY
Unidirectional surge 1.2/50 µs (voltage) 8/20 µs (current)	IEC 61000-4-5 IEC 60255-27	-	5 kV (supply) 5 kV (I/O) 1 kV (communication)

Immunity tests against radiated electromagnetic field disturbances

TEST	METHOD	CLASS	SEVERITY
Radiated electromagnetic field disturbance	IEC 61000-4-3 IEC 60255-26	3	30 V/m (15 V/m for talky-walky frequencies)

Immunity tests against recurrent fast transient

TEST	METHOD	CLASS	SEVERITY
Electrical fast transient burst	IEC 61000-4-4	4	4 kV (supply) 4 kV (input/output) 4 kV (communication)

1 MHz damped oscillatory wave tests

TEST	METHOD	CLASS	SEVERITY
1 MHz damped oscillatory wave	IEC 60255-26	3	2.5 kV CM (supply) 2.5 kV (input/output) 2.5 kV (communication)

Electrostatic discharge

TEST	METHOD	CLASS	SEVERITY
Electrostatic discharge	IEC 61000-4-2 IEC 60255-26	4	15 kV contact

Mechanical shock

TEST	METHOD	CLASS	SEVERITY
Semi-sinusoidal shock in operation	IEC 60068-2-27	-	15 g / 11 ms 1 shock per sense and per axe

Fast transient tests for measuring relays with single input

TEST	METHOD	CLASS	SEVERITY
Fast transient disturbance test	IEC 60255-3	3	2.5 kV CM (supply) 2.5 kV (input/output) 2.5 kV (communication)

Vibrations

TEST	METHOD	CLASS	SEVERITY
Sinusoidal vibrations (in operation)	IEC 60068-2-6		10 to 55 Hz / 0.15 mm or 2 gn 2 hours per axe

1.3.1.3 Ventilation

The specified equipment shall be able to operate in normal continuous service without forced ventilation under the following environmental conditions. In order to increase the reliability a forced ventilation shall be included. In case of a failure of the forced ventilation equipment, an alarm shall be sent to the substation control unit.

The formation of condensed water on the circuit boards, modules, covering and in general in the apparatus shall be avoided.

All equipment covered by this specification shall be selected and especially treated, as required, for used in a tropical climate and for protection against fungus growth and corrosion during shipment and storage.

1.3.2 Physical Environment and Service Conditions

All SCPS equipment shall be housed in dust proof and water proof housing cabinet to IEC 60529, protection class IP50 or better for indoor, and protection class IP65 for outdoor, but shall be adequately ventilated to prevent damage to any component when exposed to high ambient temperatures.

All measures shall be taken to prevent the ingress of moisture and the occurrence of corrosion on any part of the control equipment.

The SCPS and associated supporting equipment shall be suitable for rated operation at elevations up to 1,000 meters above sea level.

Ambient conditions will depend on where the device is installed (indoors or outdoors), as stated in the following sub-clauses.

1.3.2.1 Outdoor Devices

All MUs & Smart I/Os (Merging Units and Smart I/Os) plus their power supply modules and all supporting LAN plus all necessary connectors, extenders, terminators and LAN assembly devices shall be classed as SCPS outdoor devices.

The proposed SCPS outdoor devices shall be suitable for continuous operation in Thailand's tropical monsoon climate and shall also be subject to severe thunderstorms, heavy industrial pollution and high levels of airborne dust.

The proposed SCPS outdoor devices shall be conformally coated to meet the specified climatic conditions (Class C2 in accordance with IEC 60870-2-2 and class 3K7 in accordance with IEC 60721), and shall have been type tested for continuous operation over the following environmental conditions:

- Temperature : -10°C to +70°C (test with IEC 60068-2-1, 60068-2-2, 60068-2-3 and 60068-2-14)
- Temperature Gradient : Up to 30°C (test with IEC 60068-2-1, 60068-2-2, 60068-2-3 and 60068-2-14)
- Relative Humidity : Up to 95% at 40°C (test with IEC 60068-2-30 and 60068-2-38)
- Cyclic Damp Heat : +40°C to +25°C at 95% Relative Humidity (test with IEC 60068-2-30 and 60068-2-38)

- Absolute Humidity : Up to 29 g/m^3 (test with IEC 60068-2-30 and 60068-2-38)
- Vibration (sinusoidal) : 2 g acceleration 9 to 350 Hz (test with IEC 60068-2-6)
- Shock : 15 g 11 ms (test with IEC 60068-2-27)

The above referenced type tests shall be carried out by suitably accredited test laboratories, which are independent of the bidder and SCPS manufacturer. The certified copies of test certificates and test results shall be included as part of the bidder's proposal. Failure to conform to this requirement shall be constitute for rejection of the bidder's proposal.

1.3.2.2 Indoor Devices

The SCPS Systems, IED relay, BCU, IED device and Local User Interface (HMI) plus their power supplies and all supporting equipment shall be classed as SCPS indoor devices.

Indoor devices, in air-conditioned rooms, shall be suitable for continuous operation over the following environmental conditions:

- Operating Temperature : between 20°C and 27°C.
- Relative humidity : between 40% and 60%.

Malfunctioning of air conditioning equipment may cause the temperature to increase to 40°C with humidity up to 95%. Therefore, indoor devices shall be suitable for operation under these conditions for a continuous period of up to 24 hours. So, the same IEC standards as mentioned in the previous chapter (outdoor devices), shall be also the standards for indoor devices.

1.3.3 Electromagnetic Environmental Precautions

The correct operation of the substation control system and protection equipment shall not be limited or restricted by environmental influences. Therefore the substation control system and protection equipment shall be designed to withstand the influence of:

1) Switching operations in primary circuits
2) Lightning stroke in HV line
3) Lightning stroke in grounded component
4) Switching operations in secondary circuits
5) Faults occurring within or near the substation producing ground currents and ground potential rise
6) Radio interferences produced by hand-held walkie-talkie type radio communication equipment (P = 2 Watt) in the frequency range 80/160/460 MHz at 30 cm distance

The measures to be taken to reduce EMI (electromagnetic interferences) are listed below:

1.3.3.1 Primary circuits

Most of the measures listed below are necessary to protect HV equipment but they have also a beneficial effect on interference to secondary circuits.

1) Protection against lightning strokes
2) Protection by lightning arrests
3) Configuration of earthing systems
4) Use of VT and CT with acceptable transient response

1.3.3.2 Secondary circuits

In secondary circuits the following measures shall be at least adopted to reduce EMI.

1) Separation of the various circuits connected with devices having different degrees of interference level (power supplies, input and output network circuits, earth connections).
2) Galvanic separation of the I/O signal circuits and of the auxiliary supply circuit lines with isolating relays, optodiodes, transformers, coupling condensers.
3) Screens of the cables from switch bays shall not be laid to adjacent unshielded circuits.

Further following measures are to be taken in the installation:

1) Separation (spacing out or different routes) of power circuits (e.g. AC power supply cables) from control cables.
2) Separate cabling of the low frequency and high frequency circuits
3) Earthing connection of equipment shall be kept as short as possible and generally separated from the cables. For HV equipment at least two connections are necessary.
4) Increasing density of the earthing mat meshes where the occurrence of high transient current is more likely (lightning arresters, spark gaps, VT and CT).
5) Impedance between equipment (VT and CT etc.) and the earth network shall be as low as possible.
6) Cable route shall run as far as possible from and not parallel to busbars or power cables.
7) The forward and return conductor of the same circuit shall run in the same cable.
8) Twisted pairs or quad cables shall be adopted whenever possible (i.e. low current circuits and data lines).
9) Screened cables shall run as close together as possible.
10) DC auxiliary supply cables shall be laid in a radial configuration better than a ring.
11) Screen of perfectly homogeneous with low resistance, protected of the external high frequency electric and magnetic field for the cables shall be provided.
12) Screen of the cables shall have low coupling impedance within the interference frequency range.
13) Earthing of the screen shall have very low impedance with adequate section minimum length and optimum contact arrangements.

1.3.4 Immunity to Electrical Stress and Disturbance

The electrical and electronic components of the proposed SCPS shall satisfy the requirements for insulation, isolation, and immunity from electromagnetic interference, radiated disturbance and electrostatic discharge stated in the following sub-clauses 1.3.4.1 and 1.3.4.2. The ability to meet these requirements shall be verified by type tests.

These type tests shall be carried out by, or witnessed by, suitably accredited test laboratories, which are independent of the bidder and SCPS manufacturer. The certified copies of test certificates and test results shall be included as part of the bidder's proposal. Failure to conform to this requirement shall constitute grounds for rejection of the bidder's proposal.

1.3.4.1 Minimum Insulation of Equipment

The following definitions of classes of exposure to electrical interference shall be used in interpreting the insulation requirements of all SCPS equipment, including wiring:

Exposed Equipment:

"Exposed" equipment terminals may be interconnected without special protection of the insulation. Equipment terminals shall be considered "Exposed" when they directly connected to:

1) Current or voltage transformer secondary circuits.
2) Substation 125 V DC battery supplies.
3) Conductor longer than 100 meters within the substation.
4) Substation 125 V DC supplies.

Controlled Exposure Equipment:

"Controlled Exposure" equipment terminals may be interconnected when special conditions are met. Equipment terminals shall be considered "Controlled Exposure" terminals when all of the following criteria are met:

1) The rated voltage of the associated circuit does not exceed 32 V AC or 48 V DC.
2) Direct galvanic connections to exposed equipment terminals are made using a suitable barrier device which has the isolation ratings required for exposed equipment.
3) Terminals are galvanically connected to circuits which less than 100 meters in length and are themselves isolated from other components in a way that meets the requirements of exposed equipment.

The SCPS equipment shall meet or exceed the insulation requirements shown in Table 1.1:

Table 1.1 – MINIMUM INSULATION REQUIREMENTS

Requirements	Test Standard	Specified Details	
		Exposed Equipment	Controlled Exposure Equipment
Rated Insulation Voltage	IEC 60255-5 Table I	500 V	60 V
Dielectric Test Voltage	IEC 60255-5 Table I Series B (Clause 6)	2.0 kV r.m.s.	1.0 kV r.m.s.
Insulation Resistance Test	IEC 60255-5 (Clause 7)	Required	Required
Impulse Voltage Test	IEC 60255-5 (Clause 8)	5 kV, 1.2/50 µs 0.5 J	5 kV, 1.2/50 µs 0.5 J

1.3.4.2 Immunity from Electromagnetic Interference, Radiated Disturbance and Electrostatic Discharge

The SCPS shall be designed for safe operation in the harsh environment of a high voltage substation and shall conform to the immunity, susceptibility and interference requirements shown in Table 1.2:

Data communication ports shall be demonstrated to withstand disturbance test without permanent corruption of data, and subsequent delay of data transfer.

Table 1.2 – IMMUNITY, SUSCEPTIBILITY AND INTERFERENCE REQUIREMENTS

Requirements	Test Standard	Class or Level	Specified Details
High Voltage Impulse	IEC 60060-1		5 kV, 0.5 J
Electrical Disturbances (1 MHz Burst)	IEC 60255-22-1 IEC 60255-22-1	Class 3 Class 3	2.5 kV CM 1.0 kV DM
Electrostatic Discharge Immunity	IEC 61000-4-2 IEC 61000-4-2	Level 3 Level 4	8 kV air 8 kV direct
Radiated Immunity	IEC 61000-4-3 IEC 60255-22-3 IEC 61000-4-3 ENV 50204 (GSM)	Level 3 Class 3 Class 3 Level 3	80 MHz – 1 GHz 27 – 500 MHz 50 KHz – 1 GHz 10 V/m 2W at 0.6 m
Fast Transient/Burst Immunity	IEC 61000-4-4 IEC 60255-22-4 ANSI/IEEE C37.90.1	Level 4 Class 4 -	4 kV 4 kV 4 – 5 kV
Surge Immunity	IEC 61000-4-5	Level 4	2 kV / 4 kV
Conducted Immunity	IEC 61000-4-6	Level 3	10 V

Requirements	Test Standard	Class or Level	Specified Details
Harmonics Emissions	IEC 61000-4-7	-	Required for ac powered systems
Power Frequency Magnetic Field Immunity	IEC 61000-4-8	Level 4	30 A/m
Pulse Magnetic Field Immunity	IEC 61000-4-9	Level 5	1000 A/m
Damped Oscillatory Magnetic Field Immunity	IEC 61000-4-10	Level 4	30 A/m
Oscillatory Transient Immunity	IEC 61000-4-12 IEC 61000-4-12 ANSI/IEEE C37.90.1	Level 4 Level 3 -	Ring Wave Damped Oscillatory 2.5 kV

2. REFERENCE STANDARDS

2.1 MAIN REFERENCE STANDARDS

The main International standards used as reference are:

1) IEC 60529: Degree of Protection Provided by Enclosures
2) IEC 61000 series: Basic Electro Magnetic Compatibility (EMC) Publications
3) IEC 61850 series, Edition 2: Communication Networks and Systems in Substations
4) IEC 62351: Power System Control and Associated Communications – Data and Communication Security
5) ISO 9000 series: Effective Quality Assurance System
6) CISPR (International Special Committee on Radio Interference) series

Refer to Clause 2.2, for complete list of the relevant International Standards. Where the contents of the relevant international standard conflicts with these specifications, the requirements of these specifications shall take precedence. For the purpose of this specification, the terms, definitions and abbreviations given in IEC 61850-2 and other parts of IEC 61850 apply.

All equipment, materials, fabrication and testing under this Specification shall conform to the latest applicable standard specifications and codes contained in the following list, or to equivalent applicable standard specifications and codes established and approved in the country of manufacturer of the equipment. Where standards are mentioned by name, equivalent applicable standards may be used.

2.2 SPECIFIC RELEVANT STANDARDS

The following are specific standards with special relevance to this technical specification. Conformance with their content shall receive especially close scrutiny. The Contractor shall ensure that the delivered systems comply with the requirements of these standards, as conditioned by the specific requirements of this technical specification.

CISPR 11	:	Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement
CISPR 14	:	Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus
DIN VDE 0888-3	:	Optical fibre cables for communication systems – Part 3: Outdoor cables
IEC 27032	:	Information technology – Security techniques – Guidelines for cyber security.
IEC 60044-8	:	Instrument transformers – Part 8: Electronic current transformers
IEC 60060-1	:	High-voltage test techniques – Part 1: General definitions and test requirements
IEC 60068-2-1	:	Environmental testing – Part 2-1: Tests – Tests A: Cold
IEC 60068-2-2	:	Environmental testing – Part 2-2: Tests – Tests B: Dry heat
IEC 60068-2-6	:	Environmental testing – Part 2-6: Tests – Tests Fc: Vibration (sinusoidal)
IEC 60068-2-27	:	Environmental testing – Part 2-27: Tests – Tests Ea and guidance: Shock
IEC 60068-2-78	:	Environmental testing – Part 2-78: Tests – Tests Cab: Damp heat, steady state
IEC 60255-3	:	Electrical relays – Part 3: Single input energizing quantity measuring relays with dependent or independent time
IEC 60255-26	:	Measuring relays and protection equipment – Part 26: Electromagnetic compatibility requirements
IEC 60255-27	:	Measuring relays and protection equipment – Part 27: Product safety requirements
IEC 60359	:	Electrical and electronic measurement equipment – Expression of performance
IEC 60529	:	Degrees of protection provided by enclosures (IP Code)
IEC 60721	:	Classification of environmental conditions
IEC 60793-2-10	:	Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres
IEC 60794-1-1	:	Optical fibre cables – Part 1-1: Generic specification – General
IEC 60870-2-1	:	Telecontrol Equipment and Systems – Part 2: Operating Conditions – Section 1: Power Supply and Electromagnetic Compatibility
IEC 60870-2-2	:	Telecontrol Equipment and Systems – Part 2: Operating Conditions – Section 2: Environmental Conditions (Climatic, Mechanical, and other Non-Electrical Influences)
IEC 60870-3	:	Telecontrol Equipment and Systems – Part 3: Interfaces (Electrical Characteristics). This standard addresses interfaces between telecontrol equipment and the following: (1) process equipment (i.e. field I/O points), (2)

		operator equipment, (3) communication subsystems, and (4) other data processing equipment.
IEC 60870-4	:	Telecontrol Equipment and Systems – Part 4: Performance Requirements. This document shall be used as the project planning reference for addressing reliability, availability, maintainability, security, time parameters affecting performance, and overall accuracy of the delivered systems. Although written for telecontrol systems using serial communications lines, the broad content of this document applies to the systems to be delivered under this technical specification. If any aspects of this document's content are contraindicated by IEC 61850, the latter shall prevail in those instances.
IEC 60874-10-1	:	Connectors for optical fibres and cables – Part 10-1: Detail specification for fibre optic connector type BFOC/2.5 terminated to multimode fibre type A1
IEC 60874-10-2	:	Connectors for optical fibres and cables – Part 10-2: Detail specification for fibre optic connector type BFOC/2.5 terminated to single-mode fibre type B1
IEC 60874-10-3	:	Connectors for optical fibres and cables – Part 10-3: Detail specification for fibre optic adaptor type BFOC/2.5 for single and multimode fibre
IEC 60947-1	:	Low-voltage switchgear and control gear – Part 1: General rules
IEC 60947-7-1	:	Low-voltage switchgear and control gear – Part 7-1: Ancillary equipment – Terminal blocks for copper conductors
IEC 61000-4-2	:	Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test
IEC 61000-4-3	:	Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test
IEC 61000-4-4	:	Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test, Basic EMC Publication
IEC 61000-4-5	:	Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test
IEC 61588	:	Precision clock synchronization protocol for networked measurement and control systems.
IEC 61010-1	:	Safety Requirements for Electrical Equipment for measurement, Control, and Laboratory Use: General Requirements.
IEC 61346	:	Industrial systems, Installations and Equipment and Industrial Products – Structuring Principles and Reference Designations
IEC 62351	:	Security
IEC 62439	:	Standard Redundancy in Industrial Ethernet
IEEE 1588	:	IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems

IEEE 1613	:	IEEE standard for communications networking devices in electric power substations
IEEE 1615	:	IEEE Recommended Practice for Network Communication in Electric Power Substations
IEEE 802.1	:	IEEE Standard for Bridging and Management
IEEE 802.3	:	IEEE Standard for Ethernet
IEEE C37.1-1994	:	Definition, Specification, and Analysis of Systems used for Supervisory Control, Data Acquisition, and Automatic Control. This standard shall be applied to any implementation involving field connections for I/O points, such as BCU field circuits. It overlaps IEC standards 60870-2-1, 60870-2-2, and 60870-3, but addresses issues that the IEC standards may not address as well [e.g. common mode voltage standoff for analog input signal processing, rejection of normal and common mode voltages in analog input signal processing, rejection of false status changes, time-tagging precision and time of application, change of status monitoring, and change validation (i.e. digital signal filtering)].
IEEE C37.2	:	IEEE Standard Electrical Power System Device Function Numbers and Contact Designations
IEEE C37.90.1-2002	:	IEEE Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
IEEE C37.90.2-2004	:	IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
IEEE C37.111-1999	:	Common Format for Transient Data Exchange (COMTRADE) for Power Systems.
IEEE C37.115-2003	:	Test Method for Use in the Evaluation of Message Communications between IEDs in an Integrated Substation Protection, Control, and Data Acquisition System.
IETF – RFC 542	:	FTP standard.
ISO 9001	:	Quality management systems – Requirements
ISO 9506	:	Industrial automation systems, Manufacturing Message Specification
ISO/IEC 8649	:	Information technology, Open Systems Interconnection, Service definition for the Association Control Service Element
ISO/IEC 8802-3	:	Standard for Ethernet
ISO/IEC 8822	:	Information technology – Open Systems Interconnection – Presentation service definition
ISO/IEC 8824-1	:	Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation
ISO/IEC 8326	:	Information technology – Open Systems Interconnection – Session service definition

ISO/IEC 8650	:	Information technology – Open Systems Interconnection – Connection-oriented protocol for the Association Control Service Element: Protocol specification
ISO/IEC 8823-1	:	Information technology – Open Systems Interconnection – Connection-oriented presentation protocol: Protocol specification
ISO/IEC 8825-1	:	Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)
ISO/IEC 8327-1	:	Information technology – Open Systems Interconnection – Connection-oriented Session protocol: Protocol specification
ITU-T G.821	:	Error performance of an international digital connection operating at a bit rate below the primary rate and forming part of an Integrated Services Digital Network
SFF-8472	:	Specification for Diagnostic Monitoring Interface for Optical Transceivers

In all cases, the provisions of the latest current edition or revision of the applicable standards or codes in effect shall apply. Any details not specifically covered by these standards shall be subject to the approval of PEA. In the event of contradictory requirements between such standards and this Specification, the terms of the Specification shall govern.

3. ABBREVIATION

The abbreviations or acronyms given in IEC 61850-2 and other parts of IEC 61850 apply.

Table 3.1 – Abbreviations or Acronyms

Term	Explanation / Description
ACSI	Abstract Communication Service Interface
ADDC	Area Distribution Dispatching Centre – one of the 12 regional dispatching centres operated by PEA
AIS	Air Insulated Switchgear
AR	Auto-Reclose
BCU	Bay Control Unit
BLOB	Binary Large OBject (BLOB) is a collection of binary data stored as a single entity in a database management system.
CB	Circuit Breaker
CDC	Common Data Class
CID	Configured IED Description: Each device has one and it is generated by the device manufacturer in accordance with the related configuration of the current IED in the SCD document. For more information not covered by the Glossary, shall be followed by IEC 61850 Standard.

Term	Explanation / Description
Client	Entity that requests a service from a server, or which receives unrequested data from a server
CT	Current Transformer
COP	Code of Practice
DA	Data Attributes
DAC	Data Acquisition and Control
SCADA/DMS	Distribution Management System or Application with distribution system automation functions for electrical power distribution.
DED	Data Exchange Diagram
DO	Data Object
DR	Disturbance Recorder
ECT	Electronic Current Transformer: An electronic instrument transformer whose output of secondary converter is essentially in direct proportion to primary current in normal applicable conditions and phase difference is close to the known phase angle when connecting direction is correct.
EPROM	Erasable Programmable Read Only Memory
EMC	Electromagnetic Compatibility
ECVT	Electronic Current & Voltage Transformer: An electronic instrument transformer consists of electronic current transformer and electronic voltage transformer.
EVT	Electronic Voltage Transformer: An electronic instrument transformer whose secondary voltage is essentially in direct proportion to primary voltage in normal applicable conditions and phase difference is close to the known phase angle when connecting direction is correct.
EW	Engineering Workstation
FC	Functional Constraints
FR	Fault Recorder
FTP	File Transfer Protocol
GOOSE	Generic Object Oriented Substation Event: GOOSE is a generic object oriented substation event. It is mainly used to realize information transfer between multiple IEDs, including transmission of trip and closing signal (command), and has a high probability of transmission success.
GPS	Global Position System
GSE	Generic Substation Event
GSSE	Generic Substation Status Event

Term	Explanation / Description
HMI/SCPS-Server	Human Machine Interface/SCPS-Server: It is the IEC 61850 client who gathers information from various IED devices and enables the operator to supervise and have local or remote control. Include OPC-Server. HMI/SCPS-Server unit has an OPC data server, which provides the OPC interfaces for data clients in real-time, complying with the specifications defined by the OPC Foundation. With this feature other applications can access the HMI/SCPS-Server data base using the OPC standard.
HV	High Voltage
IDMT	Inverse Definite Minimum Time
ICD	IED Capability Description. This document is provided by the device manufacturer to the system integrator and describes the basic data model and service provided by IED but does not include IED instance name and communication parameter.
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device: A device that contains one or more processors, can receive data from external sources or send data to the outside or is used for control, e.g. electronic multifunction instrument, digital protection, controller etc. It is a device that has one or more particular logic node behaviours in a particular environment and is controlled by its interface.
I/O	Input/Output
IRIG-B	Inter-Range Instrumentation Group - B
ISO	International Standardisation Organisation
kV	kiloVolt
LAN	Local Area Network: Communication network which usually covers the area within a building or within a set of residential/industrial/commercial buildings. In the context of this document, it is the area within the substation.
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LD	Logical Device
LN	Logical Node
LV	Low Voltage
ms	millisecond
MICS	Model Implementation Conformance Statement

Term	Explanation / Description
MMS	Manufacturing Message Specification: is manufacturing message specification and it is a set of communication protocols defined in ISO/IEC9506 and used for industrial control system. MMS specifies the communication behaviours of intelligent sensor, intelligent electronic device (IED) and intelligent control equipment that have communication capability in the industrial field and enables the equipment of different manufacturers to have interoperation.
MU	Merging unit: A physical unit used for time-dependent combination of current and/or voltage data from secondary converter. A merging unit can be a component part of the CT or VT transformer or a separate unit.
Multicast	Unidirectional, connectionless communication between a server and a selected set of clients, usually used for Goose messages.
MV	Medium Voltage
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
NTP	Network Time Protocol
OEM	Original Equipment Manufacturer
OLE	Object Linking and Embedding
OPC	OLE for Process Control is a communication standard in the process control and monitoring field. This standard allows different sources to send data to one OPC server, to which you can connect several different programs that are compatible with this standard.
OSI	Open System Interconnection
PC	Personal Computer
PLC	Programmable Logic Controller
PICS	Protocol Implementation Conformance Statement
PICOM	Pieces of Information for Communication
PIXIT	Protocol Implementation Extra Information for Testing
PSB	Power Swing Blocking
PTP	Precision Time Protocol is a IEEE 1588TM Standard for A Precision Clock Synchronization Protocol for Networked Measurement and Control Systems
RAM	Random Access Memory
ROM	Read Only Memory
SAS	Substation Automation System
SBO	Select Before Operate
SCD	Substation Configuration Description
SCL	Substation Configuration Language

Term	Explanation / Description
SCADA	Supervisory, Control and Data Acquisition
SCSM	Specific Communication Service Mapping
SIMS	Substation Interrogation and Monitoring Systems
SNMP	Simple Network Management Protocol. Protocol to manage Ethernet networks.
SCPS	Substation Control and Protection System
SSD	System Specification Description: It should be the only one in the total station and this document describes the primary system structure of the substation and the related logic nodes and is eventually included in SCD document.
ST	Straight Tip / Bayonet Fibre Optic Connector in accordance with IEC 61754-2
SV	Sample Value
TCP/IP	Transmission Control Protocol/Internet Protocol
PEA	Provincial Electricity Authority
UCA	Utility Communication Protocol (What does A stand for??)
UDP	User Datagram Protocol
V	Voltage
VLAN	Virtual Local Area Network
VT	Voltage Transformer
VTS	Voltage Transformer Supervision
WAN	Wide Area Network
XML	EXtensible Mark-up Language.

*Servers: On a communication network, functionality of the IEDs that provides data or that allows access to its resources by other IEDs acting as clients.

4. CONTROL AND PROTECTION SYSTEM FUNCTIONAL REQUIREMENTS

4.1 GENERAL REQUIREMENTS

The SCPS shall be designed based on the required substation functionality and the following system requirements:

1) PEA operational philosophy
2) System average life time and life cycle
3) Substation environment such as EMC, etc.
4) System performance
5) Operation and maintenance (maintainability)
6) Operational and system safety
7) System configurations

A warranty period shall be at least 10 years long for Relay, and at least 2 years long for SCPS.

4.1.1 System Average Life Time and Life Cycle

The SCPS shall be designed for an expected average life time of at least 15 years. The IED shall be designed for an expected average life time of at least 20 years. The followings shall be considered for the system design:

1) Overall life expectancy of the system including life expectancy of critical parts and system components. The life expectancy is based on the parts with the shortest life expectancy.
2) Mean Time Between Failure (MTBF) and Mean Time To Repair (MTTR) figures shall be provided by the Contractor for all system parts and components. The Contractor shall provide PEA a letter from the manufacturers of these system parts and components confirming the values of MTBF and MTTR provided to PEA.
3) The Contractor shall state the expectancy support for spare parts. Availability of these parts shall be guaranteed for a period of no less than ten (10) years from the date of the latest delivery of equipment containing these parts or assemblies. The Contractor shall commit to notifying PEA at least six (6) months in advance of any part or assembly becoming unavailable for purchase, in order to enable PEA to stock up on that item.
4) The Contractor shall give an opinion on the probable technological exit or obsolescence of components and systems.

4.1.2 Substation Environment

The SCPS shall be designed to withstand harsh operational HV substation environment. All IEDs shall be certified by an independent competent entity and type tested as protection grade devices. Unless specified otherwise, all station clients shall be certified and type tested as industrial grade equipment.

The following is the summary of the required electrical technological conformance and mechanical requirements for substation environment considerations:

Table 4.1 – Substation Environment

System Requirements	Type of Test
Mechanical Stress (Vibration and shock)	Vibration Test
	Shock and bump test
	Seismic Test
Insulation	High Voltage Test and Impulse Voltage Tests
Electromagnetic Compatibility – Immunity	Damped oscillatory wave test
	Fast transient test
	Surge Test
	Conducted radio interference test
	Electrostatic discharge test
	Variations and interruptions in AC and DC auxiliary voltage
	Electromagnetic fields
	50Hz power frequency magnetic fields
Electromagnetic Compatibility – Noise Emission	Conducted RF interference on power supply terminals and radiated interference. Harmonics for AC supply
	Flicker

All the equipment shall be suitable for use in tropical climatic area and shall be capable of operating at its full ratings under site and service conditions as specified in clause 4.1 of Specification No.: RSUB-001 – GENERAL TECHNICAL SPECIFICATION.

4.1.3 System Performance

The SCPS shall be designed such that system performance, including system availability and system reliability set forth in Clause 4.3 is satisfied.

4.1.4 Operation and Maintenance (Maintainability)

The SCPS shall be designed such that system maintainability, including future extension and upgrade, system flexibility, system scalability, and substation access control and cyber security measure, which are described further in Chapter 11, is satisfied.

4.1.5 Operational and System Safety

The SCPS shall be designed so that it is compliant with PEA safety rules and other safety standards, such as IEC 61010-1. Hence, safety of personnel, plants and equipment is fully and highly aware of.

4.1.6 System Configurations

The SCPS shall be designed by taking into account the following important implementation issues which are described further in details in Annex 1 Control and Protection System Configurations.

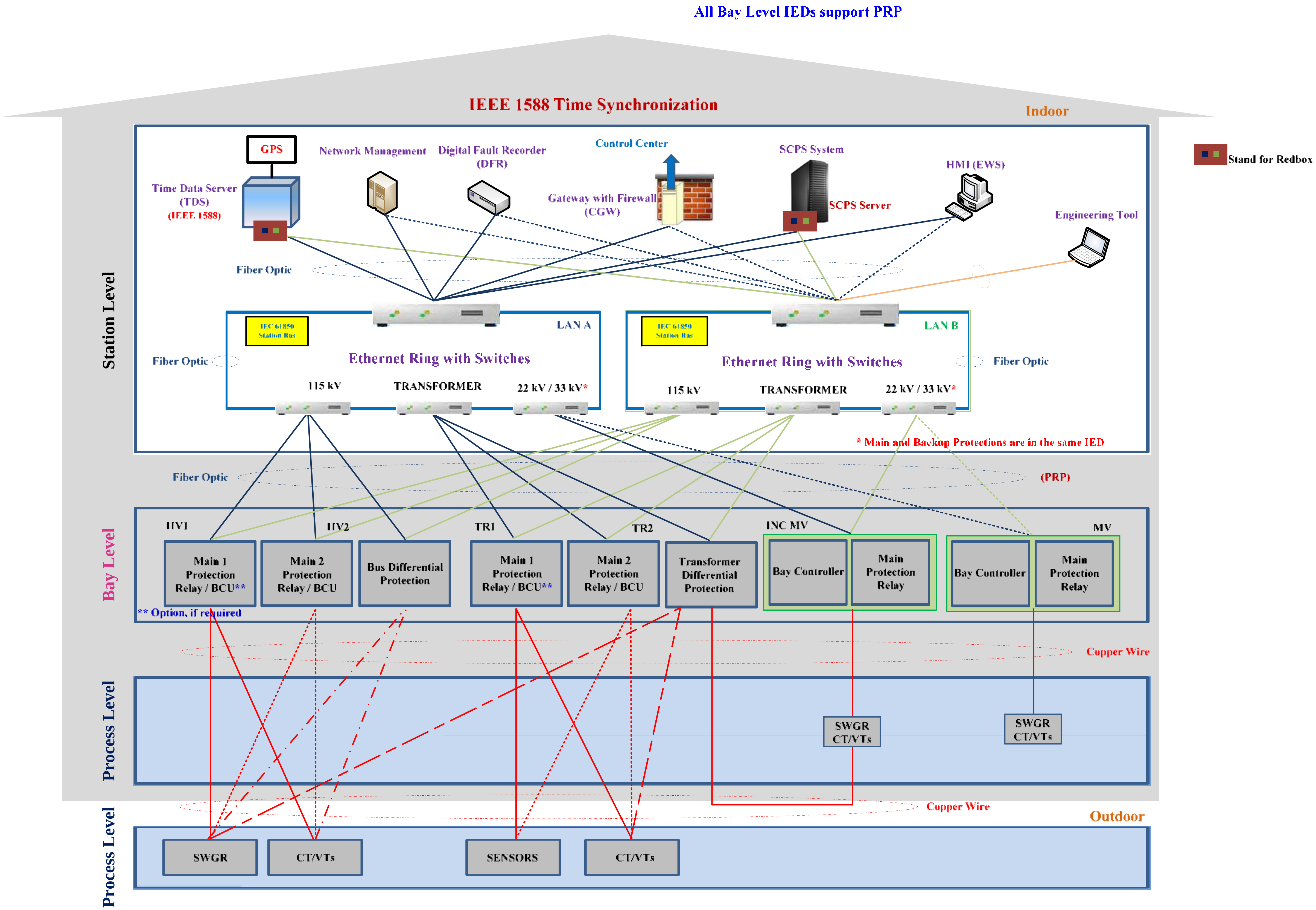
4.2 SYSTEM HIERARCHICAL STRUCTURE

The system architecture shall be configured based on multi-tier hierarchical structure. The multi-tier hierarchical structure levels as a minimum for the SCPS are:

1) Level 1 – Station Level
2) Level 2 – Bay Level
3) Level 3 – Process Level or Physical Device Level

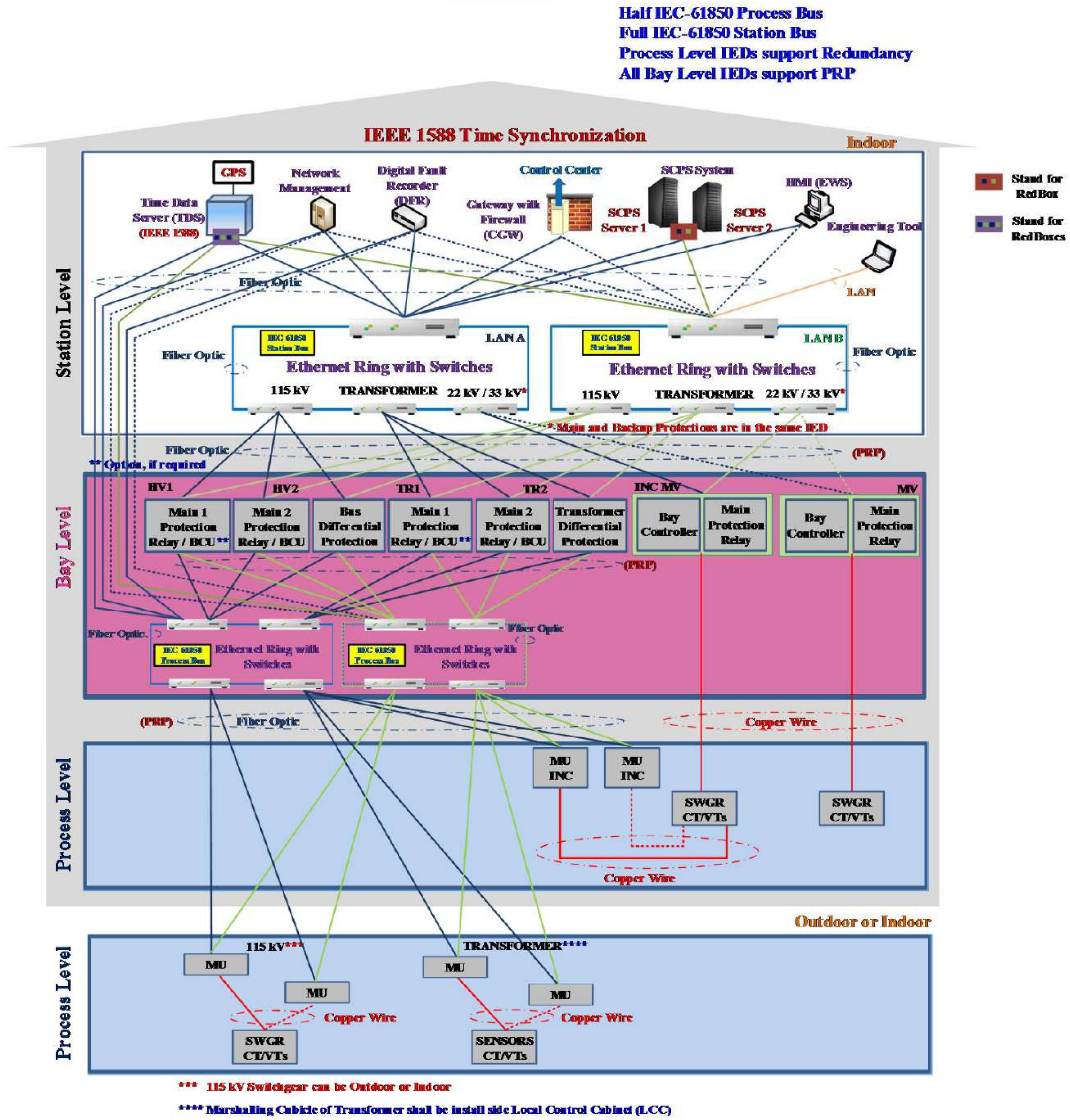
As shown in figure 4.1 below. Figure 4.1 shows the conceptual system architectures for 3 scenarios. The 3 conceptual topologies are designed to cover a wide range of possible use cases. The most suitable topology will be selected on a case by case basis for specific substation by PEA. Bidders shall be able to propose a solution, e.g., using a redundant box (Redbox), so that the systems are connected and functioning as required. When a Redbox is used with a relay, due to hardware or speed issues with massive SV traffic, a relay shall be connected to a station-level side, not to a process-level side. Bidders shall propose their solution(s) for PEA consideration. Dot lines represent redundant parts; redundant equipment should be on different source of power supply from main equipment. Please note that fiber optics are preferable to copper wires, and, hence, shall be used whenever applicable in a connection between the switch yard and control room of substation. Please see Clause 7.14 Redundancy for requirements on Redundancy.

Topology 1


All Bay Level IEDs support PRP
IEEE 1588 Time Synchronization
Indoor
Stand for Redbox
Station Level
GPS
Time Data Server
(TDS)
(IEEE 1588)
Network Management
Digital Fault Recorder
(DFR)
Control Center
Gateway with Firewall
(CGW)
SCPS System
SCPS Server
HMI (EWS)
Engineering Tool
Fiber Optic
IEC 61850
Station Bus
LAN A
LAN B
Ethernet Ring with Switches
115 kV
TRANSFORMER
22 kV / 33 kV*
* Main and Backup Protections are in the same IED
(PRP)
Bay Level
HV1
HV2
TR1
TR2
INC MV
MV
Main 1 Protection Relay / BCU**
Main 2 Protection Relay / BCU
Bus Differential Protection
Transformer Differential Protection
Bay Controller
Main Protection Relay
** Option, if required
Copper Wire
Process Level
SWGR CT/VTs
Outdoor
SWGR
CT/VTs
SENSORS

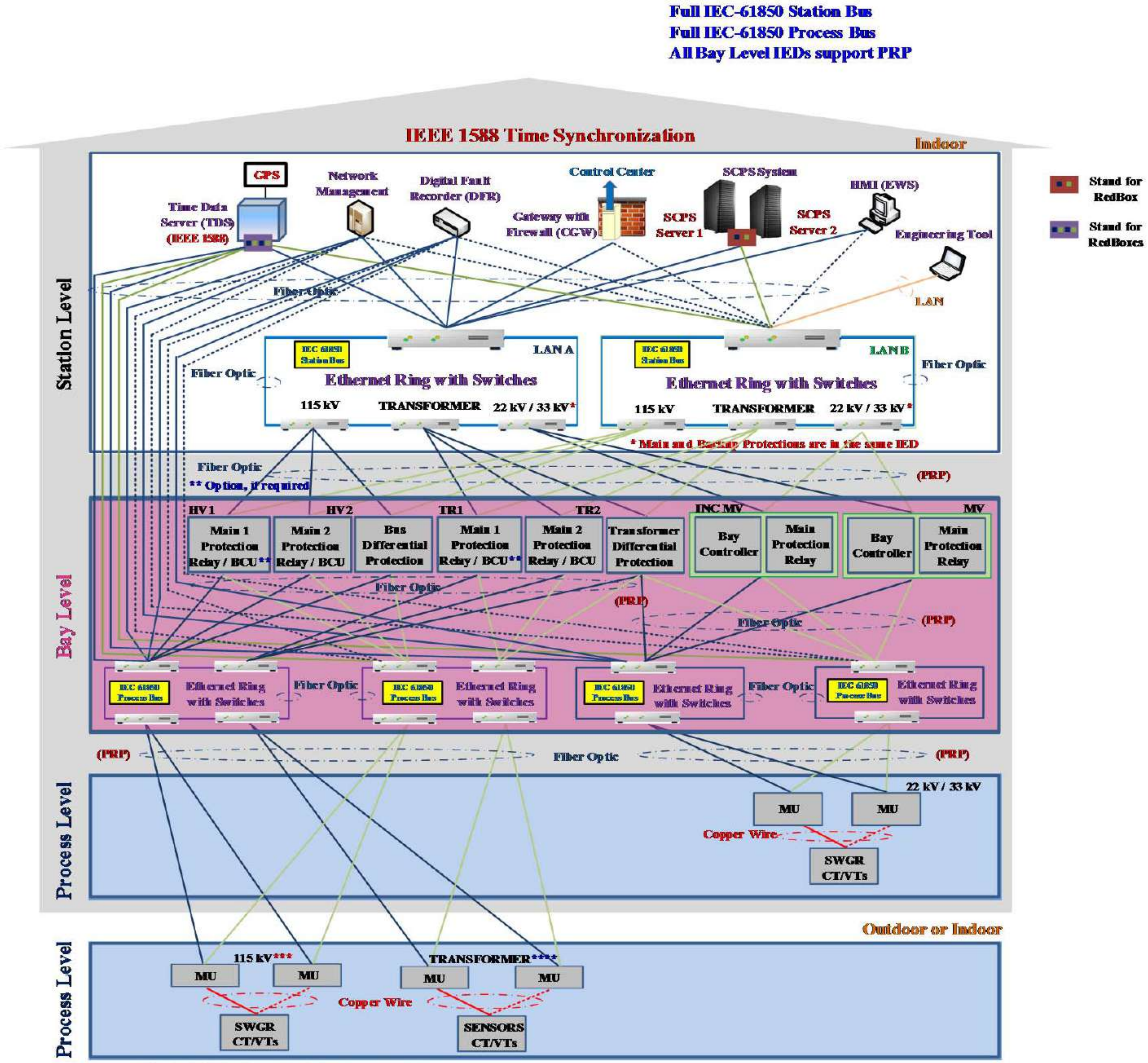
(a)

Topology 2


Half IEC-61850 Process Bus
Full IEC-61850 Station Bus
Process Level IEDs support Redundancy
All Bay Level IEDs support PRP
IEEE 1588 Time Synchronization
Indoor
Station Level
Bay Level
Process Level
GPS
Time Data Server (TDS) (IEEE 1588)
Network Management
Digital Fault Recorder (DFR)
Gateway with Firewall (GCW)
Control Center
SCPS System
SCPS Server 1
SCPS Server 2
HMI (EWS)
Engineering Tool
LAN
Fiber Optic
LAN A
LAN B
Ethernet Ring with Switches
115 kV
TRANSFORMER
22 kV / 33 kV*
* Main and Backup Protections are in the same IED
(PRP)
** Option, if required
HV1
HV2
TR1
TR2
INC MV
MV
Main 1 Protection Relay / BCU**
Main 2 Protection Relay / BCU
Bus Differential Protection
Transformer Differential Protection
Bay Controller
Main Protection Relay
Copper Wire
MU INC
SWGR CT/VTs
Outdoor or Indoor
115 kV***
TRANSFORMER****
MU
SENSORS CT/VTs
Stand for RedBox
Stand for RedBoxes
*** 115 kV Switchgear can be Outdoor or Indoor
**** Marshalling Cubicle of Transformer shall be install side Local Control Cabinet (LCC)

(b)

Topology 3



*** 115 kV Switchgear can be Outdoor or Indoor

**** Marshalling Cubicle of Transformer shall be install side Local Control Cabinet (LCC)

(c)

Figure 4.1 – Integrated SCPS Conceptual Architecture for when there is

(a) No Process Bus,

(b) Half IEC 61850 Process Bus (i.e., no process bus for 22/33 kV systems) and Full IEC 61850 Station Bus,

(c) Full IEC 61850 Process Bus and Full IEC 61850 Station Bus.

Connection and wiring should conform with these figures

Remarks:

1) Relay of 115 kV systems will be separated into Main 1 and Main 2 Relays. The mechanism control and protection of selecting either Main 1/BCU and or Main 2/BCU to perform the functions of control and protection, in case of commanding/controlling from SCADA center, shall be configured within the IEDs.
2) Smart I/O and MU can be separated, or be in the same unit.
3) An Engineering Workstation might have 1 connection port, but can interchangeably connect to main or redundant connection.
4) For topologies that require 2 SCPS-Server's, those SCPS-Server's shall work interchangeably. When one SCPS-Server did not function properly, the other SCPS-Server shall seamlessly function so that the systems are not disrupted.

Recommendation on network topology for each substation type is summarized as the following:

Substation Type	Recommended Network Topology or as shown on the drawings
1. Breaker and A-Half	Topology 1, 2 or 3
2. Double Bus Single Breaker	Topology 1, 2 or 3
3. H-Configuration	Topology 1, 2 or 3
4. Main and Transfer	Topology 1, 2 or 3
5. Double Main and Transfer	Topology 1, 2 or 3
6. Modular, Mobile and Tail End	Topology 1, 2 or 3
7. MV Switching	Topology 1

The Contractor shall provide IED servers, i.e. Bay Controller, at bay level to perform all allocated distributed functions of bay level functionality. A relay should support Process Bus; in case of a small relay, e.g., the one operating with 22 or 33 kV, that might not support Process Bus, the contractor should provide a plan and method on how to integrate this relay so that all the SCPS requirements are still satisfied.

IED servers at station level, i.e., SCPS Systems, shall perform allocated functions of station level functionalities. The system is basically composed of several bay terminals as required for each substation, usually working as communications servers and general purposes terminals working as client-server, for BCU and IED functionality, HMI (Human-Machine Interface), IEDs configuration manager, logics, etc. For the purpose of this specification, the process bus (IEC 61850-9-2, Latest Edition (LE)) shall be implemented.

The Contractor shall ensure that all client functions can be performed at station level. Station Human Machine Interface (HMI) or Station Level Operator Interface (SLOI) shall provide station-operator HMI functions to facilitate substation local control, monitoring, and handling of local alarms and events. The SCPS Systems could also serve the functions of the HMI. A Supervisory, Control and Data Acquisition (SCADA) gateway shall be provided to ensure secure information flow with the pertinent Area Distribution Dispatching Centre (ADDC).

Engineering workstation shall be provided to ensure secure information flow with the SCADA/DMS located at ADDC engineering offices. The station bus shall provide the communication network (IEC 61850), integration, data exchange and data flow between station-to-bay level and bay-to-bay level.

The highest operational control priority level for the SCPS is the closest to the process or apparatus level – Level 1. The control shall be permitted at only one level for an individual bay at any instance.

The SCPS shall undergo system acceptance testing before the system is accepted to be used in a PEA substation.

4.2.1 Station Level

The main characteristics of the station devices shall be;

1) multifunction IED
2) use of IED technology
3) IEDs conform with IEC 61850 standard
4) interface to user through device HMI and remote client such as Engineering Workstation integrated as part of SCPS through networked communication.
5) flexible applications and functions
6) capability to interoperate with other IEDs from several different manufacturers to exchange information and use the information for own functions
7) IEC 61850 server which provide rich source of IED information such as settings, configuration information, events, alarms, power system information, fault records, COMTRADE fault waveform files, etc.
    a. Station-level data management, data storage, and data retrieval mechanisms: include support for IEC 61850 information models, historical data, configuration data, diagnostic and maintenance data, and files (e.g. non-operational, configuration, application programs, software updates).
    b. Station-wide collection of maintenance data, diagnostic data, and statistical data for (1) primary system components, (2) secondary system components, and (3) application functions

8) self-monitoring and supervision
9) certified and type tested as protection grade device
10) enact programmable logic: any IED or other devices which can act as a programmable logical controller should be able to be programmed using methods stipulated in IEC 61131
11) powered from substation auxiliary DC system
12) interfaced to the station bus via hardened managed Ethernet Switch
13) failure not affecting other functions or bay level
14) Hardwired parallel connections to the primary equipment or apparatus (switchgears and instrument transformers). ("This part belongs to the Bay Level").

Local Repository and System Logs: The following data structures form the core of the SCPS system. They include six system logs that chronologically capture the stations operational history.

1) Local Repository

The Repository represents the present state of the station. It shall hold the IEC 61850-based information models for the primary system and secondary system components, including off-the-shelf and programmable logic applications.

The information stored in the Repository shall include real-time data and closely related support data (e.g. operational parameters, configuration parameters, text-based descriptions), as provided by the IEC 61850 information models. Repository data may include diagnostic and maintenance data if it is included in the IEC 61850 information models. Files are handled in special manner, which is explained under the File Management heading.

IEC 61850 provides information models for most of the available system data, and those models can be extended to include new components. Although it is not desirable for the Repository to store all data available in the station, it must at least include all data subscribed by station or enterprise clients. Operator Interface(s) [HMI] are examples of station clients; they need station data for displays, alarm lists, logs, and local control operations. Other station clients are devices that require data to perform automation. The results produced by automation application functions will need to be stored in the Repository if other clients subscribe them. SCADA/DMS, on the other hand, is an enterprise client. The Local Repository must have interfaces that are interoperable with all other system devices (i.e. servers and clients) using IEC 61850 communication services, information models, and object references.

Where PEA applications use Logical Node and/or Common Data Class extensions, these shall be supported in the Repository as well. The Repository shall be configured to support any and all data available from station servers, including the SCPS Systems themselves, subject only to any limitations stated under System Performance Requirements. The SCPS Systems shall implement all of IEC 61850's ASCI service models, with the following exceptions: GSSE Control Block and the Sampled Value Class Model. Clients and servers using the Repository shall find all of the other services available. The Repository must be maintained in a replaceable flash memory module. Battery power is an unacceptable approach to maintaining non-volatile data memory.

2) StatusLog

The StatusLog is a chronological record of recent changes in either primary or secondary system status, either commanded or uncommanded. In particular, it shall include an entry for any station component power-fail, power-on, restart, or change in on-line/off-line status. Power supply failures shall also be captured. The StatusLog shall not include control commands, although it shall include changes in status that result from those commands. The StatusLog shall not include configuration changes to parameters in the system information models. The StatusLog shall hold events for the most recent 100 records. It shall be backed up in archives, each archive containing events for a particular month.

All StatusLog entries shall include a time-stamp, identify the system item that changed, identify the new status, and identify the cause (or agent) of the change.

3) CommandLog

The CommandLog is a chronological record of recent control commands to station equipment (e.g. Trip, Close, Open, Close, Raise, Lower, Enable, Disable, and set-points) issued by System Clients. These may be initiated by a SCADA/DMS system, by a local HMI unit, or by off-the-shelf and programmable logic applications. The CommandLog shall hold commands issued during the most recent 100 days. It shall be backed up in archives, each archive containing control commands for a particular month. All CommandLog entries shall include a time-stamp, identify the system item being controlled, identify the state being commanded, and identify the source of the control command.

4) ChangeLog

The ChangeLog is a chronological record of recent changes made by an HMI unit to system and device configuration parameters. The ChangeLog shall hold changes issued during the most recent 100 days. It is backed up in archives, each archive containing changes for a particular month. All ChangeLog entries shall include a time-stamp, identify the system or IED parameter being changed, identify the new state, and identify the source (i.e. agent) of the change.

5) SubLog

The SubLog is a chronological record of changes made by clients using the IEC 61850 substitution services. The services allow clients to determine whether actual process values or substituted values are to be provided by a server IED or programmable application. The SubLog shall include all substitution events, including a return to process values, that have occured during the most recent 100 days.

6) FileLog

The FileLog is a chronological record of recent file transfers and file deletions involving any intelligent station device (e.g. BCU, SCPS Systems, HMI). The FileLog shall include all such file events that have occured during the most recent 100 days. It shall be backed up in archives, each archive containing file events for a particular month. All FileLog entries shall include a time-stamp, identify the file reference, identify the action taken, and identify the source (i.e. agent) of the action. The Local Repository is the basis for normal system operation. The five system logs save the system's recent operational history. They shall be used to bring a system client up-to-date after it goes on-line. As long as the integrity of the system logs is maintained, they provide assurance of operational continuity despite occasional failures and system maintenance actions. Integrity shall be maintained through use of standby SCPS Systems. System clients (e.g. the SCADA/DMS system or HMI unit) shall have the capability to construct a CompositeLog by chronologically interleaving entries from system logs (i.e. StatusLog, CommandLog, ChangeLog, SubLog, FileLog). The CompositeLog enables operators to understand what has happened over time. (See the more complete description found under the HMI heading.)

The station functions and the Logical Nodes (LN) shall be distributed and allocated to station level devices.

The station level (level 1) shall consist of the following main components:

1) Engineering Workstation (EWS) with HMI
2) SCADA gateway to PEA SCADA/DMS: Protocol for communications between the SCADA/DMS and substations is DNP3.0 over IP. Communications between the SCADA gateway and IED servers are via SCPS Systems
3) SCPS Systems
4) Station optical fibre ring bus, providing the means by which devices and applications exchange data within the station
5) Station-operator HMI or station level operator interface (SLOI)
6) Time synchronization server with GPS receiver

HMI shall be the centre for all O&M station activities. This includes the following categories of responsibilities:

1) 'Local control' over the primary power system. The facility shall provide all capabilities available to dispatchers at the SCADA/DMS control centres plus more. Supervisory control capabilities through the Operator Interface require the HMI/SCADA switchover per field or system at the station to be in the HMI position, meaning the SCADA/DMS centre and any other (future) enterprise clients must relinquish control for operational and safety reasons.
2) Displays and reports that inform the operator about what is happening in the station system.
3) Maintenance and testing of the station system. This includes maintenance of the data used to monitor, control, and configure the station's operation. The HMI displaces use of conventional hardwired control, metering, and annunciation panels for local operations requiring a station

operator. Where these displaced facilities already exist, they may be used for backup, as permitted by PEA policies and procedures.

Two different types (i.e., platforms) shall be used for the HMI. The first platform, with large high-resolution displays, will be used at Substations. The other platform is a portable device computer so the service engineers can move from station to station. Irrespective of the types, the interfaces will use the same system and application software.

The following are HMI unit responsibilities for Substation sites:

1) Primary On-Line Responsibilities

   a. At start-up

      At start-up, HMI unit will have either no or out-dated information regarding the operational history of the station system to which it is connected. This means there is no basis for constructing an Alarm Summary or any other display that depends on past events. The HMI also lacks current real-time data needed to support displays and operator decisions. To remedy this, the HMI unit shall read the system logs (i.e. StatusLog, CommandLog, ChangeLog, SubLog, FileLog) from the resident, primary SCPS Systems. The logs shall be read with IEC 61850 services. The system logs shall be processed to produce the Alarm Display and any other displayed data dependent on system history.

      The HMI unit shall be able to interleave system logs to produce a CompositeLog, providing an integrated, chronological list of events. This is a very helpful tool that enables an operator to see time relationships.To the extent necessary to support HMI display updates, the HMI client shall subscribe to IEC 61850 real-time data reports from the Repository. The system logs, together with the real-time data, enable the HMI unit to capture both the current state of the system and 100 days of history. It can populate all its displays with data, enable the operator to make informed decisions, and act as though it had been connected to that site for three months.

   b. Maintenance of the CompositeLog

      The HMI unit shall use new entries from system logs (i.e. StatusLog, CommandLog, ChangeLog, SubLog, FileLog), provided by SCPS Systems, to maintain the CompositeLog.

   c. Updating displays

      The HMI displays are the operator's principal means for staying abreast of the system's operating condition. The operator can also perform primary system control, substitute values for process values, and make certain configuration changes.

   d. Operational supervision of programmable logic applications

      This shall be accomplished through the use of graphics to represent the application and the use of Repository subscriptions to observe inputs and outputs.

e. Initiating file transfers and deletions

This capability supports local, operator-initiated software, application, and configuration file downloads to IEDs through the SCPS Systems.

f. Browsing capability

This capability allows an admin team to view the structure and contents of IEC 61850 information models within the Local Repository of the SCPS Systems. More importantly, it is the HMI's principal tool for reading and storing the structure and content of the Local Repository in the SCPS Systems. This information is essential for building displays and reports, saving historical data, and maintaining the system.

2) Displays
   a. Station Status
   b. Alarm Summary
   c. CompositeLog
   d. Abnormal Points Summary
   e. Communications Status / Operational Status
   f. Tagged Device Summary
   g. Substituted Value Summary
   h. Health, diagnostic, and on-line/off-line (in-service/out-of-service) status for each IED and application (i.e. technology monitoring and alarming for the secondary system)
   i. Current file directory (for each IED)

3) Control capabilities
   a. Primary Control: TRIP/CLOSE, RAISE/LOWER,
   b. Device Tagging
   c. Automatic acknowledgement
   d. Recloser Mode Selection
   e. Relay 'Settings Group' Mode Selection
   f. Primary SCPS Systems' Selection
   g. Value substitution
   h. SCPS Systems restart
   i. HMI restart

4) Historical Data application
   a. Hosted both Terminals Stations and Substations.
   b. Allows the HMI operator to create Historical Points, which become periodic, saved recordings of data values for a specific variable.
   c. Records snapshot, minimum and maximum values for designated variables over designated time periods each day.
   d. Provides reports that can be printed or displayed

5) Off-Line Responsibilities
   a. IEC 61850-based configuration control, using the SCL tools provided by the contractor.
   b. Creation and modification of displays
   c. Creation and modification of system reports
   d. Creation and modification of programmable logic applications
   e. Creation and modification of all IEDs setting / configuration parameters
   f. Modification of system behaviour and application behaviour through the use of templates provided for user-defined parameters
   g. Fault evaluation analysis (Disturbance waveform)

The SCADA gateway shall ensure that all operational data from the substation can be communicated to the pertinent area distribution control centre (ADDC). The communication protocols shall emulate and be compatible with the remote control centre protocol(s). Detail requirements for Station Level Operator Interface (SLOI) and SCADA gateway shall be referred to relevant Sections of the specification.

The SCPS Systems are the main station processor. It has several roles, as described below:

1) Principal Station Client
   The SCPS Systems are the principal station client, meaning it is responsible for collecting and maintaining the various data and files that comprise the station information base. BCU, Protective relays, and perhaps other IEDs are expected to report a large amount of their data through use of IEC 61850 report services. The primary SCPS Systems will need to poll for any remaining data, using IEC 61850 services, or calculate it from other available data, using local automation applications. Data must be acquired and stored according to the System Performance Requirements.

2) Local Repository / Compatibility with IEC 61850
   The SCPS Systems provide a Local Repository for the storage of station data. This is directly related to its role as principal station client.

3) Supporting SCADA/DMS Operations; see Clause 4.2.4 for details

4) Application Programs
   The SCPS Systems must be capable of storing and executing application programs. These may be commercial programs or they may be implemented in programmable logic. The scope and functions of these programs will typically be defined for SCPS Systems. All application functions that must be implemented in the SCPS Systems are listed below. They are described in more detail under the specification heading titled Functional Requirements, Applications Support.
   a. Heartbeat function
   b. Trip Counters for circuit breakers
   c. "Rate-of-change" calculations for selected measurements

d. "Breaker Operating Time" checks

5) Communications Gateway

The SCPS Systems shall supply and receive all application data for the Communications Gateway. Lower-level communications functions are the responsibilities of the TCP/IP, Ethernet, and/or DNP communications software. Communication parameters such as baud rates, number of data bits, parity, and transmission retries, etc. shall be configurable. These shall be user-defined parameters that the operator can change through an HMI template. This includes DNP data exchanged with SCADA/DMS control centres. In this case the SCPS Systems must be able to support the communications role of DNP 3 Level 3 Slave. DNP application data may be converted from contents of the Local Repository or maintained in a separate database. However supported, DNP response times cannot suffer.

The SCPS Systems shall be able to exchange files with enterprise clients and to store those files. They will typically be configuration, software, application, or non-operational data files (e.g. event or oscillography files from protective relays). The SCPS Systems do not need to interpret the file data. For transfers between the SCPS Systems and an enterprise client (except the Remote File Manager), FTP or COMTRADE services are preferred.

Data files for non-operation functions, such as power quality, disturbance recorder, fault recorder etc., shall be in a format that can be sent to deposit in an outsource server.

The Contractor shall provide a selector switch that will be used to select the controller of the communication gateway, between a SCADA control center and SCPS. Either SCADA control center or SCPS can control the communication gateway at a time.

The SCPS Systems shall provide appropriate, application-level security services for information transported through Communications Gateway, including authentication and access control. The Communications gateway shall be designed to provide encryption, although it may not be used initially.

Service Tracking and Functional Constraints shall be supported. Service Tracking is introduced in clause 14 of Edition 2 of IEC 61850-7-2.

The Service Tracking can be divided into three types:

a. Control Block Related Services
b. Command Related Services
c. Other Services

Common Service Tracking (CST) shall be support.

The following Functional Constraints shall be supported for enhanced Tracking Request Services:

a. SR – Service Response - To represent data from different process objects with same Tracking Object
b. OR – Operate Received - To represent result of an Operate Request to a Data Object
c. BL – Blocking – To block value updates to a Data Object

All ambiguities related to the processing of a Client request will be resolved by exposing the error information as 61850 data.

The Bidders shall clearly state how they will implement authentication and whether they will require any data to be encrypted.

6) File Agent

The SCPS Systems shall include a File Agent utility that provides file management, performs file transfers and deletions, and maintains the FileLog (see above). The File Agent shall process all file transfers, which shall occur between the SCPS Systems and other IEDs. Files may include configuration files, application programs, software updates, and non-operational data (e.g. relay disturbance files and event reports). To maintain interoperability within the station, file services, attributes, references, and other characteristics shall comply with the IEC 61850 communications standard. File content does not need to be interpreted by the File Agent. Since station IEDs and enterprise clients may currently support the COMTRADE standard [IEEE C37.111 (1999)] and/or FTP standard [IETF – RFC 542], PEA has an interest in applying them where IEC 61850 transfers cannot be supported. Potential applications may involve SDH WAN transfers involving the remote File Management Client.

Operating Systems (OS) of HMI and Engineering Workstation shall be Windows. OS of Gateway and SCPS Systems shall be a stable one, such as Linux.

All station IEDs shall be certified by an independent competent entity and type tested as suitable protection grade devices. Unless specified otherwise, all station clients shall be certified and type tested by an independent competent entity as industrial grade equipment. Distributed station functions shall be allocated to the station IEDs. Failure of station protection device(s) shall not affect the bay level protection functions. Failure of other single device shall not affect the functions of the bay and station levels, except for station wide interlock function. The devices and station clients are interfaced to the station bus via hardened managed Ethernet switches.

All components in the substation shall be powered from substation 125V auxiliary DC system without DC/AC inverter.

The Contractor shall specify the protocol that is used for communications between SCPS Systems and HMI.

4.2.2 Bay Level

The term bay, used in the context of this specification, refers to the practice of grouping certain secondary system equipment together to protect, control, monitor, and automate certain primary system equipment within the station. There may be numerous bays in a station, including different types (e.g. "line bay", "feeder bay", "transformer bay") and multiple instances of the same type (e.g. "line bay"). That package could be reused in multiple stations, saving non-recurring and recurring costs in engineering, installation, configuration, test, and so on.

The main characteristics of the bay devices shall be;

1) multifunction IED
2) use of IED technology
3) IED conform with IEC 61850 standard
4) performing distributed bay level functionalities
5) interface to user through device HMI and remote client such as Engineering Workstation
6) compact with integrated functionalities in one device. Integrated as part of SCPS through networked communication.
7) flexible applications and functions
8) duplicated Protection Devices with similar functions but from different manufacturers
9) ability to activate or deactivate the main functions
10) capability to interoperate with other IEDs from several different manufacturers to exchange information and use the information for own functions
11) IEDs which provide rich source of IED information such as settings, configuration information, events, alarms, power system information, fault records, COMTRADE fault waveform files, etc.
12) self-monitoring and supervision
13) certified and type tested as protection grade device
14) enact programmable logic.interfaced to the station bus via hardened managed Ethernet Switch
15) possibility to minimise the use of external electromechanical auxiliary relays and lockout relay. powered from substation 125V auxiliary DC system interfaced to the station bus via hardened managed Ethernet Switch
16) proxy to legacy devices or non-IEDs (as an alternative, a dedicated protocol converter with generic logical nodes shall be provided)
17) failure not affecting other functions within or external to the particular bay or level
18) hardwired parallel connections to the primary equipment or apparatus (switchgears and instrument transformers). The IEC 61850 process bus shall also be implemented.

The bay functions and the Logical Nodes shall be distributed and allocated to bay level devices, i.e. protection devices and single control device.

For each bay, bay control and protection IEDs shall be integrated in a single panel located at the substation relay room. The bay level consists of the following components:

1) Automatic voltage control device for each transformer bay

2) Bay controller for each bay
3) Bay emergency control for each bay (located at the protection IED): for Circuit Breaker (CB) operation only
4) Distributed busbar protection bay acquisition units for centralized busbar protection architecture
5) Bay protection devices or protective relays for each bay; functions might be similar, but devices are from different manufacturers
6) Local panel (mimic screen) in each distributed relay panel for distributed housing implementation option

All bay IEDs shall be certified and type tested as protection grade device. The protection devices and control devices shall be assembled in single integrated panel for each bay. Distributed bay functions shall be allocated to the bay multifunction IEDs. Failure of single protection device or relay shall not affect the protection functions of the particular bay, other bays and station level. Failure of other single device shall not affect the functions of the other bays and station level. The devices are interfaced to the station bus via hardened managed Ethernet switches. Independent Ethernet Switch shall be provided for each bay, with proven make of Ethernet switch type. Redundancy should be provided so that each Bay is connected to at least two Ethernet switches on the same ring. The bay controller may also function as proxy to legacy devices or non-IEDs.

Data flow of operational real time data and control, through client-servers communication, shall be ensured between IEDs and station level clients. Each IED shall be able to support multiple clients (at least 5 clients). The IEDs shall be able to provide configuration information and IED specific information including COMTRADE files, IED native individual parameters, etc. to the Engineering Workstation at station level.

In general data flow and peer-to-peer communication through GOOSE messaging (Publisher-Subscriber) shall be implemented for specified control and protection related functions and for the direct protection tripping function. Hardwired parallel connections from IEDs to the primary equipment or apparatus (switchgears and instrument transformers) may be allowed at PEA discretion.

Power Distribution System:
All the bay level components shall be powered from substation 125 V auxiliary DC system.

IED Bay Control Units (BCU):
This specification refers to smart bay implementations as BCU. Please refer to Clause 4.8.6 for details required function of BCU.

IED Protective relay:
The Contractor shall refer to Clause 6.3 115 kV DEDICATED PROTECTION and Clause 6.4 MV DEDICATED PROTECTION for dedicated protection details.

Typical of Protective relay functions can be categorized as:

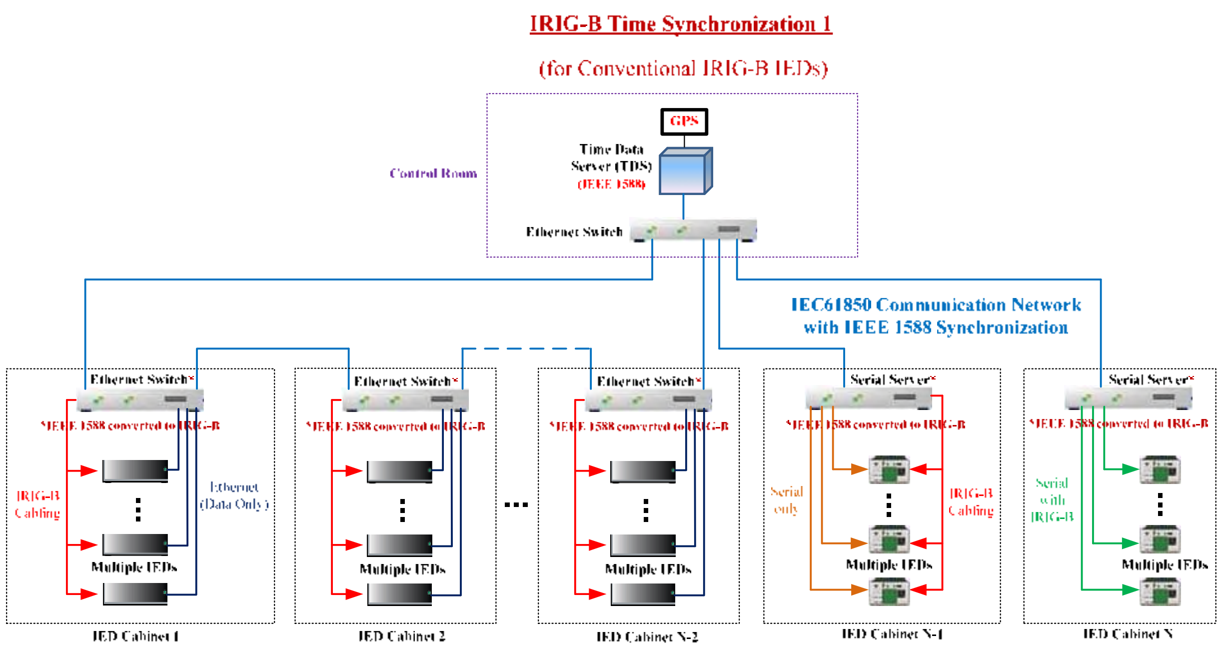
1) 115 kV Bus Protection 87B, 95B
2) 115 kV Line Protection (Main 1) 21/21N, 25, 27, 59, 79
3) 115 kV Line Protection (Main 2) 67/67N, 50BF
4) 115 kV Transformer Protection (Main 1) 87T, 64
5) 115 kV Transformer Protection (Main 2) 50/51, 50N/51N, 50BF
6) Others 115 kV Protections
7) 22 or 33 kV Feeder Protection 50/51, 50N/51N, 50BF, 79
8) Others MV Protections

The Contractor shall refer to SUBTATION SINGLE LINE DIAGRAMS AND RELAY AND METERING DIAGRAMS DRAWING for specific detailed protection of SCPS.

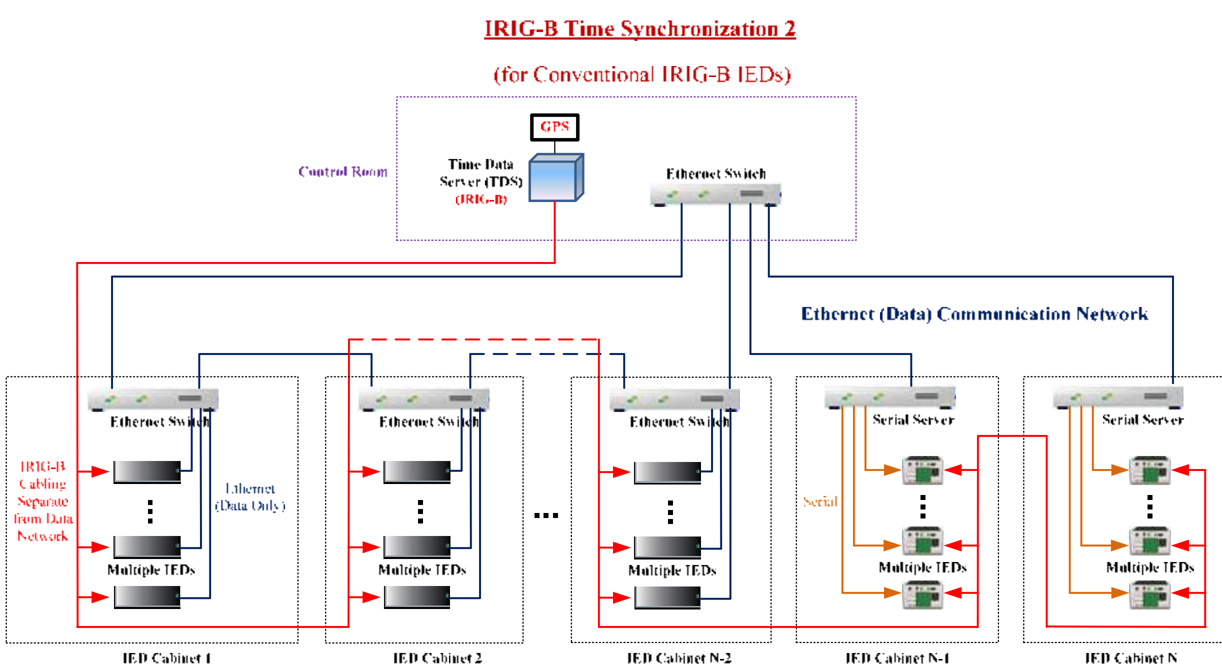
4.2.3 System Logical Architecture

The main features of the SCPS architecture are:

1) Distributed architecture using Ethernet Local Area Network (LAN) station bus with 1 Gbits/s optical fibre ring topology
2) All IEDs and clients are connected to the station bus via hardened managed Ethernet Switch certified to IEC 61850-3 and IEEE 1613
3) Distributed multifunction bay IEDs or relays integrated in single panel per bay
4) Transformer Automatic Voltage Control/Regulator device shall be located in a separate panel
5) For AIS (Air Insulated Switchgear?) substations, the bay panels may be located in Prefabricated relay house(s) at the substation switchyard
6) Local displays (mimic screen) in independent panel at each Prefabricated relay house to provide safe operational awareness for operation and maintenance purposes, unless PEA states otherwise
7) SCPS Systems to perform station level functions including control and automation functions
8) Station Level Operator Interface (SLOI) to perform Station-operator HMI functions
9) Gateway for communication interface with PEA SCADA/DMS. The gateway shall be supplied by the Contractor.
10) Engineering Workstation to manage the SCPS, communication network and substation information, and to provide applications utilizing the substation information
11) Time synchronization server (NTP, and IEEE 1588 or IRIG-B, with the latest version, if IEEE 1588 is not available, Server) synchronizing with GPS master clock receiver to provide time source for time synchronization of all SCPS components. Depending on synchronization standard used, a dedicated communication interface and network might be provided for time synchronization, such as for IRIG-B. Figure 4.2 shows Generalized Time Synchronization Network for IRIG-B IEDs.



(a)



(b)

Figure 4.2 – Generalized Time Synchronization Network for IRIG-B IEDs, (a) in case the Time Data Server (TDS) is based on IEEE 1588, and (b) in case the Time Data Server (TDS) is based on IRIG-B. Connection and wiring should conform with these figures.

The Contractor shall define the logical architecture to identify all the data flows in the communication network based on the SCPS physical architecture. The logical architecture definition and consideration shall include:

1) ***Nominal data flow***: clients/servers and peer-to-peer (publisher-subscriber), short and medium term sizing
2) ***Non nominal data flow***: missing device, invalid data, performance during avalanches
3) ***Redundancy management***: client and server sides
4) ***Performance management***: multi-cast filtering, VLAN, clusters
5) ***Security***: how to protect from external threats

4.2.4 Supporting SCADA/DMS Operations

The Dispatchers shall be able to control station equipment and gather system data via DNP3.0 over IP command and polling messages transmitted from the SCADA/DMS control centre. Implementation of DNP 3.0 over IP protocol shall meet at least ALL DNP 3.0 over IP standard requirements.

A completed DNP 3.0 over IP 'Device Profile Document' and 'Implementation Table' shall be submitted to PEA within 180 (one hundred and eighty) days after the Effective Date of Contract. If not already available, DNP requirements that transcend Level 3 shall be implemented by the Contractor in the course of project execution.

The DNP communications shall be supported by the Gateway via a process that links and converts IEC 61850 data from the Local Repository to the desired DNP values and formats. These resulting DNP data shall be stored and maintained in a separate DNP database that can be accessed by DNP data communication services. This approach provides two significant advantages: (1) the continual DNP data conversion process is independent of (i.e. not interrupted by) DNP message processing, and (2) the DNP database allows the HMI to quickly respond to message requests. DNP commands shall likewise be translated to use IEC 61850 control blocks and procedures for controlling system equipment.

4.3 SYSTEM PERFORMANCE

Individual IED devices and components should be supplied with certificates indicating the worst case performance that that component should meet e.g. the Protective relay will operate within a maximum of so many milliseconds. Overall system performance should be guaranteed by the Contractor in the details statement of work and should provide detailed test procedures to describe how the performance will be measured.

The system performance shall be as specified to below.

4.3.1 System Availability

Since a Substation LAN is shared for all information-related processes, any failure or disruption that significantly impairs network communications has the potential for bringing down a critical portion of the whole system. It is very important to anticipate the situations that may cause this to happen and to mitigate the overall risk to an acceptable level.

Risks can be expressed in terms of probabilities, and those probabilities can be combined mathematically to calculate an estimate of annual system downtime. Those calculations depend on the system configuration, interdependencies of system components, and how well the individual components are designed. Realistically, low failure rates are heavily dependent on consideration of environmental and electrical susceptibility factors in equipment selection and design, good engineering judgment and practice, competent and trained O&M personnel, proper attention to system problems, and avoidance of electrical components that require manual adjustment or repositioning during configuration or maintenance (e.g. electronic connectors, jumpers, and switches). The Contractor shall keep these and related factors in mind when responding to this specification with a proposed design.

The Contractor shall submit his rationale, reliability data, and availability calculations in support of his proposal. The Contractor may use any widely recognized reliability tool or method that he believes helps construct his case, but how these are applied must be documented for PEA review. PEA will expect cogent, credible, and persuasive evidence for the selected approach. Proven track records will carry greater weight than purely theoretical calculations, although track records need to be substantiated through a number of customer references for like systems (including contact information for persons who can provide authentic testimony). Cherry-picking of several customer references is strongly discouraged; a greater number or references will dispel this concern. Documents supporting the Contractor's reliability/availability claims shall be submitted to PEA within 30 days of the bid opening date. PEA has a strong preference for a system approach that does not require routine maintenance. The IEC 60870-4 standard shall be used as a guide for addressing these issues.

The availability of the system is defined as the probability that the system will be available when required, or as the proportion of total time that the system is available for use. The proportion of total time that the system is available is the inherent availability (A), given by:

$$A = MTBF/(MTBF+MTTR)$$

where:

A : a system inherent availability
MTBF : Mean Time Between Failure of the system
MTTR : Mean Time To Repair for the system

The operational availability A of the system is defined as the ratio of the system uptime and total operating time, given by:

A = Uptime/ Operating Cycle

where:

1) Annual availability of the system shall be 99.95% or better on average (IEC 60870-4, Table 2 – Class A3). This requires that system downtime be less than 262 minutes per year.
2) MTTR: Trained maintenance personnel shall not require more than six (6) hours to restore the SCPS system to normal service (IEC 60870-4 Table 3 – Class M4).

The above figures shall exclude administration time and travelling time. Recommended test equipment and replaceable spares are assumed to be locally available to sites needing their use, although these assumed resources must consequently be included in the proposal.

The SCPS Contractor shall provide the necessary:

1) system and component MTBF and MTTR figures calculated based on reliability prediction standards as defined in US Military Handbook, MIL-HDBK-217F
2) system availability evaluation methodology
3) system availability calculations
4) assumptions made for the calculations
5) expected number of system failures per year

for PEA verification and validation.

4.3.2 System Reliability

The reliability of the system is defined as the probability that a piece of equipment or component will perform its intended function satisfactorily for a prescribed time and under stipulated environmental conditions. The system reliability requirements are:

1) Safe – better than 99.999%
2) Secure – better than 99.999%
3) Dependable – better than 99.999%
4) Free from design error
5) Self-monitoring and diagnostics

The system reliability shall be based on:

1) Failure modes, effects and criticality analysis of the parts and design
2) Worst-case event estimation and consequences

The Contractor shall clearly declare the expected failure modes for the system and the components. Preferably, the failure mode and effect analysis (FMEA) shall be based on IEC 60812.

The proposed reliability evaluation techniques to be used:

1) Analytical methods, such as IEC 61025 analysis techniques for dependability – Reliability Block Diagram
2) Simulation methods
3) Qualitative or methods contingency-based methods
4) Actual incidence of field failures for a large population of installed units
5) Parts count and parts stress analysis methods as defined in US Military Handbook, MIL-HDBK-217F

The SCPS manufacturer shall provide the necessary:

1) System and component failure rates
2) Worst-case event estimation and consequences
3) System reliability evaluation methodology
4) System reliability analysis and calculations
5) Assumptions for the analysis and calculations

for PEA verification and validation.

The followings are the required reliability requirements of the system:

Table 4.2 – Reliability Issues

System Reliability	Requirements
Safe	Free from contributing to hazards, accidents or losses
Secure	The number of failure event, i.e. non-performance or inability of the system or component to perform the intended function
Dependable	No single point of failure that will cause the substation to be inoperable
Free from Error	1) Free from design flaw 2) Free from deviation from a desired or intended state Free from design (Static) error 3) Design error shall be detected and tested out before installation and commissioning

System Reliability	Requirements
Self-monitoring and diagnostics	1) Data acquisition system testing. The analogy acquisition chain is checked: multiplexer, programmable gain amplifiers, ADC converter. The ADC conversion time is checked 2) Memory testing. The memories (typically flash ROM) contents are checked 3) Set point testing. Set points are stored in two different memories (typically EPROM's and RAM). Whenever any set-point is changed, the checksum of the set points is calculated from one of the memory (EEPROM) and compared with the one calculated from the RAM 4) Watchdog timer. The IED hardware design includes a watchdog timer reset circuit to take the processor through an orderly reset should the program get lost due to a hardware or software glitch

4.4 CRITICAL FUNCTIONS

Critical functions are defined as the system functions that need to remain available when a single point of failure occurs in the system. Failures that affect critical functions are subject to the guaranteed reliability criteria. They include the following:

1) Any failure that brings down the entire system.
2) Any failure that causes loss of core station functionality, including:
   a. Local station control (i.e. HMI functions)
   b. Historical data processing (Historical data are real-time data which are stored in the running system)
   c. SCADA/DMS support
   d. Enterprise communications
   e. Station LAN communications
   f. Operation of or access to the Repository
   g. Programmable logic application processing or supervision
   h. Proper operation of the system logs
   i. System configuration control or diagnostics
   j. Field data acquisition and processing
   k. Time synchronization
3) Any other failure that interrupts system capability beyond that solely attributable to the failed resource.

For example, loss of a single BCU may be excluded if it only results in the loss of data for which it is directly responsible. Loss of all data acquisition, however, comprehensively disables SCADA/DMS support, requiring that failure be subject to the guaranteed reliability criteria.

4.5 NON-CRITICAL FUNCTIONS

Non-critical functions are defined as system functions that do not need to remain available when a single point of failure occurs in the system. Failures of non-critical functions are not subject to the guaranteed reliability criteria. Non-critical functions include the following:

1) Database generation and modification (an off-line function)
2) Display generation and modification (an off-line function)
3) 'Programmable logic application' generation and modification (an off-line function)
4) Backup of real-time data
5) Archiving (Archived data are stored in a system and/or media that is offline)
6) Access to on-line documentation
7) Printing functions

4.6 SYSTEM SECURITY

Because of the critical nature of the SCPS system's operation and its networked relationship with other systems, security is of major concern to PEA. System components and integration methodology shall provide robust security features to prevent unauthorized users from reading or writing data or files, executing programs, or performing operations for which they do not have appropriate privileges.

The SCPS system software shall have no special undocumented user sign-on procedure, such as might be used by the programming staff of the Contractor or the vendor/supplier of the operating system while the software is being developed. Any backdoor password is not allowed.

The software system shall be the latest version, and free of viruses when the Contractor delivers. During the guarantee period, the Contractor shall keep the software up-to-date. After the guarantee period, the Contractor shall propose an option to update the software to PEA; the update shall not be via the internet.

The Contractor shall recommend security capabilities that conform with standard IEC 62351 for SCPS security, and IEC 27032 for other relevant Information Technology (IT) operations. The recommendations shall provide reasonable protection for a reasonable cost, so as to significantly reduce the risk of damage, loss of information, unauthorized use, or impairment of use or control of the station facility.

4.7 CONTROL FUNCTIONS

The general substation control system consists of the following functions:

1) Control (including both Manual Control (local) and Automatic Control (local and remote))
    a. local control operation, which is defined as control functions of the SCPS, and
    b. local control monitoring, which is defined as monitoring functions of the SCPS

The control operation function facilitates the reconfiguration of the substation and power system.

2) Measurement

The measurement function provides:

a. measurement of electrical parameters (such as voltage, current, active power, reactive power, etc.), mechanical and thermal quantities; and
b. Conveying of such measurement information to local and remote applications.

3) Monitoring

The control monitoring function provides comprehensive and accurate information for the benefit of substation operation and operational analysis.

4) Interfacing, Analytics and Archiving (including EWS)
5) Protection related

The control function should be:

1) Secure, such that no inadvertent control operation shall be possible,
2) Safe, such that a control operation shall never compromise the safety of plant or personnel,
3) Reliable, such that it shall always be possible to control the plant and the system at all times.

The control operation can be initiated from any of these levels:

1) Network level (Network level is where the devices such as HMI are connected to the station bus.)
2) Substation level
3) Bay level
4) Process level

Control priority is as follows:

Table 4.3 – Control Priority Levels

Level	Source of Control	Priority
Level 1	Network Level	4
Level 2	Station Level	3
Level 3	Bay Level	2
Level 4	Process Level	1 (Highest)

Only one level shall be permitted to initiate control of the switchgear switching devices or equipment at any instance. At the location of control levels, it shall be possible to transfer control authority to the next lower priority level.

The control operation of switchgear switching devices, except earthing switches, shall be available at all control levels. Earthing switches shall only be operable at process level.

The control function shall operate in the following stages;

1) Control Command Initiation
2) Operation Condition Check such as Interlocking, Synchronism Check, etc.
3) Execution or Operation

Control operation at network, station and bay control levels shall be based on Select-Before-Execute control command principle to ensure a high degree of security against unwanted operation. A switching operation sequence shall be completed before the next operation is initiated within a substation.

The local control functions are modelled and grouped according to the IEC 61850 Logical Node Group which begins with the character C.

The control functions consist of but not limited to:

1) Switchgear manual close and open control operation
    a. Control of circuit breaker
    b. Control of isolator
2) Backup manual CB open operation
3) Network, station, bay or local control selection
4) Manual close synchronism & voltage check
5) Interlocking
    a. Bay interlocking
    b. Station-wide interlocking
    c. Under voltage interlocking
6) Transformer tap changer control
7) Automatic voltage regulator or controller
8) Transformer paralleling mode
    a. Master-follower scheme
    b. Circulating current
9) Point-on-wave controller (for shunt capacitor)
10) Event and alarm handling
11) Voltage selection scheme
12) Synchroscope
13) Station-wide time synchronization
14) Live transfer trip block (for bus coupler and bus section)

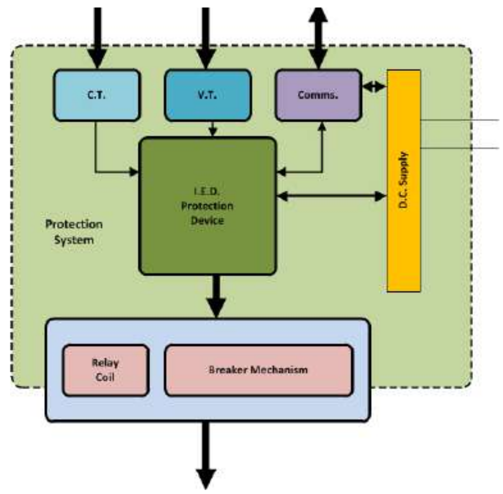
4.8 PROTECTION FUNCTIONS

The objective of the protection functions are;

1) To detect abnormal power system conditions and faults
2) To selectively isolate the affected faulty equipment from the rest of the power system

The protection functions and Protective relays (protection IEDs) are an integral part of the SCPS protection system and fault clearing system.

To work the protection functions need to use process value measurements such as current and voltage, and produce directly a start or operate/trip. The protection related functions also record data or block protection functions under dedicated conditions.



Protection System

Figure 4.3 – Protection System

The protection system of the substations 115 kV and MV is based on the principle of local back-up. In some other terms, any fault occurring anywhere on an outgoing line, transformer or on the busbar should be detected and cleared locally by the relays and circuit breakers located in the substation concerned, before the distance or back-up relays located in the second zone; being controlled by the adjacent substation can be operated. This should be the case under normal operating conditions or in the event of the failure of one element of the protective chain - i.e. the failure of a relay, circuit breaker, circuitry instrument, battery etc.

Protection and protection related functions shall be able to be distributed and allocated in IEC 61850 compliant IED. The IED of different vendors shall be able to be integrated within the SCPS without applying any special adaptive effort. All information (operational and non-operational data) from SCPS Systems, and from the IEDs shall be able to be retrieved as part of the substation Information Management System. These information, both operational and non-operational, should be kept at a centralized server so that the information can be retrieved without affecting the SCPS Systems nor the IED's.

The protection functions shall consider the followings;

1) Fault Clearing System constraints
2) Fault Clearing System requirements
3) Protection design criteria

4) Specific station and bay protection functions

The protection functions are modelled and grouped according to the IEC 61850 Logical Node Group which begins with the character P.

4.8.1 Protection Functions

The protection functions are defined as functions which are measuring process values like current and voltage, and produce directly a start or an operate/trip.

The bay protection functions consist of but not limited to:

1) Current transformer ratio correction
2) Distance protection
3) Frequency protection (for load shedding)
4) Line differential protection
5) Overcurrent protection
6) Phase segregated
7) Signal propagation delay compensation
8) Thermal overload protection
9) Transformer biased differential protection
10) Transformer guards:
    a. Main and OLTC Bucholz
    b. Oil temperature
    c. Pressure relief device
    d. Winding temperature
11) Transformer high, or low, impedance differential protection (for autotransformer)
12) Transformer over excitation protection (volt per Hz protection)
13) Transformer restricted earth fault
14) Trip scheme logic
15) Under voltage and overvoltage protection

The substation protection functions consist of but not limited to:

1) Arc busbar protection (for MV switchgear)
2) High impedance busbar protection
3) Low impedance busbar protection (central and distributed bay acquisition units)
4) Special protection scheme: the Contractor shall provide details on equipment that need special protection, if any.

4.8.2 Protection Related Functions

The Contractor shall refer to Chapter 6 Control Protection and Measures, for details of the required protection related functions.

4.8.3 Design Criteria

The protection system design criteria are as follow;

1) **Effectiveness** – The components must be effective in performing operations as follows:
   a. The protective device should operate in a time period that minimizes the system interruptions or duration of system disturbance and to improve system stability
   b. The protective device should only trip part(s) of the system just as necessary to de-energize only distressed components.
   c. The protective device should be sensitive enough to operate under minimum fault condition.
   d. The protective device should be sensitive enough to operate under minimum fault condition.

2) **Reliable** – There must be a degree of certainty that the protective device will function correctly for as long as possible
   a. The protective device shall be stable and remain operative under certain specified conditions such as transmission system disturbance, through fault, transients, etc.
   b. The protective device should not fail to operate for faults in the protected zone. It will be necessary to provide backup protection to cover the failure of the main protection.
   c. Increase in hardware components may reduce the system reliability
   d. Self-diagnostic, supervision and monitoring capabilities to improve system availability

3) **Dependability** – There must be a great deal of certainty that the protective device will operate correctly
   a. The ability that the protection to identify the faulty section and/or phase(s) of a power system
   b. The measure of certainty that the protective device will not operate incorrectly for any fault

4) **Security** – There must be a degree of certainty that a protective device will not mal-function
   a. The measure of certainty that the protective device will operate correctly for all the faults for which it is designed to operate.

4.8.4 Fault Clearing and Operating Time

The maximum fault clearing time is as the following:

Table 4.4 – Fault Clearing Times

Protection Classification	Maximum Fault Clearing Time
Main Protection	150 ms
Backup Protection	3 second (short circuit rating of the primary equipment)

The maximum fault clearing time is defined as the maximum time interval as the maximum time interval between the fault inception and the fault clearance of the faulty element from the power system.

4.8.5 Fault Clearing System Constraints

Fault clearing system constraints shall consider the following requirements;

1) Single failure scenario – failure of any one component in a fault clearance system should not result in a complete failure to clear a power system fault or abnormalities
2) Reliability, i.e. dependability and security of the protection system. Increase availability, dependability and performance of fault clearance system by selectively introducing duplicated protection. Improve dependability by introducing backup protection function
3) Reduction in the fault clearance time

Therefore two protection IEDs or relays shall be provided for each bay. Both duplicated protection functions shall not lose the function simultaneously due to the following;

1) A single hardware failure of the relay or the peripheral equipment
2) Any relay malfunction
3) Any disturbance happening inside the relay
4) Any power system disturbance

Main and backup protection functions shall be available in each Protective relay.

4.8.6 Protection Related Functions

The protection related functions;

1) happen mostly when a protection function has started or operated
2) record data functions under all conditions
3) block protection functions under certain conditions

The protection related functions are modelled and grouped according to the IEC 61850 Logical Node Group which begins with the character R.

4.9 AUTOMATIC CONTROL FUNCTIONS

Automatic function is like programmable inside the memory of Relay or BCU, and shall be included in Relay or BCU, for example, Sequential Switching, Load Shedding, Automatic Transfer Switch etc.

The automatic functions operate directly on the process with process and system data without the interference of the operator. The different high voltage switchgear switching devices or equipment within the substation may be operated automatically by programmed logical sequences.

The automation function shall be programmed and performed at station level in the station intelligent electronic device IED. However, the automated sequence may be initiated by operator at the Station-operator HMI or Station Level Operator Interface (SLOI).

The automatic switching sequence operation shall stop at the unsuccessful command stage and shall not rollback. Each individual switching command within the sequence operation shall check with the interlocking scheme. Each switching operation in the sequence shall wait for the successful status confirmation before commencing subsequent operation.

The setting of reference value for the automatic regulating devices such as Automatic Voltage Controller (AVC) shall be made available at network, station and bay levels.

The automation functions are modelled and grouped according to the IEC 61850 Logical Node Group which begins with the character A. The automation functions may also be implemented using generic Logical Node GAPC.

These requirements in this section shall be considered as a minimum to be satisfied.

The protective relay shall be of the IED type with a documented past service period of not less than two years.

The protection system for transmission lines shall take into consideration the grounding network practice of the project. All transformers (Dyn or Yyn vector group) are solidly grounded on MV network, meanwhile PEA will improve in the future the low-resistance grounding method by the addition of a resistance in the neutral connection.

The system objective maximum fault clearance times are as follows:

1) 100 ms: maximum fault clearing time of 1st step of distance protective relay
2) 100 ms: maximum fault clearing time of busbar protection

In the event of a failure to interrupt fault current by the line Circuit breaker, the breaker failure must trip all the necessary adjacent circuit breakers within 250 ms starting from the primary protection release the trip command.

The automatic functions consist of but not limited to:

1) Heartbeat function *[at all sites]*
2) Bay and inter-bay interlocking *[at all sites]*
3) Bus coupler throw-over scheme (CTO) *[at selected sites]*
4) Line throw-over scheme (LTO) *[at selected sites]*
5) Bus throw-over scheme (BTO) *[at all sites]*
6) Load shedding and restoration scheme (ALS/ALR) *[at all sites]*
7) Breaker failure protection (50BF) *[at all sites]*
8) Voltage Selection (VS) *[at all sites]*
9) Automatic Transformer Restoration (ATR) *[at selected sites]*
10) Automatic Capacitor Switching *[at all sites]*
11) Automatic Overload Shedding Scheme *[only selected site(s)]*

4.10 MEASUREMENT FUNCTIONS

Measurement of electrical quantities such as voltage, current, active power, reactive power, etc. shall be taken directly, without separate interposing or transducers, by the IED from substation current and/or voltage transformer(s). Measurement from DC and 400V AC voltages may be derived from substation auxiliary AC and DC systems.

The measurement functions are modelled and grouped according to the IEC 61850 Logical Node Group which begins with the character M.

The measurement functions (for operative purpose) consist of but not limited to:

1) Busbar frequency (Hz)
2) Busbar voltage (V)
3) Current (A)
4) Frequency (Hz)
5) Measurement calculation
6) Power (MW and MVAR)
7) Power factor
8) Rate of change of frequency
9) Substation DC system voltage
10) Substation AC low voltage
11) Temperature
12) Trending and statistics
13) Voltage (V)

4.11 MONITORING FUNCTIONS

The monitoring function provides substation device or equipment indications and information as follows;

Status including devices position and operation modes, substation communications health status, etc.

1) Alarms, defined as information about a change of state from normal to alert/emergency situation
2) Events, defined as status change of an external value (e.g. input contact) or of an internal/calculated value (e.g. trip decision, limit violation), which is recording with the related instant of time (time tag at resolution of 1 millisecond). All events must be time-tagged with the time of occurrence at the source of acquisition. Such events are defined as Sequence of Event (SOE) data.

For switchgear switching devices, the device status shall be monitored at all control levels. The switchgear status position shall be indicated by four state digital(double point binary) auxiliary switches monitoring, i.e. monitoring of both normally open (NO) and normally close (NC) auxiliary contact positions.

For four state digitals configured as Sequence of Events (SOE) points, the detecting system shall time tag the event recorded at the time of the event in the following manner:-

1) If the point changes state to a transition state and then to a final valid state during that interval, the detecting system will time-tag the event at the time that the point changes state to a valid state.
2) If the point fails to reach a valid state and remains in the transition state until the end of the time interval, then the detecting system shall time-tag the event at the time the point initially changes state to the transition state.

Digital Inputs are to be taken only from a single source, and information is to be distributed on IEC61850 bus. There shall be no duplication of inputs onto the IEC61850 bus.

The monitoring functions consist of but not limited to:

1) Switchgear status indication and mimic
2) Bay alarm annunciator
    a. Bay IED operations
    b. Bay IED status
    c. Trip circuit condition
    d. Auxiliary supply condition
    e. CB alarm
3) Station alarm annunciator
    a. Station IED operations
    b. Station IED status
    c. Station auxiliaries alarm
4) Alarm statistics
5) Telecommunication equipment failure monitoring
6) Gateway for legacy IED monitoring
7) Trip circuit supervision
8) Auto and manual trip counter
9) Voltage transformer supervision
10) Condition monitoring including communication systems monitoring, and system health monitoring
11) Time synchronization monitoring
12) Auxiliary supply supervision
    a. Protection DC supply
    b. Control DC supply
    c. Signalling DC Supply
    d. AC Supply
    e. Switchgear mechanism motor DC supply
13) DC system (charger and battery) monitoring

14) Station LVAC monitoring
15) Power quality recorder

4.12 CONTROL INTERLOCKING FUNCTIONS

The control interlocking function, for both operational and maintenance interlocking schemes, shall be provided to prevent unsafe operation of switchgear switching devices such as Circuit Breaker, Isolator/Disconnector and Earthing Switch within a bay or station wide. The interlocking scheme shall also ensure correct sequence of operation of the switching devices.

All station and bay interlocking schemes shall be provided and controlled by intelligent electronic control devices using GOOSE messages. Additional fail-safe checking mechanism for high voltage level earthing switch shall be made using an under-voltage function.

4.13 INTERFACING, ADVANCED ANALYTICS AND ARCHIVING FUNCTIONS

The interfacing and archiving functions are performed at the following locations:

1) Station-operator HMI or station level operator interface (SLOI)
2) SCADA gateway for remote interface to PEA SCADA/DMS
3) Prefabricated relay housing screen mimic (If applicable)
4) Engineering workstation
5) Bay HMI (Bay Control IED Mimic)
6) Emergency control interface (Backup Mimic)

Table 4.5 – Interfacing Issues

System Component	Comments
Station-operator HMI or Station Level Operator Interface (SLOI)	Station Level Operator Interface (SLOI) shall provide station-operator HMI functions such as substation local control, monitoring, and handling of local alarms and events. The detail requirements shall be referred to the relevant Section of the Specification, see Table 11 ("should be made sure that this Table is put in this Specification")
SCADA Gateway(SGW)	The SCADA Gateway forms the interface between the substation and Network Control Centre(s), and between the substation and other substations using standard SCADA protocol. This is interconnection device that supports the full stack of relevant protocol and security to interface or communicate with the SCADA/DMS and other future systems that access to station for operation and maintenance.
Prefabricated Relay Housing Screen Mimic (If Applicable)	Mimic screen in independent panel at each Prefabricated relay house shall provide the following: 1) to provide safe operational awareness for operation and maintenance purposes 2) to provide station-operator HMI or substation level operator interface (SLOI) functions. The mimic screen shall access information & database from the SLOI located in the central building. However, no control operation shall be permitted from the station-operator HMI or substation level operator interface (SLOI). 3) to provide access to Engineering Workstation functions through Engineering Workstation web server The Screen Mimic for each Prefabricated Relay Housing includes: 1) LCD mimic display screen with substation switchgear status indication display, preferably a Touch Screen type panel mounted display 2) Alarm monitoring and measurement display 3) Engineering Workstation function displays

System Component	Comments
Engineering Workstation – Engineering Unit Interface (EUI) (See more details in Clause 8.4.)	Engineer Interface Unit. It is the IEC 61850 client that gathers information from various IED devices and enables the operator to supervise and have local or remote control. Include OPC-Server Engineering Workstation manages the SCPS, communication network and substation information, and to provide applications utilising the substation information. The Engineering Workstation functions are: 1) Real time data historian & analysis 2) Communication network management 3) System access control and cyber security management 4) SCPS monitoring, diagnostics and maintenance 5) Substation IED interrogation and monitoring 6) Substation Protection, Automation and Control system and IED configuration management 7) GOOSE messaging management (configurable via the work station) 8) Disturbance and fault information handling, analysis and evaluation (via Program Fault Record) 9) Engineering HMI 10) Web browser and interface (for equipment setting) 11) Substation status display 12) Sequence of events and alarm analysis 13) Data archiving, trending and historical analysis 14) Automatic fault report generation and notification 15) Substation equipment monitoring 16) Substation documentation management The HMI software shall be capable of IED devices management function such as setting and resetting of all Protective relays and other by remote via Router.

System Component	Comments
Merging Unit (MU)	The Merging Unit is a physical unit used for time-dependent combination of current and/or voltage data from secondary converter. A merging unit can be a component part of the instrument transformer or a separate unit. Typical locations for MU shall be as follows: 1) MV switchgear: low-voltage compartment of each cubicle (mounted on MV switchgear). 2) HV switchgear: marshalling cubicles/junction boxes, local control cabinets. 3) HV/MV power transformer: local control cabinets. 4) Automatic switching capacitor bank: local control cabinets.
Protocol Convertor (i.e., IEC 61850 Gateway)	Element that allows the integration of devices that have not yet implemented the IEC 61850 architecture. The IEC 61850 Gateway collects the information through the communication protocol of the devices and it adapts this information by integrating it in the new IEC 61850 format.
Communications Network	The communication network is constituted by an Ethernet network (ISO/IEC 8802-3), as it is shown in Part 8-1, 9-1, 9-2 of the IEC61850 standard.
Ethernet Switch	They are the local network connection elements. Enables network access to the different units of the system avoiding collisions.
Time Reference Unit (GPS clock)	Time server with GPS synchronization. It is the main synchronization source of the system. NTP, and IEEE 1588 (PTP-the latest version) or IRIG-B protocol enable the synchronization through a local communication network of the different devices. The Contractor shall provide time accuracy corresponding to the proposed synchronization protocol for PEA approval.
Intelligent Electronic Devices (IED)	IEC 61850 clients which receives the information from the bay level IEDs, and support the communication with the SCADA system, thus executing the logics at station level. The RTU functions and the logics may be separated into independent IEDs.

System Component	Comments
Bay HMI (Bay Control IED Mimic)	The Bay HMI incorporated in Bay Control device includes: 1) LCD mimic display with switchgear status indication display 2) Bay Monitoring and measurement display 3) Local control at bay IED level
Emergency Control Interface, if requested by PEA	Emergency Control for each bay (for CB operation only) in the event of Control Bay Control IED failure. 1) The Emergency Control interface includes: Pushbutton to trip or open the circuit breaker 2) Pushbutton to close the circuit breaker with hardwire interlocking command supervision and synchronizing bypass switch 3) Hardwire connection

4.14 OTHER IEC 61850 FUNCTIONS

4.14.1 IEC 61850 Configuration functions for Tools and Process

The IEC 61850 communication standard provides a System Configuration Language (SCL) that can be used to configure communications for both IEDs and the entire system. It involves the use of several types of files, created for different purposes, and two levels of tools for creating and managing those files. The files are represented in XML (Extensible Mark-up Language), enabling the interoperable exchange of configuration and capability information between supplier tools. The semi-automated process (i.e. people still need to enter design intentions), virtually eliminates hand-entry of information and manual configuration of equipment.

The four types of files that comprise SCL, listed roughly in the order they are used to produce a configured system, are the following:

1) ICD: IED Capabilities Description

This file describes the communications capabilities of an individual IED, and it is typically installed in the IED before shipment from the factory. The file can be extracted from the IED at any time. It contains no information about how the device is to be used in a target system, but does fully describe what communication services and information models can be supported by the IED.

2) SSD: System Specification Description

This file describes the functional specification of the whole secondary system at the station, including the communications system. Among other things, it captures a one-line diagram of the targeted system. It allows Logical Nodes [LNs] (i.e. functional pieces of the whole IEC 61850 information model) to be assigned to the various IEDs according to their functional roles and capabilities. These actions are typically performed using a single System Configuration Tool, selected from among those offered by IED manufacturers.

3) SCD: System Configuration Description

This file is created using the System Configuration Tool, the SSD file and ICD files for all IEDs used in the system. The result is a complete 'process configuration' for the secondary system, with IEDs bound to individual process functions, primary equipment, and client-access privileges. It also includes all predefined network associations and all client-server connections with LNs on a data level. A complete set of SCD files are required to fully describe the engineering configuration.

4) CID: Configured IED Description

When the SCD file has been created, it is used to create an individual, downloadable Configured IED Description file for each IED in the secondary system. This is achieved using the IED Configuration Tool provided by each manufacturer. As long as these tools have an interoperable SCL interface, as described by the IEC 61850 standard, they may be proprietary. This is often necessary, so that the tools can download additional IED configurationally data that is proprietary in nature, but which does not affect system interoperability.

4.14.2 Open System Provision functions

Although these systems will be provided through a turnkey project, it is imperative that the resulting systems be open. It is not acceptable that PEA be locked into one or even a limited number of IED suppliers for future upgrades. Therefore, a special provision is required: The contractor shall demonstrate that two additional IEDs, each of different manufacture and approved by PEA, can be integrated into these systems using the SCL tools, files, and process described by the IEC 61850 communications standard. The open system demonstration shall be done during FAT and SAT. The open system experience/reference list of the supplier in supplying SCPS shall be submitted with the bid.

4.14.3 File Management functions

File management is concerned with the use, control, and organization of files in a system environment, so that required objectives are met.

4.14.3.1 Objectives

Files of various types are used with the IEDs of these systems. They include configuration files, software files, user-application files, and IED-generated data files. These files need to be managed and occasionally transferred, so that the system operates properly, reliably, and efficiently. PEA specific objectives include the following:

1) Download Capability: Devices need all their software, application program components, and configuration files if they are to work properly. Even if they are preloaded when the system is first commissioned, they will very likely need to be updated or replaced in the future.

PEA needs to be able to accomplish these changes via file-download procedures over the network, initiated from a remote location or at the station site, per PEA discretion on each occurrence. File services are needed to perform these downloads and to delete files that are no longer relevant.

2) Upload Capability: Sometimes, during system operation, IEDs may generate data files (e.g. disturbance files). These files need to be uploaded to a higher system level and then directed to one or more clients for analysis. The IEDs that generate these files have limited resources, and they may need to get the current file uploaded relatively quickly, so that they have freed resources (e.g. memory) to accept the next file, whenever it may be generated. So a mechanism is needed for the responsible system component to recognize when a new data file is present and a file-upload service is needed to transfer the file, or the mechanism to download the files after one event which triggers the download.

3) File Attribute and Directory Services: The file management procedures must be relatively simple and fool-proof, to avoid confusion and ensure reliable results. And because operators occasionally need to check their assumptions, they will want confirm that files reside where they are expected and that the files have the proper attributes (e.g. last-time-modified). So file services are needed to provide these capabilities.

4) Audit Trail for File Transfer Activity: From a system perspective, it is important to keep an audit trail of significant occurrences. File transfers are always important, as personnel need a reliable record of past transfers. Such information may be needed at a future time when analysing a problem and deciding how to proceed. An audit trail should create a record each time a file is transferred or deleted, recording the file name, its attributes, where it was transferred from and to, and what party (or client) authorized the transfer.

4.14.3.2 FTP management

The IED shall be configured with one CID file. This file is uploaded into the device via FTP with any standard client through the same Ethernet port and network used for the IEC 61850 communication.

The directory structure of the FTP server is as indicated in part 8-1 of the IEC 61850 standard, which proposes a root directory called SCL, which will contain another two subdirectories:

1) Not validated: In this directory it will be uploaded the new CID file to configure the device.
2) Validated: If the IED validate the new CID file uploaded in the not validated directory, the device moves the CID file to this directory. If the new file is not validated it will stay in the not validated directory.

The FTP access is protected by user/password. Only authorized users can upload a CID configuration file to the device. The IED not only accepts the uploading of the CID file, it also accepts the downloading of the file. So we can recover the configuration file from the IED also via FTP. The FTP server also allows to access to any other file generated in the device (Oscillography, reports, logs, etc.).

4.14.4 Technical IEC 61850 Functions

1) All devices shall conform with IEC 61850 standard and the following requirements:
   a. Interoperability, i.e. ability to communicate and to exchange information with other IEDs from several different manufacturers and use the information for own functions
   b. Free configuration and allocation of functions Future proof, independent of communication technology and evolving system requirements
   c. Successfully pass IED conformance test based on IEC 61850 part10 as necessary
   d. Information management by standardizing the Data Models and Abstract Communication Services
   e. Engineering and configuration management using XML based Substation Configuration Language (SCL) and IEC 61850 conformant Engineering Tools.
   f. Client-Server communication including relevant services such as reporting, data sets, control blocks and self-description via MMS protocol
   g. Peer-to-peer communication using IEC61850-9-2 SV and IEC61850 GOOSE tripping channels.
   h. IED native Ethernet port that support all relevant IEC 61850 protocols
   i. Engineering access, event report collection, and non-IEC 61850 setting transfer via TCP/IP mechanisms

2) The following device information shall be provided:
   a. IED Capability Description (ICD)
   b. Configured IED capability Description (CID)
   c. Model Implementation Conformance Statement (MICS)
   d. Protocol Implementation Conformance Statement (PICS)
   e. Protocol Implementation Extra Information for Testing (PIXIT)

3) Conformance testing part 10 shall be used for the definition of the test procedures.
   The test cases cover followings:
   a. Check of SCL configuration file according to IEC 61850
   b. Check of Data Model implementation according to IEC 61850-7-3 and -4
   c. Test of the ACSI services according to IEC61850-7-2 and specific mappings (8-1 and 9-1, 9-2).

4) The IED shall support IEC 61850 standard in terms of the following:
   a. Buffered reports supported
   b. Unbuffered reports supported
   c. Customization of the reports and data sets
   d. Ability to freely rename data sets, and logical devices
   e. Ability to add prefix and suffix to logical nodes

f. Use specific logical node name for commonly used information rather than generic data references (such as GGIO)

g. Ability to change data sets and reporting configuration via Configuration Tool

h. Ability to download CID file directly into IED via Configuration Tool

i. Ability to download CID file directly into IED via Ethernet using standard TCP/IP mechanism from remote such as from HMI.

j. Flexible configuration of data sets

k. Ability to setting logical devices, logical nodes, and their contents

l. Ability for user to query IED directly and to verify which IEC 61850 configuration file (.CID file) is active within the IED

5) The IED shall also support the IEC 61850 GOOSE implementation in terms of the followings:

a. At least 8 of unique GOOSE messages capable to be published

b. At least 24 GOOSE messages to be subscribed

c. Capability of monitoring GOOSE message quality

d. Capability of processing incoming data elements and their associated quality

e. Capability of monitoring message and data quality as permissive prior to use of the incoming data. At the time of configuration, the end user can choose to ignore the possibly corrupted data if the data or message quality fails to prevent an unwanted operation.

f. Capability of creating GOOSE data set that include Boolean values and non-Boolean data type, such as Analog values

g. Capability of accepting and processing data sets from other IEDs that contain Boolean and non-Boolean data types

h. Ability to support priority tagging of GOOSE messages for optimizing latency through Ethernet Switch.

i. Ability to support VLAN identifiers to facilitate segregation of GOOSE traffic on Ethernet network.

j. Ability to support custom editing of data sets published in the GOOSE messages.

k. Ability to change data sets, GOOSE parameters, GOOSE publication, and GOOSE subscription via Configuration Tool.

l. Ability to support Recovery delay demands acc. to IEC 61850-5 Ed. 2 on Ethernet network.

6) The Network shall also support the Recovery Time implementation in terms of the followings:

a. IEC 61850-8-1 Station Bus.

- GOOSE traffic not delayed beyond a critical threshold due to failover.
- Unless stated otherwise, PRP and/or HSR provide seamless recovery, i.e. zero recovery time, on Station Bus for demanding applications. If a RedBox (Redundant Box) is needed in the proposed topology, the Bidder shall provide specification and quotation of the RedBox for PEA approval.

b. IEC 61850-9-2 Process Bus.

- SV traffic not to be affected during disruption.
- No failover time.
- Seamless redundancy
- PRP and/or HSR fulfil these requirements with zero recovery time.

7) The IEDs specified in the specifications are for the followings:
   a. Control devices, i.e. station and bay control devices
   b. IED Protective relay or devices
   c. IED for Protection (main & backup) for each bay level shall be physically independent.
   d. The IEDs are devices incorporating one or more processors with the capability to receive or send data/control from or to an external source. The IEDs shall also be capable for peer-to-peer communication (IEC61850 GOOSE) and Client/Server communication. (Such as Reporting by Exception)
   e. All IEDs supplied shall pass the IEC 61850 Conformance Test based on IEC61850-10. The IEC 61850 Conformance Test Certificate from an independent laboratory shall be provided as evidence and part of the tender submission. The laboratory shall be accredited by UCA International Users Group with ISO/IEC17025 certification with certification.
   f. The IEDs shall not show any non-conformance to IEC 61850-3, 6, 7-1, 7-2, 7-3, 7-4&8-1, and 9-2 (2011).
   g. Markings and Labelling Data. Clearly inscribed labels or markings shall be provided on the devices to describe the manufacturer name, model number, application and ratings.

8) Device Electrical Parameter Values.
   The standard device electrical parameter values are:
   a. The device shall be suitable for operation using substation auxiliary DC system.
   b. The device shall not mal-operate on DC auxiliary supply interruption or application/restoration or when energized from inverted polarities.
   c. The device shall also be stable and not affected by slow decay, surges, dips, ripples, spikes, capacitive coupling, DC earth fault, transient and switching disturbances. Indication shall be made available in the event of DC failure.

4.14.5 Station Level Devices Functions

The main characteristics of the station devices shall be:

1) Multifunction IED
2) Use of IED technology.
3) IED conform with IEC 61850 standard
4) Interface to user through device HMI and remote client such as Engineering Workstation
5) Integrated as part of SCPS through networked communication flexible applications and functions.

6) Capability to interoperate with other IEDs from several different manufacturers to exchange information and use the information for own functions.
7) IEC 61850 server which provide rich source of IED information such as settings, configuration information, events, alarms, power system information, fault records, COMTRADE fault waveform files and can be send COMTRADE files to HMI by automatically, etc.
8) Self-monitoring and supervision.
9) Certified and type tested as protection grade device.
10) Interfaced to the station bus via hardened managed Ethernet Switch.
11) Failure not affecting other functions or bay level.
12) The station functions and the Logical Nodes shall be distributed and allocated to station level devices.

4.14.6 Bay Level Devices Functions

Generally, Bay Control Device functions and specifications are:

1) Switchgear Manual Close and Open Control Operation
   a. Control of Circuit Breaker
   b. Control of Isolator Switch
   c. Control Mode Selection (Local/Remote/OFF)
   d. Select-Before-Execute Control Command Procedure- Manual Close Synchronism & Voltage Check
   e. Synchronism check - Voltage difference, Phase angle difference, Slip frequency/difference
   f. Voltage check

2) Dead line-live bus (DLLB), Live line-dead bus (LLDB), Dead line-dead bus (DLDB)

3) Interlocking (Command Supervision) 27UV
   a. Bay Interlocking
   b. Station-Wide Interlocking (Peer-to-peer)
   c. Under voltage Interlocking

4) Event and Alarm Handling

5) Monitoring
   a. Switchgear Status Indication and Mimic
   b. Bay Alarm Annunciator

6) Bay IED Operations and Status, CB Alarm
   a. Auto and Manual Trip Counter
   b. IED Self Supervision and Monitoring

7) User Interface
   a. LCD User Interface with keypad

b. Display of Mimic, Switchgear Status
c. Indication and Mimic, Bay IED Operations and Status, measurements
d. IED LED Indication

8) Measurements
a. Current (Amps)
b. Voltage (V)
c. Power (MW and MVAR)
d. Frequency (Hz)
e. Power Factor

4.14.6.1 IED Bay Control Unit (BCU) without Protective Relay

This specification refers to smart bay implementations as BCU. As such, they are assumed to have sufficient local processing, memory, programmable logic, and communication resources to support expanded responsibilities and capabilities. In case of an IED BCU (without Protective Relay), the programmable logic should be included in the IED. When these resources are combined with support for the IEC 61850 communications standard, BCU gain flexibility and power that can significantly elevate their system roles and provide enormous flexibility.

Since a number of capable protection IED's now support the IEC 61850 communications architecture as well as mainstream protocols, the need for non-relay, bay-level processing is at best questionable. In all but the most demanding circumstances, protection IED's are very capable of managing bay-level responsibilities in coordination with the station level, while taking care of their primary protection responsibilities.

The following are two examples of how PEA would like to apply bay-level processing at SCPS.

1) Bay-level IEDs can gather, pre-process, and store data locally. That same data can be selectively reported to the station level when triggered by the occurrence of defined events. The data may include power system measurements, status, and a variety of other candidates that surpass typical BCU capabilities. IEDs can also execute commands delivered from the station level.

   This approach not only relieves the station level from performing these tasks for multiple bay units, it provides for graceful loss of functionality when a critical processing resource at the station level fails. Because IEC 61850 uses named data, represents it in engineering units, and hierarchically structures it within station information models, data management is simplified.

2) Certain applications may be deployed within a bay or among a group of cooperating bays spread conveniently across a site. In the latter case, we say the application is distributed. These applications may be implemented through commercially available software and/or programmable logic.

For distributed applications, the participating Protective relays usually need to directly exchange interlocking signals (e.g. status and commands) with each other. For a protection application, these exchanges must be quick, perhaps within 4 ms to satisfy the timing requirements of the application. The IEC 61850 communications standard provides GOOSE messaging services for this purpose, using the Substation LAN in lieu of traditional hardwired connections.

The IED BCU and Protective relays shall have been submitted/passed a test certificate compliance with the IEC 61850 part 10 Conformance Testing such as the following:-

1) Basic Exchange
2) Data Set Definition
3) Unbuffered Report
4) GOOSE Publish
5) GOOSE Subscribe
6) Time Synchronization
7) File Transfer (if any)

The tests certificate compliance with IEC 61850-10 have to be certified by international accredited testing laboratories which are independent of the Bidder and Supplier.

4.14.7 Process Level Devices Functions

The main characteristics of the process devices shall be:

1) Ability to define the Specific Communication Service Mapping (SCSM), as defined in IEC 61850-9, for sampled values over ISO/IEC 8802-3. The intent of this SCSM definition is to include the complete mapping of the sampled value model. Each SCSM consists of three parts:
    a. A specification of the communication stack being used,
    b. The mapping of the abstract specifications of IEC 61850-7 series on the real elements of the stack being used, and
    c. The implementation specification of functionality, which is not covered by the stack being used.

2) Applies to electronic current and voltage transformers (ECT and EVT having a digital output), MU, and IED, for example protection units, bay controllers and meters, or sensors.

3) Ability to define Process bus communication structures can be arranged in different ways as described in IEC/TR 61850-1. In addition to the transmission of sampled value data sets, which are directly connected to ISO/IEC 8802-3, a selection of IEC 61850-8-1 service is necessary to support the access to the SV control block. References to the relevant IEC 61850-8-1 services are provided in this SCSM. For less complex devices (for example MUs), the sampled value control block can be preconfigured, in which case there is no need to implement IEC 61850-8-1 services based on the MMS-Stack.

4) Ability to define the mapping of sampled value class model (IEC 61850-7-2) to ISO/IEC 8802-3. This SCSM, in combination with IEC 61850-7 and IEC 61850-6, allows interoperability between devices from different manufacturers.

This specification refers to smart bay implementations as MU:

1) MU

The MU work as a bridge between primary equipment (such as electronic CT/VT or traditional electro-magnetic CT/VT) and bay level IEDs for signal capturing and transmission based on IEC 61850-9-2 or IEC 60044-8. MU can be used to convert Analog signals to digital signals for electro-magnetic CTs/VTs and dispatch them to different relays and controllers after data synchronization. Signal type accessed through merging unit can be:

a. Digital sampling data outputs from electronic CT/VT or simulator (Now digital sampling output module is available in relay testing equipment such as Omicron).
b. Analog signals from electro-magnetic CT/VT or simulator.
c. Switching signals from intelligent primary equipment.

2) Smart I/O (Input/Output Units)

The intelligent control units connect circuit breakers and bay level IEDs for capturing the circuit breaker status information to protection & control devices via GOOSE network. In the other direction, the I/O Units deliver GOOSE commands from the protection & control devices to circuit breakers. The I/O Units can be installed outdoor nearby the primary equipment and connected to the protection & control devices in the control room via optic GOOSE network.

4.14.8 Enhanced Automation Functions

The SCPS systems shall perform enhanced automation functions, including the following:

1) Heartbeat function for IED health and on-line status monitoring
2) Maintenance of TRIP Counters for breakers
3) Rate of Change (ROC) Limit Checking
4) Breaker operating time checks (should perform at HMI)
5) Substation-wide, automated control sequences: Automatic Transfer Switch(ATS), Bus Coupler Throw-over Scheme (CTO), Line Throw-over (LTO) & Bus Throw-over (BTO), Load Shedding / Load Restoration, and Voltage Selection (VT connection is Hardwire, Logic at Software at Bay Level).
6) Station-wide interlocking (GOOSE interlocking at Bay level)
7) Protection applications (Breaker Failure Protection) (at Bay level, both Main & Back up protection)

The contractor shall be responsible for the creation, design, implementation, configuration, installation, testing, and documentation of logical control sequences for the above tasks for each station's ultimate configuration. The contractor shall consult with PEA regarding the various design and planning issues and submit the finalized plans for PEA approval. All Programmable Logic

Control (PLC) software and source code shall be included in the deliverables, so that PEA can use them for future modifications. These applications shall be verified during the Factory Acceptance Tests (FAT), using an I/O simulation panel provided by the contractor.

The closing of circuit breakers shall be supervised by appropriate interlocking. For example, a circuit breaker shall only be closed if its two disconnect switches are already closed and the ground switch is in the ungrounded position. Abnormal conditions such as 'low air' or 'low gas lockout' in the breaker, etc., shall inhibit the control operation. These procedures represent standard station practice, and PEA expects them to be incorporated into applications without explicit direction. Other situations involve other interlocks or permissive signalling, and practice may differ among utilities. Where PEA operational practice is unclear, the contractor shall submit the issues for written clarification. Generally speaking, applications shall monitor their operations and avoid situations that can damage equipment, pose safety hazards, or lead to unsatisfactory results.

Applications shall be configured to subscribe the input data they need from the Local Repository. If station or enterprise clients need the results generated by the application, then those data also need to reside in the Repository.

4.14.8.1 Heartbeat Function

All IEDs shall support the heartbeat function. Each IED broadcasts a GOOSE message over its Substation LAN every 10 seconds to indicate that it is healthy, on-line, and performing its responsibilities without any significant impairment. If that isn't true, it doesn't broadcast the message. Every IED in the system monitors these heartbeat functions to determine whether any of its peers has a problem or is off-line. An IED is deemed by its peers to be off-line or malfunctioning if a GOOSE message is not received from it within an interval of 25 seconds. If an IED is dependent on a non-operational peer, it may use a contingent peer to complete its responsibilities, if that contingency has been provided in its programmable logic or through other means.

In particular, the HMI units shall monitor heartbeat messages to determine which IEDs are operational and which are not. This information shall be displayed, logged, and reported to the SCADA/DMS system.

Heartbeat messages from the various IEDs shall be offset in time by some mechanism that prevents all system heartbeat messages from being issued simultaneously.

4.14.8.2 TRIP Counters for Circuit Breakers

This application shall run in the bay level and be responsible for maintaining the values of TRIP Counters, one for each circuit breaker in the station. Each TRIP Counter keeps track of the number of times its associated breaker trips. It doesn't matter whether the breaker is tripped by command, by protection logic, or by other means; the TRIP Counter shall be incremented by +1 for each trip occurrence. The TRIP Counters will principally be used to keep track of breaker usage for maintenance purposes. They may also be used to understand operational patterns over a long period of time.

The TRIP Counters eventually roll over. By default, the roll-over value is the decimal equivalent of a 32-bit value. However, it shall be possible to configure the roll-over value on a point by-point basis. It shall also be possible to pre-set TRIP Counters, so that the counts can be synchronized with prior records or external equipment.

The implementation of this application shall support the inclusion of each TRIP Counter in the Local Repository, accompanied by a configuration parameter for the roll-over value. One approach would be to create a new LN called STRC (Sensor Group: TRIP Counter), containing an INC CDC to represent the TRIP Counter. This would provide all the tools needed to manage the counter per the discussion above. The INC CDC supports data type INT32 for the controllable integer status, allowing it to be operated as a 32-bit counter. The application itself would need to subscribe to breaker status events for the breakers to be monitored, preferably from the Repository.

The application would normally respond to each trip event by incrementing the appropriate TRIP Counter. Once in a great while, it would reset the counter if the roll-over value was attained. The application should perform the incrementing or resetting via a direct control operation, with the ctlClass configured for 'operate-once and ctl Model configured for 'direct-with-normal-security'.

4.14.8.3 Rate of Change (ROC) Limit Checking

This application shall run in the HMI and be applied to selected analog input variables that are acquired from IEDs and maintained in the Local Repository. For these variables, the application shall divide the change in value for successive value reports by the difference in time-tags. Filtering shall be applied so that single scan excursions do not cause an alarm. The calculated rate-of-change shall be compared against a limit, and shall create an alarm if the rate-of-change exceeds that limit.

To support the implementation of this capability, analog input values shall be reported using IEC 61850 report services, ensuring that their reported values are time-tagged. Care needs to be taken that Dead bands for the analog input values are set sufficiently small to support effective calculations by the HMI. The calculated ROC variables shall be modelled as instances of either the MV (Measured Value) or CMV (Complex Measured Value) CDC (Common Data Class), as appropriate. The MMXU (measurement) LN (Logical Node) can be extended to include the desired ROC variables as 'optional' components. This is the way the ROC variables would be represented and stored in the Local Repository. Once the range limits are configured for the individual ROC MV or CMV instances, IEC 61850 change-of-range events will occur naturally and can be processed as alarms by an HMI unit or the SCADA/DMS system.

4.14.8.4 Breaker Operating Time Checks

This application shall run in the HMI and be applied to all circuit breakers at the station. The objective is to determine how long it takes each breaker to TRIP, from the time that the tripping mechanism starts to work to the time that the tripping action is complete. The results are used to direct breaker maintenance, and they need to be stored in the Local Repository for each breaker.

Breaker operating times can be calculated by monitoring 'a' and 'b' auxiliary contacts on the breaker. The interval begins at the instant when both 'a' and 'b' contacts are open; the interval ends the instant the 'b' contact is closes (with the 'a' contact remaining open).

'Breaker Operating Time' measurements shall be included in the Local Repository, associated with other data related to the circuit breaker (e.g. the TRIP Counter).

4.14.8.5 Feeder Fault and Breaker Lockout Recognition

Feeder Protective relays shall provide starting signal that indicates a downstream fault has been detected, tripping the feeder breaker. A second signal shall indicate a breaker lockout condition if re-closing has not been successful, indicating that the fault may still persist.

For all distribution breakers, a programmable logic application in the HMI or BCU shall detect starting signal, delay for a user-defined period, and then (1) check the status of the second signal or (2) check the status of the breaker. If the second signal indicates lockout or if the breaker is OPEN, breaker lockout shall be inferred. If the second signal indicates no lockout or if the breaker is CLOSED, a transient fault and successful re-closing shall be inferred.

In the case of a transient fault with successful re-closing, the operator shall reset the relay target that indicated a downstream fault, and the resulting status change shall consequently reset the programmable logic application for that breaker. In the case of lockout, the operator shall reset both relay targets (i.e. downstream fault and lockout, if the lockout target exists) when the fault has been cleared. Again in this case, resetting the downstream fault target shall consequently reset the programmable logic application for that breaker.

4.14.8.6 Automated Control Sequences

The following automated control sequences are currently used at selected stations within PEA power delivery system, these applications shall all run in the BCU and Protection IEDs.

4.14.8.6.1 Load Shed and Restoration

The SCPS shall provide an accurate frequency measurement for the voltage on each of the MV bus sections. The under-frequency load shedding application shall provide for up to five (5) stages of load shedding, at user definable pre-set frequencies, with minimum increments of 0.03 Hz over an operating range of 50 to 47 Hz, and with user-definable pre-set time delays within a range from 0 sec through 120 sec, with increments of 0.1 sec in range from 0 sec through 1 sec, and with increments of 1 sec in range from 1 sec through 120 sec.

An under-voltage function for blocking load shedding application shall provide for up to five (5) stages of load shedding at user definable pre-set voltages, with minimum increments of 1% overran operating range within 50% through 95% of nominal voltage, and with user-definable time delay from 0 sec through 60 sec in 0.1 sec increments.

Feeder trip-groups and trip-points shall be user definable to ensure maximum flexibility of the application. Each of the outgoing feeders shall be assignable to trip at any of the five (5) pre-set under-frequency levels.

The load shedding application shall block any auto-reclosing functions. The under-frequency application shall be enabled or disabled from the HMI or (subject to Station Level interlocks) from the SCADA/DMS control centre.

The under-frequency load shedding application shall be guaranteed to run at user definable voltage limits between +10% to –40% of rated voltage, and shall be blocked if the voltage is less than a user-definable level.

Load restoration of a trip-group shall be manually initiated from the HMI, or (subject to Station Level interlocks) from the SCADA/DMS control centre. Restoration of any trip– group shall be by single command and the programmable logic applications shall automatically sequence closing of the feeders so as to avoid troublesome load initiation surges.

Load restoration application shall switch an auto-reclosing function in ON position after feeders circuit breaker have been closed. Auto-reclosing function shall be switched ON only feeders were tripped by load shedding function).

A second alternative for the load shedding and restoration scheme is by using the dry contact from the under frequency/under-voltage relays at the substation. Provision for a selection of each alternative and the reset of the under-frequency/under-voltage tripping relay from the HMI shall be provided. In addition, automatic VT voltage selection function for frequency-voltage measurement shall be provided to switchover to the other VT in case of the main MV busbar VT supply is lost.

4.14.8.6.2 Voltage Selection (VS)

Busbar voltage simulation which displays simulated bus voltage according to the bus selector switch and input voltage for HV Transformers BCU is available from the line voltage transformer at the incoming lines. Voltage selection scheme (VS) shall be provided for voltage circuit switching to the appropriate line voltage transformer.

Suitable low voltage circuit breaker shall be supplied.

4.14.8.7 Protection Applications (Breaker failure protection, 50BF)

Breaker failure protection (50BF) shall be provided. The phase currents of the feeders shall be monitored for each phase.

The overall reset function of the 50BF system shall not be slower than 25 ms. It shall be sensitive to detect from 0.2 to 2.0 times the rated feeder current, adjustable in steps of less or equal to 0.2 times of this current and being able to be operated continuously at 1.2 times the rated current.

The 50BF relay has to be provided for each individual CB. It shall be initiated by all other protection devices tripping commands. The starting and tripping provided from a protection to be in feed from the same DC auxiliary circuit. Starting from Protective relays with tripping shall be transferred segregated per phase. The Contractor shall select a tripping mechanism that makes the systems work properly; the Contractor shall give the details of the tripping mechanism selected to PEA.

All lock-out functions provided by the CBs i.e. SF6 under pressure, N2 and oil monitoring shall be incorporated to the BFR tripping logic. In case one of these lock-out functions is activated the trip signal to the remote CB shall be sent or performed without delay.

External signal inputs provided for non-current sensing elements e.g. Buchholz performed via binary inputs shall be incorporated in a tripping logic with an auxiliary contact of the CB.

A software matrix shall allow to use the 50BF in different tripping configurations, send signals and combination with several timers.

Trip cutout switch shall be provided as required. All such switches shall provide with suitable nameplate stating the device number and function.

One lamp, LED, marked “OFF” shall be fixed on the panel near the double throw switch to indicate the status of breaker failure protection.

5. SCPS: CONTROL REQUIREMENTS

5.1 SCOPE OF WORK

The old Computer-based Substation Control System (CSCS) is the subset and has been renamed to Substation Control and Protection System (SCPS). SCPS might also be referred to Substation Automation System (SAS). By covering the minimum technical requirements for the design, manufacture, testing in the manufacturer's workshop, supply and delivery, transportation to the site(s), erection, installation, site-tests, pre-commissioning, commissioning, training, and special tools and accessories of an Integrated SCPS for PEA new breed of SAS substation(s). The Contractor shall provide complete, in every respect, main facilities and system functional requirements for reliable continuous operation. All details shall be provided in place whether or not they are expressively stated in these specifications.

The scope of work shall include:

1) The preparation of a SCPS Detailed Design Documents for approval by PEA prior to commencement of system production. The initial list of required data points and typical screen displays are provided in Annexes 4 and 5, respectively. A printout report shall be kept

electronically as a raw log file, and can be printed out according to the format guideline given in Annex 5.

2) The development of the control software to perform all substation manual and automatic functions.

3) All necessary hardware/software required for integrating the SCPS to the Distribution Management System (DMS) Mater Station located at each Area Distribution Dispatching Center (ADDC).

4) The preparation and maintenance to as-built stage of a database, which documents all data points within the substation.

The Contractor shall submit performance test report and interoperability test report from independent testing laboratories for PEA approval.

5.2 SOFTWARE/FIRMWARE

The term “software” is used in these Technical Specifications to mean software or software implemented through firmware. All software shall be implemented according to the Contractor’s established design and coding standards. Complete and comprehensive documentation shall be provided for all software.

A real-time operating system shall be provided capable of managing the applications of the SCPS.

Software shall provide automatic restart of the SCPS upon power restoration, memory parity errors, hardware failures, and manual request. The software shall initialize the SCPS and begin execution of the SCPS functions without intervention by the DMS. All restarts shall be reported to the DMS.

The software shall be prepared in a high level language and shall be documented in detail. No separate licensing charges or agreements shall attach to the SCPS software or its underlying operating system.

In order to easily support the system under continuously changing site conditions all protocol, configuration, and application data must be contained in easily programmable non-volatile memory.

The SCPS design shall be independent of any communication protocol that would impose restrictions on the flexibility or functionality of the SCPS. Protocol changes shall be accomplished by software/firmware changes only.

The SCPS software shall provide an easy, user friendly human interface to the substation control terminal. There shall be a context sensitive interactive help window, which may be a pop up text window displaying relevant help information. "Windows" type software shall be preferred.

The SCPS software shall be provided to allow the configuration of a suitable information filter and development of a hierarchical control structure.

The major system functions to be implemented in the SCPS software area shall be as follows:

1) Substation equipment control
2) Substation equipment indications
3) Substation equipment alarm and event handling facilities
4) Graphical information display
5) System configuration and database maintenance
6) Manual and automatic control function maintenance
7) Interlocking maintenance
8) Serial ports protocol assignment
9) DMS Interface software maintenance
10) IED devices management
11) System Disturbance Analysis
12) Measurement values including Load reports and Load curves creation and display
13) Printing
14) Automatic self-diagnostic
15) Help information
16) Archiving

5.3 FUNCTIONAL REQUIREMENTS

5.3.1 General

The SCPS shall perform the following functions:

1) Control electric power substation equipment
2) Monitor the status of electric power substation equipment
3) Acquire operating data from electric power substations
4) Operate autonomously and on command from the DMS and a local user interface (HMI).

All parameters shall be defined in the database and shall be adjustable by PEA personnel. To prevent unauthorized updates of the database, password protection shall have to be included, and may be set active or inactive on a per user basis.

The SCPS shall acquire inputs from, and issue output (control) commands to power system devices located in the substations. In addition, the SCPS shall be capable of acquiring data from Contractor-supplied IED.

The SCPS shall include all hardware, software, and firmware necessary to meet the Input/Output (I/O) point requirements contained in these Technical Specifications, including input and output cards and output relays.

A Contractor should also refer to Chapter 4: Control and Protection System Functional Requirements for additional requirements.

5.3.2 Input/Output Point Types

The SCPS shall include facilities for handling all analog input, status input, and control output points. Requirements for each type of I/O point are described in the following sub-clauses.

Where the SCPS is used to acquire any of the specified data I/O via an interface to the IED devices such as substation Protective relays or power meters, the overall system performance and responses as called for in theses specifications shall not be compromised.

5.3.2.1 Analog Input

Analog measurement from CT/VT shall be processed in IED relay and/or BCU and input through MU&Smart I/O (Merging Unit and Smart I/O) equipment.

The SCPS shall acquire the ac inputs directly from current transformers/sensors (CTs) and voltage transformers/sensors (VTs) without transducers and shall use these inputs to calculate true r.m.s., 50 Hz phasor, and other power quality data, such as harmonics, voltage sags, voltage swells, etc. The data shall include the following quantities:

1) Neutral r.m.s. current, (normal load and fault current)
2) Peak current and voltage
3) Current direction
4) kW, kVAR
5) Power factor

The SCPS shall accept current input signals with normal signal ranges of 0 to 5 A AC or 0 to 1 A AC. In order support DMS Fault Isolation function, the SCPS shall be able to read and transmit the fault current signal levels up to 20 times full load, together with operation information of protective devices, to the DMS master station instantly when the fault occurs. Therefore the current input circuit shall be designed so that it will accurately resolve current signal levels up to 20 times full load while still maintaining the accuracy stipulated for the normal full load level. In this respect the input circuit shall not saturate over the full 20 times rating. However to fulfil these requirements, one of following methods shall be used:

1) Using one set of AC current inputs connected to current sensors that can provide ac current signal range of 0 to 20 times full load.
2) Using two sets of AC current inputs, one set connected to metering CTs and the other set connected to protection CTs.
3) Using one set of AC current inputs connected to metering CTs and acquiring the fault current data from the associated IED Protective relay through communication link. In this respect the response time shall not exceed 1 second.

The SCPS shall accept voltage input signals with a normal input signal of 125 V AC. The voltage input circuit shall be designed so that it will accurately resolve voltage signal levels of 0 to 220 V AC.

The sampling rate for AC quantities shall be at least 128 samples per cycle.

The total burden imposed by the SCPS analog input circuit shall not exceed 0.5 VA for current and voltage inputs.

In addition, the SCPS shall accept DC inputs from linear transducers and other DC instrument sources. The ability of the SCPS to accommodate DC inputs shall include the following signal ranges:

1) Unipolar Voltage : 0-0.5 V, 0-1 V, 0-5 V, 0-15 V, 0-30 V
2) Unipolar Current : 0-1 mA, 0-10 mA, 0-20 mA, 4-20 mA
3) Bipolar Voltage : 0.5 V, 2.5 V, 5 V, (all -V to +V)

The SCPS shall include at least one highly stable reference voltage that shall be monitored to determine the integrity of its analog input subsystem. The reference voltage shall not vary by more than ±0.1% of full scale over the range of specified service conditions.

The SCPS shall be capable of reporting Analog values to the DMS by exception. The SCPS shall be able to report all Analog values that have changed by more than a programmable deadband from the last value, which was successfully reported to the DMS. The deadband shall be specified for each point individually. In addition, the ability of the SCPS to alarm Analog high and low limit violations is desirable.

5.3.2.2 Status Input

Status Inputs shall be processed in IED relay and/or BCU and input through Smart I/O equipment.

The Contractor shall supply the necessary sensing voltage, current limiting, input isolation, and bounce filtering for all status inputs. The debounce time period for each status input shall be individually user configurable. The input circuits of the status input modules shall be optically isolated from the external signal. In addition, each input circuit shall include an LED indicator next to the circuit terminations to show the status of the associated input contact.

The wetting voltage for status input contacts shall be provided by the individual DC power supply feed to each of the circuit's Smart I/O modules. The wetting voltage for each input contact shall be the same as the primary control voltage (either 48 V DC or 125 V DC) used within the control cabinet from which the status point is acquired. The status input points shall connect directly into primary equipment without interposing devices.

The state of each status point shall be reported to the DMS on an exception basis. That is, a status point shall not be reported to the DMS during normal scanning unless the point state has changed from the last normal scan. The SCPS shall also report the state of selected status points upon receipt of a demand scan request from the DMS.

The following types of status input points shall be provided:

1) Single Contact, Two-State Status (SC-2S): For single contact, two-state status input points, a single contact shall represent both states of the monitored device. One position of the contact

shall indicate an alarm or failure condition, while the opposite state of the contact shall indicate the normal condition.

2) Double Contact

a. Two-State Status (DC-2S): For double contact, two-state status input points, separate contacts shall be provided for representing each state of the monitored device. One contact shall indicate an open condition of the monitored device. The other shall indicate a closed condition. The contacts shall be treated as a complimentary pair. Conflicting contact positions shall be labeled INVALID.

b. Two-State Status but Slowly Change (SLOW DC-2S): These status points shall be provided to indicate the current state of devices that slowly change from one state to another. The status of such devices shall be provided by a complimentary pair of contacts (contact “1" and contact “2") as shown in Table 5.1.

Table 5.1 – TWO-STATE STATUS INPUT OPERATION

State of Monitored device	Contact “1"	Contact “2"
Closed	Closed	Open
Open	Open	Closed
Changing State	Open	Open

The fourth combination (CLOSED-CLOSED) shall be identified as an invalid state.

c. Three-State Status (DC-3S): For double contact, three-state status input points, separate contacts shall be provided for representing each state of the monitored device. The status of such devices shall be provided by a complimentary pair of contacts (contact “1" and contact “2") as shown in Table 5.2.

Table 5.2 – THREE-STATE STATUS INPUT OPERATION

State of Monitored device	Contact “1"	Contact “2"
Step 1 on	Closed	Open
Step 2 on	Open	Closed
Off	Open	Open

The fourth combination (CLOSED-CLOSED) shall be identified as an invalid state.

5.3.2.3 Control Output

Control Output shall be processed in IED relay and/or BCU and output through Smart I/O equipment.

The SCPS shall include the following types of control points to support control actions initiated by the DMS master stations or, where applicable, the integral programmable logic facilities of the SCPS:

1) On/Off Device Control: The SCPS shall perform on/off control actions using complimentary pairs of contact outputs. One contact output shall perform the "On" control action, and a second output contact shall perform the "Off" control action. The SCPS shall be designed such that only one output in a complimentary pair can be activated at a time.

2) Raise/Lower Control: The SCPS shall perform raise/lower control actions using complimentary pairs of contact outputs. One contact output shall perform the "Raise" control action, and a second output contact shall perform the "Lower" control action. The SCPS shall be designed such that only one output in a complimentary pair can be activated at a time.

3) Setpoint Control: The SCPS shall be able to accept setpoint values from the DMS and of using the received setpoint value to initiate their own closed-loop control actions with the programmable logic capabilities as stated in Clause 10.4, e.g., raise/lower controls sent to the transformer tap changers to maintain line voltage at the setpoint value.

To support the above capabilities, the SCPS shall include momentary control outputs and latching control outputs. Each momentary control output shall provide a contact closure (pulse) that shall have programmable pulse duration. The pulse duration shall be adjustable on an individual point basis from 0.1 to 60 seconds in increments of 0.01 seconds. In contrast, latching outputs shall remain in a given state until a subsequent command changes the control output state. The setpoint facilities of the SCPS shall allow for conventional analog inputs, together with miscellaneous digital I/O, and be capable of autonomously implementing closed loop controls with integral auto/manual, local/remote, and loop inhibit status and command features.

Control point selection by the DMS (or SCPS) shall be cancelled if the operate command or Raise/Lower command is not received within a programmable time period measured at the SCPS by a "Command Receipt" timer. The SCPS's Command Receipt timer shall be in addition to the "Select Verification" timer in the DMS. The Command Receipt timer shall be adjustable between 10 and 60 seconds. The time period shall initially be set at 10 seconds.

The voltage rating of the control output contacts shall be the same as the primary control voltage (either 48 V DC or 125 V DC) used within the control cabinet for the controlled device. All control outputs shall be capable of driving a load of 6 A DC at the primary control voltage. The output relays shall be designed for 10^6 operations. PEA prefers that the SCPS control output is equipped with high power relay (for driving close/trip coils and transformer tap changers), as an integral part of BCU, so that the high power control output shall be directly connected to primary control circuit. In case integral control output relay does not satisfy the above ratings then an external auxiliary high power control relay shall be provided.

All control points shall follow a Select-Checkback-Before-Operate (SCBO) procedure for control operation.

Except for Raise/Lower type control outputs, point selection shall be cancelled automatically following the completion of the control action, and re-selection of the point shall be required for each subsequent control action. For Raise/Lower control actions, the control point shall remain selected for an adjustable time-out period, so that re-selection is not required for subsequent Raise/Lower control actions.

The closing operation of circuit breakers shall be supervised by the appropriate interlocking. The closing of the circuit breaker shall be supervised by the status of associated disconnectors and ground switch. The system shall also monitor all operations and give warnings or advisory messages when any wrong operational sequence is requested. Abnormal condition such as low air or low gas lockout of the breaker, etc. shall inhibit the control operation.

5.3.3 I/O Point Counts:

The SCPS shall be equipped to handle the I/O points described in these Technical Specifications. The SCPS shall also include spare I/O points that are fully configured and available for PEA use. At least 10% of the number of each as-built I/O point type in each BCU and/or Smart I/O shall be spare. The spare points in each BCU and/or Smart I/O shall be distributed in approximately equal fashion among all I/O point types implemented in the I/O cards (i.e., approximately 10% of the total number of initially provided Analog points shall be spare, 10% of the status points shall be spare, and 10% of the control outputs shall be spare).

Spare control points shall include external auxiliary control relays (if required for the proposed SCPS).

The spare points shall be wired from the SCPS I/O card to the associated terminal strips in the control cabinet. Additional I/O points on the I/O card beyond that needed to satisfy the requirement for spare points need not be wired to the control cabinet terminal strips.

It shall be possible to expand the SCPS by an additional ten percent (10%) of the initially-delivered (including spare) I/O points by merely adding circuit cards and terminations.

In case the specified 10% spare Analog points cannot be provided in the BCU as-built points then at least 5% of spare Analog cards or modules of the total number of Analog cards used in the substation shall be provided instead.

5.4 SYSTEM PERFORMANCE REQUIREMENTS

5.4.1 Response to a Control

The delay between the completion of an operator's keying sequence and the response of the substation equipment as observed on the HMI display shall not exceed 2.0 second. This time does not include the operating time of the primary equipment.

5.4.2 Status Change

The delay between the occurrence of a spontaneous status change at the substation and the appearance of the corresponding indication on the HMI display shall not exceed 1.0 second.

Where the SCPS is used to acquire any of the specified data I/O via an interface to the IED devices such as substation Protective relays. The response time requirement shall also be applied for the information acquired from such Protective relays when they operated.

5.4.3 Measured Values

Measured values, which are rapidly varying quantities, shall be updated on the HMI display at least every 2 seconds.

Where the SCPS is used to acquire any of the specified data and SV (Sample Value) via an interface to the IED devices such as MU&Smart I/O equipment. The response time requirement shall also be applied for all information acquired from such MU&Smart I/O equipment.

5.4.4 Alarms/Events

The delay between the occurrence of an alarm/event at the substation and the appearance of the corresponding logged message on the HMI display shall not exceed 1.0 second.

Where the SCPS is used to acquire any of the specified data I/O via an interface to the IED devices such as substation Protective relays. The response time requirement shall also be applied for the information acquired from such Protective relays when they operated

5.4.5 Alarm Generation

The alarms shall be stored in buffer in chronological order with 10 ms or better resolution time and shall be possible to be displayed on HMI display or printed on a printer. The following conditions listed below shall be considered as alarms and shall give both audible and visual indications.

1) Failure of equipment or predefined change in the condition of equipment into the alarm state. These include both substation equipment and SCPS equipment.
2) Surpassing of predefined upper/lower limits by the Analog values including fault current, harmonics, voltage sag, and voltage swells.
3) Executed command not successful.
4) Uncommanded status change.
5) Disagreement of normally open or normally closed contacts input for the substation equipment status.

5.4.6 Sequential Events Recording

The sequential events recording shall include all events, which can be of interest, occuring in the substation. The normal events shall be stored in database in chronological order with 10 ms or better resolution time and shall be displayed on HMI display or printed out on a printer. The system shall automatically log the following events:

1) All alarm conditions as defined in Clause 5.4.5
2) All alarmed failure of substation and SCPS equipment returning to normal
3) All alarmed Analog value points returning to normal.
4) All status changes.
5) All operator intervention.
6) Placement and removal of all tags.
7) Changing of the measured value limits and scaling: the Contractor shall describe in detail how the two repositories are kept in sync
8) Any other important events input by PEA.

5.4.7 High-resolution Sequence-of-Events (SOE)

The SCPS shall include a high-resolution Sequence-of-Events (SOE) reporting capability. As a minimum, the status input points shall be assigned to SOE reporting in addition to normal status reporting.

The SCPS shall detect changes in the state of SOE points, record the date and time of change with a resolution of ± 1 ms relative to the SCPS internal clock, inform the DMS that SOE data has been recorded, and report SOE data to the DMS upon request.

The time tagging of all SOE inputs within a substation shall be made in the BCU and shall be synchronized to ensure that SOE inputs connected to different control cabinets satisfy the time resolution requirement. Time delays introduced by Contractor-supplied auxiliary relays used to acquire SOE status inputs from substation control circuits shall be consistent between devices to prevent time tag “skewing”.

Where the SCPS is used to acquire any of the specified data I/O via an interface to the IED devices such as substation Protective relays, the resolution time requirement shall also be applied for the information acquired from such Protective relays when they operated.

To ensure that SOE data is not lost or overwritten until the DMS acknowledges receipt of the data, a SCPS buffer capable of storing a minimum of 512 events shall be provided. The SCPS shall be able to retransmit stored SOE data if requested by the DMS.

5.4.8 Storage of System Disturbance and Power Quality Data

5.4.8.1 System Disturbance Data

The SCPS shall include a function for storing AC voltage and current waveform data prior to, during, and following power system disturbances detected as user-defined events. The stored data shall be made available to the DMS master station for post-disturbance analysis and shall be in an IEEE COMTRADE format.

At least 12 user-defined data track shall be provided for each measuring point of each switchgear bay. Each track shall be capable of storing data up to 1 second in one time window with a user-defined trigger. The capabilities for storing data of multiple disturbances such as auto-reclose on fault shall be provided.

Typical triggers include those that shall occur when events such as overvoltage and undervoltage are detected. In general, however, the ability to define event triggers based on calculated as well as actual data points shall be provided.

When an event occurs, the SCPS shall save the contents of the associated time window together with a time-stamped event flag. This flag shall identify the event type and shall be made available to the DMS master station for use by its Disturbance Data Collection function. The user shall be able to specify whether the contents of the saved buffer should remain frozen until collected or released by the DMS.

Where the SCPS is used to acquire any data of the specified functions via an interface to the IED devices such as substation Protective relays or power meters, the overall system performance and responses as called for in theses specifications shall not be compromised.

5.4.8.2 Power Quality Data

1) Harmonics

The SCPS shall be able to calculate, record and display harmonics for all AC voltage and current input points. As a minimum, the following requirements shall be provided:

a. Total harmonic distortion (THD) expressed as a percentage (%) of the fundamental amplitude based on a computed resolution of all harmonic frequencies up to and including the 25^{th} order. The SCPS shall continuously monitor the %THD for each AC voltage and current input and the detection of surpassing of user predefined limit shall create a time tagged event together with %THD and the time tagged event when the %THD returned to its 'normal' operating range.

   The SCPS shall save the %THD event as a database record for reporting to the HMI and the DMS master as required. The SCPS shall be capable of saving at least 256 such events in its database.

b. An analysis of the harmonic spectrum, which shall include the amplitude, expressed as a percentage of the fundamental frequency, for every harmonic frequency from the 2^{nd} through to the 25^{th} order. Provision shall be included for PEA to select any or all of the harmonic frequencies that it may require for inclusion in the SCPS database for reporting to the HMI and DMS master station as required.

2) Voltage Sags and Voltage Swells (This is the function of a Digital Fault Recorder (DFR), of which details are in Annex 10.)

The SCPS shall include the function to acquire, calculate, and store voltage sags and voltage swells data.

Voltage sag and swell recording shall be available for every AC voltage input to the SCPS. The function shall provide for the recording, time tagged to 100 millisecond, of an excursion outside user definable limits, together with the average deviation from the limit barrier, the peak deviation from the limit barrier and duration of sag/swell.

The SCPS shall save the sag/swell event as a database record for reporting to the HMI and the DMS master as required. The SCPS shall be capable of saving at least 256 such events in its database.
Where the SCPS is used to acquire any data of the specified functions via an interface to the IED devices such as substation Protective relays or power meters, the overall system performance and responses as called for in theses specifications shall not be compromised.

5.4.9 Fault Current Detection

The SCPS shall provide the facilities for detecting and reporting a fault current level for each of its AC current inputs. The function shall provide for the recording, time tagged to 10 millisecond, of an excursion outside user definable limits, together with the peak deviation and the time that the measured value returned to a point below the user defined trigger level. The limits of the fault current amplitude resolution shall be 20 times normal full load, and the trigger point for saving the record shall be user definable.

The SCPS shall save the fault current detection event as a database record for reporting to the HMI and the DMS master as required. The SCPS shall be capable of saving at least 256 such events in its database.
Where the SCPS is used to acquire any data of the specified functions via an interface to the IED devices such as substation Protective relays or power meters, the overall system performance and responses as called for in theses specifications shall not be compromised.

5.4.10 Tagging and Labelling

The proposed SCPS shall provide labelling and tagging facilities which allow the substation operator to indicate the presence of control suppression, live line working, advise of the control status of a device and allow limited control of the system's scanning and alarm processing functions. The OFF NORMAL and EVENTS list entries shall record the application of these tags and labels. The minimum requirement for labels and tags shall be but not limited the following:

5.4.10.1 Out of Scan Tag

A visual tag indicating that scanning of a device has been suppressed by the operator. All other system functions shall also be suppressed for such a point. It shall be possible to place screen comments regarding the status of tagged points.

5.4.10.2 Alarm Suppression Tag

A visual tag indicating that alarm processing on a system point (a device or measured value) has been suppressed by the operator. Status/Value information shall continue to be scanned and displayed. Provision shall be made for single point and functional group alarm suppression.

5.4.10.3 Live Line Working Tags

A visual tag indicating that some of PEA workers are doing some maintenance task on the line outside substation territory while the line is being energized. When this tag is applied to any line protection circuit breaker, selection of an auto-reclosing device of such circuit breaker shall result in a message to the operator e.g. CB_ AUTO-RECLOSING CONTROL BLOCKED.

5.4.10.4 Control Suppression Tag

A visual tag indicating that primary system equipment appearing on the HMI operator display has been suppressed. Selection of a device with control suppressed shall result in a message to the operator e.g. CB_ CONTROL BLOCKED.

5.4.10.5 Method of Application of Tags and Labels

The tags and labels shall be quickly and easily applied by the operator. The preferred method shall be by using cursor positioning and a simple keystroke sequence to apply any of the tag to any point/device on operating diagrams.

5.4.11 Interlocking

The closing or opening operation of primary equipment such as circuit breakers, disconnectors, earth switches, etc. shall be supervised by the appropriate predefined interlocking. The facilities for interlocking maintenance shall also be provided.

5.4.12 Load Reports and Load Curves

Analog measured and calculated values shall be recorded in historical data file at the end of each half hour (snapshot) for subsequence reports creation. As a minimum, daily load report, monthly load report, peak & light load report and yearly load report of each incoming and outgoing shall be provided and shall be in accordance with typical printout report format provide in Annex 5. These reports shall be able to be shown on the HMI display, with the required format at any time by the operator. Screen menus shall be provided for operator to select the required period of information by entering date(s), month and year. Daily and monthly load curve creation shall also be provided by using such stored data. The delay between the completion of an operator's keying sequence and the response of any report or curve display as observed on the HMI display shall not exceed 5 second.

A substation will provide the format text file Mircrosoft Access for load reports and load curves save to Local HMI and the format text file CSV for send to a SCADA control centre.

5.4.13 IED Device Management

The HMI software shall be capable of IED device management via the router and firewall for remote the IED devices management function such as setting and resetting of all Protective relays and BCU.

5.4.14 Archiving

The SCPS system shall be able to take care of archiving data on measurements, events, alarms, and fault records to hard disk. The hard disk shall be capable of storing all of above data for at least 1 year. The data stored on a hard disk shall be in the form of standard databases and shall be processed by means of the system itself as well as by means of the other standard packages such as Ms-Access, etc.

5.4.15 Operation Screen Displays

The operation screen displays for the monitoring and control of the substation shall include but not be limited to the following:

1) Detailed equipment status, and network configuration information.
2) Visual indication of device setting, selection, operation and interlocking
3) Service and measurement values, including analog measurements and their limit setting.
4) Alarm annunciation.
5) Visual record of system alarms, including fault information, events and SOE.
6) A means of displaying the status of devices that are not monitored automatically but are under the substation operator's control such as application of tags or labels.
7) If keyboard inputs have not been received for 1 hour then the screen shall revert to screen saver mode.
8) IED internal events.

5.4.15.1 Display Layout

Each page of the operation screen displays shall consist of at least the following 4 areas:

1) Title area consists of display title, date and time field, and system wide control mode (SCPS/SCADA Control Center).
2) Main operator selected display area.
3) Button menu area which allow the operator directly access into each display group or subsequent subordinate display.
4) Alarm area consists of at least two lines displaying the latest unacknowledged alarms. The main purpose of this field is to indicate the present and whereabouts of an unacknowledged alarm in the system.

5.4.15.2 Display Groups

The display system shall be organized and accessed in a systematic manner. A standardized display structure shall be operationally desirable. The structure shall be such that it shall be accessed in the following groups each providing access to the subsequent subordinate displays.

1) Communication and SCPS Equipment Overview Group
   a. Communication Network Diagram
   b. SCPS Equipment Diagram
2) Substation Group
   a. Substation Overview Diagram.
   b. Substation Electrical Diagrams.
3) Lists Group
   a. Event/SOE List.
   b. Alarm List.
   c. Off Normal List.
   d. Systems /Communication List.
4) Substation Area Data Group
   a. Operating Administrative Data (common page).
   b. Station and System Data (common page).
5) Substation Statistical Log Display Group

5.4.15.3 Communication and SCPS Equipment Overview Group

1) Communication Network Diagram

A representation of the HMI, SCPS Systems, relay, BCU and IED device, communication network, this diagram shall display equipment/communication path status (in service, out of service, standby) and serve as the operating diagram for those devices in the communications system under the operators control.

2) SCPS Equipment Status Diagram

This display shall show the status and assignment of operator assignable devices (e.g. printers). The display shall also serve as an operating diagram enabling operator assignment of system facilities. Where the size of the substation enables all functions and requirements of the communication network diagram and SCPS equipment status diagram can be fulfilled by one diagram no separate display is required.

5.4.15.4 Substation Group

1) Substation Overview Diagrams

The substation overview shall be a non-operative diagrams and shall show:

   a. The status of:
      - All circuit breakers (CBs).
      - All disconnectors.

- All earthing switches.
- Group alarm indication for each bay

b. measured values (e.g. voltage (phase B-C), active power, reactive power, etc.) for:
- All interconnecting and power transformers.
- All transmission and distribution lines connected to the substation.

c. Necessary reduction of single line diagram detail shall be achieved by the removal of devices in the following order:
- CB's disconnector and by-pass
- Earthing switch
- Device numbering, however line and buse shall be named/identified in the manner required by PEA standard.

Consistent orientation shall have to be maintained between the substation overview diagram and subsequent substation electrical diagrams.

2) Substation Electrical Diagrams

These diagrams shall be the only diagrams through which control of substation equipment shall be exercised. Fully detailed single line diagrams, the substation electrical diagrams shall be displayed as at least one page per nominal bus-voltage, except in the case of smaller stations where complete diagrams for two or more bus voltages shall be displayed on a single HMI display page. Each diagram shall have to display but not be limited to the following:

a. All devices relevant to normal operation.
- CBs
- Disconnectors
- Earthing switches
- Buses
- Lines
- Cables
- VTs
- Power transformers
- Station service transformers
- Capacitors
- etc.

b. All measured and calculated analog values
- Voltage
- Current
- Active and reactive power
- Power factor
- Power transformer tap number, temperatures

- % THD

c. Additionally, the diagrams shall show:
   - The duty VT with its measured voltage, frequency, its number and its phase.
   - Equipment numbers
   - Line numbers and names
   - Nominal bus voltages

The diagram orientation shall have to be consistent with the overviews. Where the diagram of the substation is divided between HMI display pages, overlap of the diagrams shall be as follows:

a. Diagrams at the same nominal voltage (e.g. 2 or more diagrams showing parts of a bus), the overlap shall be to the extent of one switching device (CB or disconnector) which should be controllable from either picture.

b. Diagrams of different voltages (e.g. diagrams dividing the network at interconnecting or power transformers), The overlap shall be:
   - For feeders, no overlap.
   - For interconnecting and power transformers, there shall be an asymmetric overlap as follows:

The HV picture shall include the MV side of the transformer with no MV disconnectors or CBs shown. The HV CB shall be operable from the HV picture. The MV picture shall show the HV circuit up to the connection to the HV bus i.e. the picture shall show HV disconnectors CB's and all MV equipment. The HV switchgear shall be operable from the MV picture.

The overlap shall be required to enable transformer switching to be accomplished from a single diagram, the MV diagram, avoiding the need to change pictures in the middle of switching operations.

5.4.15.5 Lists Group

1) Event/SOE List

The event list shall consist of a chronologically ordered listing of all events stated in Clause 5.4.6 and 5.4.7.

However the event list shall performs several functions, the most important of which are considered to be:

a. The provision of operator data.
b. The provision of computer maintenance related data.
c. The provision of area post-mortem analysis data.

While the simple chronological list may satisfy items (b) and (c) it does not readily satisfy the first requirement. In particular the event list for the operators' use shall not include computer system events; this may be achieved by provision of two or three event lists or by any suitable sorting scheme. Irrespective of the method of achieving this division of event lists shall be readily accessible and shall provide the facility enabling their review via the HMI display for the period of at least the preceding 1 year.

An Event/SOE list shall be able to be exported to pdf and/or excel file formats.

2) Alarm List
The alarm list shall be a fixed length "first on first off" stack of chronologically ordered entries of alarms that have occurred in the system. The size of the "stack" shall ensure that alarms generated by the largest credible disturbance in the substation shall be retained without loss of unacknowledged alarms from the alarm list.

The structure of the Alarm List shall be such that it may by accessed in its entirety or accessed in sublists based on priority. The manner of access is to be the operator's choice. In larger installations where the possible size of the sublists warrants, the station sublists shall be divisible into further lists based on bus voltage and priority.

3) Off Normal List
Off normal list shall contain descriptions of all devices that are not in their normal state. This shall include situations that have not been reset by the operator, SCPS/local switches in the local setting, devices for which control has been blocked etc.

4) Systems/Communication List

5.4.15.6 Substation Data Group

This group shall be intended to contain data useful to the operator of a semi-permanent nature. This shall be considered to be of two forms:

1) Operating administrative data e.g. telephone numbers, addresses etc.
2) System and Station Data e.g. load shedding schedules, operating limitations etc.

Provision shall be made in the HMI display system permitting at least 10 pages in each of these categories to contain defined data.

The Contractor shall state clearly how data/files in Substation Data Group be updated.

5.4.15.7 Substation Statistical Log Display Group

This group of diagrams shall permit the operator to view or printout any statistical logs, graphs, tables and trend plots compiled by the system.

5.4.15.8 Diagram Symbols and Conventions

The static symbols used in HMI displays shall as far as possible be consistent with the symbols defined by the PEA standard. Device status shall be indicated primarily by shape. Colour shall be used to indicate status but shall remain secondary to change of shape. Where colour coding is used to indicate status the following convention is preferred:

"Open" = green
"Closed" = red
"Changing state or undefined"= white
"Invalid" = blink white

Colour shall be used for the enhancement of HMI display diagram clarity (e.g. discrimination of voltages) provided no ambiguity of device status results.

Power flow (real and reactive) and current figures shall be shown with no sign or minus sign depend on the following conditions;

1) If the actual flow direction and static arrow symbol, which shown its normal flow direction, are in the same direction then the figure shall be shown without sign.
2) If the actual flow direction and static arrow symbol are in opposite direction then the figure shall be shown with minus sign.

Colours and indications shall be used to discriminate between acknowledged and unacknowledged alarms in the HMI displays alarm lists. In addition different colours shall be used for different priorities of unacknowledged alarms. As a minimum, 10 priorities shall be provided.

5.4.15.9 Modes of Operation

In order to control the scope of functions that users are authorized to operate; it shall be possible to assign the HMI to modes of operation. The functions permitted for each mode shall be defined in a table. PEA programmers shall be able to edit this table in order to change the authorizations of existing modes and to define new modes. Initial modes that shall be implemented by the contractor are tentatively defined below. Final definition shall be developed in consultation with PEA during the implementation of the project.

HMI applications can be run in different ways:

1) With Non-Automatic Login: When this type of login is configured, it will be the user who has to introduce the User and password of the Windows operating system and start the program from the start icon. A dialogue box will appear and will display the records registered in this node (installations and logged-on user), and the user will also be able to enter the necessary information in order to start the session in the SCADA system and run different actions on the installations.

2) With Automatic Login: The operating system will automatically start with a defined user in the application and in the panel. The initial applications will be launched directly, without showing the launcher dialogue. If the program does not find any configured the applications license or user, any hardware key entered, or there was no active installation, the program will switch into the same operation mode that is configured when login is no done automatically, so that the user can have an interface from where the proper programs can be launched and can carry out

the necessary configurations to start the applications. According to the shell type (including the user interface, task bar, desktop, Windows browser, dialogues, etc.), the behaviour of the Launcher program has been configured as follows:

a. Without Desktop: When restarting the PC, the desktop and the launch bar will not appear because they are not configured like the launcher. User intervention is not required to start it because the operating system will start the launcher and will carry out the necessary actions for starting the applications.

b. With Desktop: The user will have to start the program from the start icon and after this the panel and the starting applications will be launched directly, without displaying the launcher dialogue, as previously mentioned.

In order to complete the automatic start of the HMI, it is also necessary to have a PC which starts automatically when the device is powered on.

User Log-On Mode

Users shall be required to log-on to gain access to the SCPS system. The log-on procedure shall require entering an associated password. A list of authorized users shall be maintained, and a default operation mode shall be assigned to each user. Upon log-on, the HMI shall be put into the user's default mode. In order to facilitate the transition between station working shifts, it shall not be required for the current user to log-off before a new user logs on. Logging on and off shall be recorded in the Change Log. When nobody is logged on to a HMI, logging-on shall be the only function allowed at the HMI.

Operator Mode

The station operator is authorized to perform all the control and monitoring functions. See in clause Clause 4.3.15 Operation Screen Display.

Supervisor Mode

In this mode, the user shall be able to perform all the functions permitted in the Operator Mode. In addition, supervisors shall be able to manage the configuration of the SCPS system, change the operating mode, change the assignments of user passwords, set system-wide operating parameters, choose another set of limits, restart the system, request system warm restart, manage communications interfaces, etc. Any change to an operating parameter, whether it changes parameters in other IEDs or is stored and used strictly by the HMI unit, shall result in an entry to the Change Log. In cases where the change doesn't result in changes to other IEDs, the HMI unit still has to effect the change through the HMI, so that a Change Log entry is generated. This means that user-defined parameters, even for the private use of HMI unit functionality, must be represented within the Local Repository.

In particular, any HMI unit that is restarted or placed on-line at the site shall need to pick up the Change Log to determine the current values of operating parameters that have been changed from the default values. It has already been stipulated elsewhere in this technical specification that any HMI unit that is restarted or placed on-line shall gather and process all the system logs as part of its start-up procedures.

Maintenance Mode

This mode shall provide access to the HMI database and display editors, including programmable logic applications. Users shall be able to build, edit, integrate and test database and display changes, including programmable logic applications, but shall not be permitted to perform any power system operations. This mode shall be used to modify or reconfigure IEDs or the system at large, using the IEC 61850 SCL tools.

All editing and reconfiguration tools shall use version control, inserting version numbers into configuration files and archiving them in the preparation process. This mode shall be used to upgrade software in IEDs via file downloads. Software files shall carry version codes.

The contractor shall explain in his bid proposal how these capabilities will be implemented. To the extent these responsibilities involve file services, they are likely the same ones used by the Remote File Manager.

The Remote File Manager shall comprise software and any ancillary hardware running on a desktop or notebook PC. It shall provide the capability to remotely manage and perform file operations with a target SCPS system. These operations shall include file downloads (e.g. software, applications, configuration, data), uploads (e.g. configuration, data), file deletions, and file attributes.

In other words, it shall support all file services described under the File Management heading.

As these operations are to be performed from a remote location, care shall be taken to provide security measures. These capabilities shall require administrative passwords and be complemented by audit trail records to identify the person, platform, time, and file action for each remote operation.

Note that the latter may be fulfilled through the File Log records produced by the HMI at the station site. The contractor shall ensure that these capabilities work together in the intended manner.

Programmer Mode

Programmers and software developers shall be able to perform software development, debugging, integration, and configuration activities from the HMI Unit. Programmers shall also be authorized to perform all the maintenance mode functions.

5.4.15.10 Event and Alarm Processing

Events

The following occurrences shall be processed as events:

1) All changes of status points resulting from supervisory control commands. (These shall result in StatusLog entries.)
2) Substation operator's actions including, but not limited to, the following:
    a. Supervisory control. (These shall result in CommandLog entries.)
    b. Tagging and removal of tags. (These shall result in CommandLog entries.)
    c. HMI log-on or log-off. (These shall result in ChangeLog entries.)
    d. Changing of HMI modes. (These shall result in ChangeLog entries.)
    e. Alarm acknowledgement. (These shall result in AlarmLog entries.)
    f. Deactivation and activation of data and command points and of audible alarming. (These shall result in ChangeLog entries.)
    g. Manual substitution for process values. (These shall result in SubLog entries.)
    h. System warm restart. (These shall result in ChangeLog entries.)
3) Events declared by application programs. (These shall result in entries to the most appropriate system log, according to the defined purpose of each system log.)
4) Other conditions that may be specifically called out in this specification

Definition of Alarms

Alarms are the result of interpreting system events and determining which events generally require notification of the operator and further action. The following types of events shall be processed as alarms:

1) Uncommanded changes of state of status points
2) Limit crossing by Analog values from one defined operating region to another.
3) Failures of a device to respond to a supervisory control command
4) The passage of an SCPS system component (e.g. IED) to or from on-line status.
5) The power-up of an SCPS system component.
6) The detected failure of an SCPS system component (e.g. printer).
7) When a communications resource (e.g. SubLAN) experiences a high error rate (i.e. beyond a defined threshold).
8) Reported loss of heartbeat or abnormal heartbeat for any SCPS system IED.
9) When an alarm is declared by an application program.
10) Other conditions specifically called out in this specification.

PEA shall be permitted to add, delete or redefine conditions for alarming at any time before the entire contractor's design documents are approved. It shall be possible to assign points and specific alarm conditions to major and minor alarms. Therefore, for instance, it shall be possible to define the excursion of a value of an Analog value outside the operational limits as a minor alarm and exceeding of emergency limits as a major alarm.

Alarm Processing

1) Alarm Reporting

The following shall occur when an alarm is detected:

a. An audible tone shall sound.
b. The visual representation of the point in alarm (the status symbol, or the numerical value) shall flash.
c. An entry shall be made in appropriate Alarm Summary displays.
d. An entry shall be made in the Alarm and Event (A&E) file.

2) Alarm Inhibition

The station operator shall be able to inhibit alarm processing for any point. When a point is alarm-inhibited it shall be processed as usual, and Analog points shall continue to be shown in the colour (or other characteristic) that corresponds to their limits range, however no alarm conditions associated with the point shall be reported.

3) Alarm Tones

Different tones shall be used for major and minor alarms. If a minor, audible alarm is already sounding when a major alarm is generated for the same point, the tone shall change to that of a major alarm. The station operator shall be able to silence audible alarms at their workstations. The station operator shall also be allowed to inhibit audible alarming; however, a conspicuous indication shall be displayed as long as audible alarming is inhibited.

4) Acknowledgment and Deletion of Alarms

The station operator shall be able to acknowledge alarms. On Alarm Summary displays, it shall be possible to use the mouse or keyboard to select individual alarms or blocks of alarms for acknowledgement and for deletion from the summary. Deletion shall be permitted only for previously acknowledged alarms. When an alarm is acknowledged, its visual representation shall no longer flash.

Recording of Alarms and Events

1) Alarm Summary
   a. The alarm messages shall be shown in chronological order. The last page, with the most recent alarms, shall appear when a summary is called. Scrolling shall provide access to the complete summary.
   b. Only one (1) alarm shall be shown for a point. An old message for a point shall be deleted when a new alarm is generated for that point.
   c. The time field shall flash for unacknowledged alarms.

2) Alarm Log

An entry shall be made in an AlarmLog for each occurrence of an event that is defined as an alarm, provided alarming for the item is not currently suppressed (e.g. alarm-inhibited). The alarms shall be chronologically ordered. Unlike the Alarm Summary, the AlarmLog shall have a time-tagged entry for every occurrence, rather than just the most recent occurrence. The AlarmLog is not to be considered as one of the system logs. It is private to an HMI unit and only serves as an audit trail for the handling of Alarm Summary entries (e.g. alarm entry, acknowledgement, and deletion). The

AlarmLog shall be incrementally saved in non-volatile or disk memory. It shall be archived monthly.

The AlarmLog, along with the system logs (i.e. StatusLog, CommandLog, ChangeLog, SubLog, and FileLog) shall be part of the Historical Database (HIS), and entries shall be kept on-line for the period specified for historical data.

3) Alarm and AlarmLog Entry Format

All entries in Alarm Summaries and the AlarmLog shall be a maximum one (1) monitor line in length. Display and print versions shall be identical. No unduly cryptic abbreviations shall be used in alarm and AlarmLog entries. The exact format of the alarm and AlarmLog entries shall be subject to PEA approval. Alarm and AlarmLog entries shall contain the following information, as applicable:

a. Class or Priority Major alarm or minor alarm, indicated through colour and a symbol.
b. Date and Time:

   Date and time of the detection of the condition, or of the user's action. Date shall be in the format DD /MM/ YYYY.

   - The User ID (for user-initiated events)
   - Location (e.g. substation ID or application)
   - Point name
   - Point descriptor
   - Statement of the nature of the alarm or event

For status changes: TRIPPED/CLOSED/TRIPPED or 'Clearance Tag Placed'. For Analog value transitions between operating regions: The region entered, as well as the Analog value shall be stated.

CompositeLog Capability

As a result of an HMI unit's start-up or return to on-line status, it shall construct a CompositeLog for the station from the system logs it finds on the HMI. The system log entries shall be chronologically interleaved to produce the CompositeLog. CompositeLog entries from each system log (i.e. StatusLog, CommandLog, ChangeLog, SubLog, FileLog) shall be enabled or disabled for display and printing by a user, through the use of a supporting template. This action shall only affect display and printing for the user's convenience; it shall not change the content of the CompositeLog, which shall retain all entries. Printout of the enabled portion of the CompositeLog shall be in landscape mode. Each sheet shall have the field headings at the top. Two lines per entry are acceptable if the formatted arrangement is consistent, clean, and easy to read. To the extent possible, the arrangement of fields for the CompositeLog shall be compatible with the arrangement of fields for the Alarm Summary.

The CompositeLog shall maintain entries for the prior 100 days, including the present one. At the end of each calendar month (or at the first opportunity thereafter), all entries for the just-completed month shall be saved in a separate 'CompositeLog Archive', regardless of whether event entries have been acknowledged on the Alarm Summary display. CompositeLog Archives shall be saved on the local disk and on all HMI(s). File names for these archives shall be labeled as follows:

CompLogArchive%'StationName'%'Year-Month'.log (actual name) (actual year & month)
Operators shall be able to open and display LogArchives on a view-only basis. They may be printed in the same format as the CompositeLog if a printer is available. CompositeLog archives shall not be deletable at an HMI unit, but may be duplicated to separate media (e.g. a portable disk) for backup or analysis at a different site (where deletion shall be allowed).

The operator shall have the capability to enter a mode in which he can select and sort CompositeLog entries for viewing and printout (if a printer is available), using various field-related search keys. For example, he should be able to search for events related to a specific circuit breaker, across a particular period of time. It shall be possible to apply several search criteria at the same time.

The 'annotation' field shall provide quick-reference information for each line entry. More than one annotation code may be used for the field entry (e.g. 'm e').

1) 'C' for command
2) 'M' for major status alarm
3) 'M/' for transition out of major alarm
4) 'm' for minor status alarm
5) 'm/' for transition out of minor alarm
6) 'S' for manual value substitution
7) 'S/' for return to actual system values
8) 'F' for file transfer
9) 'D' for file deletion
10) 'P' for a configuration parameter change
11) 'e' for entry time (when date & time reflect Alarm Summary entry time, rather than a timestamp from the data source).

Log Displays

1) System Logs
    a. StatusLog
    b. CommandLog
    c. ChangeLog
    d. SubLog
    e. FileLog

2) CompositeLog

An operator shall be able to selectively enable which system logs are used for displaying or printing CompositeLog entries. Entries from the enabled system logs shall be chronologically interleaved, with the most recent entries at the bottom.

3) AlarmLog

This display is for viewing AlarmLog entries in chronological order, with the most recent entries at the bottom.

5.4.16 System Management Displays

These are displays for monitoring and controlling the SCPS system. They shall include:

1) System Configuration Control Display
2) HMI Assignments Display, for the management of HMI modes
3) Display for monitoring and controlling the SubLAN

Control Capabilities

1) Primary Controls

These shall provide control capabilities for the primary system equipment (e.g. circuit breakers, disconnects, earthing switches, power transformer LTCs, recloser enable/disable) through the substation's one-line diagram, using select-before-operate control procedures.

2) Device Tagging

This control capability shall allow controllable devices to be tagged, so that control is by SCADA/DMS, an HMI, or any other system or enterprise client is inhibited. This electronic tagging shall be coordinated with use of physical tags on manual control boards and panels. The Tagged Device Summary shall show the system devices that are currently tagged.

Tagged devices must be clearly indicated on the one-line station diagram.

3) Recloser Mode Selection

This control shall allow recloser modes to be selected according to the prevailing situation (e.g. normal, storm, high wind). It shall be supported by a display of the current mode setting.

4) Relay 'Settings Group' Mode Selection

This control shall allow a particular Protective relay group setting to be activated, when multiple group settings are available. It shall be supported by display of the currently active setting.

5) Primary HMI Selection

This control shall allow the operator to designate which HMI is managing the station, if two are provided. If there is only one HMI, this capability shall be disabled. If enabled, the primary HMI shall be identified in the Station Status Display.

6) Value Substitution

This control capability allows the operator to set substitute values for malfunctioning data points. IEC 61850 substitution services and object references shall be used to carry this out.

7) HMI Restart

This control allows a warm restart or cold restart to be initiated.

8) Other Capabilities

a. Historical Data Reports

It allows historical data reports to be viewed and printed, as allowed by the tools and facilities provided by the Historical Data application. The data should be collected in a standard text file format, such as a csv format, so that the report of these data can be customized to fit different requirements of different departments of PEA. For each bay, the data collected on a daily basis should be at least, but not limit to, max, min average and snapshot (from every 30- minute interval) of various parameters such as V, P, I, Q, and PF etc.

The structure of data and data that will be collected, such as current, voltage, power, reactive power etc., shall be able to be modified via a configuration file.

b. IEC 61850 Configuration Control

The HMI unit shall be able to use the SCL tools (described under the System Configuration heading) off-line to prepare system and IED configuration files. Subsequently, it shall be have the capability to download these files to IEDs

c. Off-line Editing

Although the HMI shall be delivered with a set of displays already intact,

PEA personnel shall be provided with tools and procedures for editing the information to be presented on each display, as well as the screen layouts. These tools shall use IEC 61850 object references to identify data. System reports shall likewise be accommodated. The editing tools and capabilities shall allow PEA personnel to modify displays and related data on another off-line PC platform. The editing tools and capabilities shall apply to both text-based displays and one-line diagrams. They shall include use of graphical elements, dynamic behaviour (e.g. flashing, colour), displayed data, static text, and screen layout. The editing tools and capabilities shall allow PEA to modify and/or create the dynamic and static icons used to represent primary and secondary system components. The editing tools and capabilities shall allow PEA to designate whether alarms are major or minor, to determine the normal states for all status data (as appropriate), and to identify the electrical equipment contact associated with each status input (e.g. ‘b’, normally closed contact).

6. SCPS: PROTECTION REQUIREMENTS

6.1 GENERAL REQUIREMENTS

6.1.1 Scope of Work

The control and protection switchboard shall be designed for the control and protection as indicated by the drawings and as specified herein. IED Protective relays (or "Protective relays") and their associated auxiliary relays shall perform the functions as shown on the drawing entitled: "Protective Device Functions", for each substation. The Contractor shall furnish any necessary control and protection functions indicated, mounted and wired as required, whether such devices are itemized herein or not.

The initial list of required I/O data points are provided in Annex 4.

Any modifications to the arrangement indicated or arrangement of equipment not shown shall be subject to the approval of PEA.

The protection system of the substations 115 kV and MV is based on the principle of local back-up. In some other terms, any fault occurring anywhere on an outgoing line, transformer or on the busbar should be detected and cleared locally by the relays and circuit breakers located in the substation concerned, before the distance or back-up relays located in the second zone, and controlled by the adjacent substation can be operated. This should be the case under normal operating conditions or in the event of the failure of one element of the protective chain - i.e. the failure of a relay, circuit breaker, circuitry instrument, battery.

Digital Fault Recorder (DFR) for a switching substation is an optional, which PEA shall specify its requirements case by case. At the minimum, the DFR shall conform with the specification given in Annex 10.

6.1.2 Reference Standards

All equipment, materials, fabrication and testing under this Specification shall conform to the latest applicable standard specifications and codes contained in the following list, or to equivalent applicable standard specifications and codes established and approved in the country of manufacturer of the equipment. Where standards are mentioned by name, equivalent applicable standards may be used.

IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-27, IEC 60068-2-78, IEC 60255-3, IEC 60255-27, IEC 60255-26, IEC 60870-5-101[2], IEC 60947-1, IEC 60947-7-1, IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5; see more details in Clause 2.2 Specific Relevant Standards.

Any details not specifically covered by these standards shall be subject to the approval of PEA. In the event of contradictory requirements between such standards and this Specification, the terms of the Specification shall govern.

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[2] *The standards IEC 60870-5-101, IEC 60870-5-103, IEC 60870-5-104 have been included in this specification but there is a word of caution. The biggest advantage of IEC 60870-5-104 is that it enables communication via a standard network, which allows simultaneous data transmission between several devices and services. Apart from this, the same pros and cons apply to IEC 60870-5-104 sand IEC 60870-5-101. IEC 60870-5-104 limits the information types and configuration parameters defined in IEC 60870-5-101, which means that not all functions available IEC 60870-5-101 are supported by IEC 60870-5-104. For instance IEC 60870-5-104 does not support short time stamps (3-byte format), the length of the various address elements is set to defined maximum values. But in practice, vendors very often combine the IEC 60870-5-101 application layer with the IEC 60870-5-104 transport profile, without paying attention to these restrictions. This might then lead to problems, if a device strictly applies the standard.*

6.1.3 General Design

6.1.3.1 Details of Switchboard Construction

Each control switchboard, each control and protective relay switchboard, each protective relay switchboard and each interposing relay cabinet, shall consist of an assembly made from not less than No. 3.0 mm levelled sheet steel and formed steel members as required to form a rigid self-supporting structure. No butt surface joints shall be made on the outside surfaces of switchboards and cabinets. No holes or fasteners shall be visible as viewed from the front of the panels. Switchboards and cabinets shall be designed to have bottom sheets and each bottom sheet shall be provided with gland plate which shall be made of a non-magnetic metal. Each gland plate shall be provided with adequate quantity of holes for control cable entrance from underneath the switchboard and cabinet. They shall be furnished with channel bases. The front and rear panels of the switchboards and the cabinets shall have bent angle or flange edges with an outside radius not exceeding 10 mm.

The construction details of the switchboards shall be as shown on Drawing No. OOT10N.
Finished panel surfaces shall be free from waves, bellies, or other imperfections. Exterior and interior surfaces shall be cleaned by sanding and steam cleaning, ground smooth, filled, primed, sanded and shall be finish-painted inside and outside with RAL 7032.

6.1.3.1.1 Control Switchboard

Each control switchboard shall be of the enclosed type.
Each enclosed switchboard assembly shall consist of basic panel assemblies, and necessary bolted-on floor channels, top sheets, and rear enclosure covering the back. Access to each switchboard section shall be provided by two hinged flat rear doors. The access doors shall be equipped with locks, latches, fully concealed hinges and handles.

Both sides of each control switchboard shall be enclosed.

End trims of the two end sections shall be readily removable so as to permit future control boards to be installed at both ends.

Mounting brackets as required shall be arranged on the rear of panels for mounting auxiliary equipment. They shall be located to allow access to the back of the equipment mounted on the front of the panels.
If the auxiliary equipment mounted on the brackets prevent access to the rear of the equipment on the front of the panels, then mounting brackets shall not be acceptable and the auxiliary equipment shall be mounted on hinged panels instead.

The enclosed switchboard panel size shall be 1,000 mm deep. The height, channel base, and panel width shall be as indicated on the drawings entitled : "Control Switchboard and Swing Rack type Protective relay Switchboard Equipment Layout" for 115 kV Breaker and a Half (with / without transformer) Substation.
The detail of each enclosed switchboard shall be as shown on Drawing No. OOT10N.

All control, selector, recloser, cutoff and other switches shall be of the direct control type without using any interposing relays.

There shall be furnished in the control switchboard one fluorescent lamp, mounted and wired inside the top of the switchboard for interior lighting and controlled by a cutoff switch on the hinged rear door, so that the panel light is automatically extinguished when the door is closed. One duplex receptacle outlet of single-phase, 2-pole, 3-wire grounded type 15A at 250 V shall be furnished mounted and wired in a convenient location near the hinged rear door. The light and duplex receptacle outlet shall be connected to the 125 V DC, with grounded wire, AC source furnished by PEA.

Each basic panel assembly for the control switchboard shall be a self-contained unit with factory wiring complete to conveniently located terminal blocks for the incoming cables. Each shall have vertical side members, which include vertical raceways and raceway covers for factory wiring, and shall be bolted to the right and left sides of the basic panel.
These side members shall provide separate raceways to house, protect, and conceal the incoming cables and inter-panel leads. Terminal blocks shall be furnished and mounted in vertical rows on both sides of the basic panel assembly.

Suitable wire slots with rubber bushings in vertical rows on both sides of the basic panel assembly near terminal blocks shall be provided for outgoing leads.

Each basic panel assembly shall be readily removable without disturbing the control switchboard assembly.

Each control switchboard shall be designed to provide cable entrance at the bottom of the switchboard in accordance with the requirements of Clause 6.1.3.1.

6.1.3.1.2 Swing Rack Type Switchboard

Each switchboard shall be of the swing rack type, consisting of a swing rack assembly, top sheet and rear enclosure covering the back and ends of the entire structure. Each cabinet shall have a front cover door equipped with a glass window for viewing all targets and indications. The cabinet door shall be equipped with locking handle, latches, fully concealed hinges, and complete with screened louvers at the top and bottom.

The cabinet door shall be hinged on the right hand side, front view. The relay rack assembly shall be hinged on the left hand side, front view.

Swing rack type switchboards shall have two types: one type shall be the control and protective relay switchboard and the other type shall be the protective relay switchboard.

- Each control and protective relay switchboard shall be provided with conventional bay control consisting of breaker discrepancy control switch, synchronizing selector switch, recloser cutoff discrepancy control switches for 115 kV motor operated disconnect switches, electrically operated ground semaphore switches, light boxes for indicating bus and line energized and symbols and mimic buses. One annunciator assembly and one IED power meter shall be provided for each bay control. There shall be digital bus voltmeter (s) provided for each main bus. This conventional bay control complete with symbols and mimic buses shall be as indicated on the drawing entitled: "Control and Protective Relay Switchboard Equipment Layout" for each substation. All conventional bay control switches shall be indirect control by using interposing relays to accomplish the control functions of the substation.

All other cutoff and pushbutton switches for auxiliary tripping and lockout relays for transformer and bus differential and breaker failure protection and all reset pushbutton functions shall be of the direct control type without using the interposing relays.

- Each protective relay switchboard shall be used in conjunction with the control switchboard in Article 6.1.3.1.1 and as indicated on the drawing entitled: "Control Switchboard and Swing Rack Type Protective Relay Switchboard Equipment Layout" for 115 kV Breaker and a Half (with / without transformer) Substation, and shall also be used with the swing rack type control board as indicated on the drawing entitled: "Control and Protective Relay Switchboard Equipment Layout" for 115 kV Substation Connected by Tie Line. All other cutoff, pushbutton switches shall be the same type as the preceding paragraph.

Each cabinet shall be designed for mounting standard 19-inch wide rack-mounted relays.

Each relay rack assembly shall be arranged to swing through not less than 150 degrees from closed position to allow easy access to the back of the equipment mounted on the rack and to the interior of the cabinet.

Each switchboard shall be provided with a vertical wiring duct complete with a cover for factory wiring and a vertical raceway and a raceway cover to house, protect, and conceal the incoming cables. The vertical wiring duct and the vertical raceway shall be arranged as shown on Drawing No. OOT10N. Terminal blocks shall be furnished and mounted in vertical rows on the back inside the switchboard and located between the wiring duct and the raceway as shown on the above drawing. All wiring which connects to the external circuits shall terminate on these terminal blocks. Provision shall be made for interconnection of wiring between switchboard sections.

Mounting brackets, as required, shall be arranged for mounting and wiring auxiliary equipment. They shall be located to allow access to terminal blocks mounted on the back inside of the switchboard.

Each switchboard shall be designed to provide cable entrance at the bottom of the switchboard in accordance with the requirements of Clause 6.1.3.1.

Panel openings of the swing rack assembly not utilized by equipment shall be covered by cover plates.

The switchboard size shall be 800 mm wide, 610 mm deep and the height shall be 2,300 mm plus a 40 mm channel bases.

There shall be furnished in the control and protective relay switchboard and the protective relay switchboard one fluorescent lamp for each switchboard, mounted and wired inside the top of the switchboard for interior lighting and controlled by a cutoff switch on the hinged rear door, so that the panel light is automatically extinguished when the door is closed. One duplex receptacle outlet of single-phase, 2-pole, 3-wire grounded type 15A at 250 V shall be furnished mounted and wired in a convenient location near the hinged rear door. The light and duplex receptacle outlet shall be connected to the 125 V DC, with grounded wire, source furnished by PEA.

6.1.3.1.3 Interposing Relay Cabinet

Each interposing relay cabinet shall be provided with the interposing relays for substation control and protection functions.

All relays shall be furnished complete with integral accessories, mounted and completely wired.

In general, control signals to the switchyard shall be first connected to the interposing relays before being connected to the relevant switchyard equipment.

The interposing relays shall be furnished mounted and wired with sufficient quantities to fulfill the requirements of substation control, indication, and protection functions as specified. Not less than 10 per cent spare of each function of interposing relays shall be furnished and mounted inside the cabinet, however the minimum of two spare relays shall be furnished and mounted for each function of the relays. The coils shall be suitable for continuous duty at their normal operating voltage. All contacts shall be of the renewable type with ample current-carrying and interrupting capacity for the application, and shall withstand at least 10 A at 1 second, 5 A at continuous duty, and be capable of interrupting 0.3 A of inductive current (L/R $\leq$40 ms) in a 125 V DC control circuit.

Where necessary, interposing relay shall be of the latched-in type especially for those concerning the mode selection functions.

Interposing relays shall be of the highly insulated type capable of withstanding 5 kV positive or negative pulses applied across the coils and between the coil terminals and ground with the contact assemblies bonded to ground.

Interposing relay cabinets shall be furnished and designed in accordance with Drawing No. OOT10N Each cabinet shall be an assembly enclosed at top and sides and shall have front and rear access doors for access to both sides of the center mounting plate. Interposing relays shall be mounted on both sides of this center plate. The front and rear shall each be provided with one hinged flat door and the rear shall be provided with two hinged flat rear doors. Access doors shall be equipped with locks, latches and fully concealed hinges.

Each cabinet shall be 915 mm wide, 1,000 mm deep and the height shall be 2,300 mm plus a 40 mm channel base.

Each cabinet shall have vertical side members, which include vertical raceways and raceway covers for factory wiring, and shall be bolted to the right and left sides of the cabinet. These side members shall provide separate raceways to house, protect, and conceal the incoming cables and inter-panel leads.

Terminal blocks shall be furnished and mounted in vertical rows on both sides of the cabinet. The number of vertical rows and the arrangement of terminal blocks shall be in accordance with the Drawing No. OOT10N. All wiring which connects to the external circuits shall terminate on these terminal blocks.

Each cabinet shall be designed to provide cable entrance at the bottom of the cabinet in accordance with the requirements of Clause 6.1.3.1. There shall be four (4) cable glands: two cable glands at the right side and other two at the left side of each interposing relay cabinet as indicated on the Drawing No. OOT10N

6.1.3.1.4 Hinged Synchronizing Panel

Each hinged synchronizing panel shall be fabricated from not less than 2.5 mm leveled sheet steel and shall be approximately 200 mm wide, 600 mm high, and 200 mm deep. If specified, each hinged synchronizing panel shall be furnished and shall constitute a part of each control switchboard or control and protective switchboard assembly. Each shall be designed to swing back in line with the other panels when not in use to present straight line appearance. Each shall be readily removable and re-installed when future control board installation is required. The rear sheet shall be readily removable for access to the instruments and wiring in the panel.

1) One – Twin indicating voltmeter, 0-150 V scale, 150 V coil, 50 Hz, 144 mm square face, for incoming and running potential.

2) One – Twin indicating frequency meter, 48-52 Hz scale, 115 V, 144 mm square face, for incoming and running frequency.

3) One – Synchroscope, 144 mm square face.

4) Two – Synchronizing lamps, 15 W each, clear, to be connected to indicate synchronism.

6.1.3.1.5 Drawings and Data Requirements.

The Contractor shall submit for approval the following drawings and data, sufficient to demonstrate fully that the equipment to be furnished shall conform to the requirements and intent of this Specification.

1) Metering and Relaying Diagrams. The metering and relaying single line diagrams of each substation are included in this Specification. The Contractor shall supply single line diagrams showing conformity with the specified requirements indicating clearly changes necessitated by the proposed equipment.

2) Three Line Diagrams. Each three line diagram shall show voltage and current connections to all metering and relaying equipment.

3) AC Schematic Diagrams. All diagrams shall show AC connections such as AC supply to all metering and relaying equipment, synchronizing schematic diagrams, etc.

4) DC Schematic Diagrams. All diagrams shall show the DC wiring for control, indication, annunciation, protection, etc., arranged in a schematic form and shall include the necessary wiring of all power circuit breakers that received a trip signal from the protective relays that are listed in the drawings, "Protective Device Functions", for each substation. On each schematic diagram where the main relays or auxiliary relays are shown, all contacts for indicated relays shall show the detailed functions of the contacts to be used, including the reference drawing near the relevant relays.

   For the annunciator, the Contractor shall furnish enough information in detail to understand complete operation of the annunciator system. It shall be furnished with a description of the operation of each component and an explanation of the operational sequence of each component in regard to the overall annunciator scheme. All components shall show internal schematic diagrams and circuit board illustrations.

5) Logic Diagrams. Logic diagrams shall show details of the logic control circuits for each individual control and protection equipment.

6) Wiring Diagrams. Wiring diagrams shall show connections from point to point for all control board equipment. All the wiring connections to the equipment on any one panel shall be shown on the same drawing. Inter-panel connections shall be properly identified on both the incoming and outgoing panel drawings.

   Wiring list or tabular type wiring diagrams shall not be accepted.

7) Control, Selector, Cutoff and Pushbutton Switches-Contact Tabulation Diagrams. Contact tabulation diagrams of control and other switches shall show terminal arrangement, escutcheon plate and contact tabulation. On each schematic diagram where switch contacts are shown, switch position tabulations for the indicated switches shall be included somewhere on the same drawing.

8) Nameplate Schedule Diagrams. A nameplate schedule diagram for each substation shall show designations on all nameplates. The wording of each nameplate designation may be revised to satisfy physical limitations subject to the approval of PEA.

9) Annunciator Schedule Diagrams. An annunciator schedule diagram for each substation shall show annunciator designations for all the annunciator points including spares provided. The wording of each annunciator designation may be revised to satisfy physical limitations subject to the approval of PEA.

10) Equipment Layout Diagrams of Switchboards and Cabinets. Each equipment layout diagram shall show dimensions, location, and general layout of all panels and all equipment to be located on the panels.

11) Switchboard and Cabinet Construction. The Contractor shall provide for approval the general assembly drawings including dimensions, details of arrangement plan and section and floor plan complete with anchor both setting plan.

The equipment as indicated on the control switchboards, protective relay switchboard, control and protective relay switchboards and the interposing relay cabinets, shall cover only the major equipment. It is to be understood that, all other associated auxiliary equipment and accessories, although not indicated on the drawings entitled: "Control Switchboard and Protective Relay Switchboard Equipment Layout, Control and Protective Relay Switchboard Equipment Layout, and Interposing Relay Cabinet Equipment Layout", but necessary for the complete and sound functions of the switchboards and cabinets as described in this Specification, and as generally accepted as the applicable standards, shall be furnished by the Contractor. The Bidder at the time of bidding shall, to the best of his knowledge, furnish the list showing quantity and details of all the equipment he intends to supply.

The switchboards and cabinets proposed shall give the best optimum result as called for in this Specification, and as basically required by standard electrical engineering practice.

The Contractor, after having finished the design of the switchboards and cabinets shall submit PEA for approval all the design details including individual equipment of the switchboards and cabinets, and to all associated equipment in the substation, and showing overall functions of the schematic diagrams. PEA shall then review the schemes, and should any proper functions required in this Specification or required for sound engineering practice of the switchboards and cabinets entail necessary modifications to the scheme or additional equipment other than those originally proposed by the Bidder at the time of bidding, PEA will return the scheme to the Contractor to carry out the modification required without any extra charge to PEA.

6.1.3.1.6 Ground Bus

A 6 mm by 25 mm cross-section bare copper ground bus shall be provided at the bottom of each switchboard panel and each cabinet, to which the metallic cases of meters, instruments, relays and grounding circuits of all other equipment shall be connected. The grounding buses shall be solidly bolted to the steel framework so as to make good electrical contact. Solderless lugs or terminals shall be provided on the ground buses for terminating No. 95-120 sq-mm stranded copper ground cables from the substation grounding system.

6.1.3.1.7 Wiring

All wiring used within the switchboards, interposing relay cabinets, shall meet the requirements of the Specification No. RSUB-015/2560 (Rev. 1.0) – SMALL WIRING and NEMA standard Publication No. WC5-1992/ICEA S-61-402 and shall be rated 600V, tinned, stranded copper switchboard wire and polyvinyl chloride insulated. All hinged wiring shall be extra flexible. Internal wiring of each basic panel assembly and each cabinet shall be neatly and carefully installed in suitable wiring ducts with removable covers and complete to conveniently located terminal blocks for connecting to incoming and outgoing leads.

The terminal arrangement shall group all leads for each particular function to facilitate connections to the incoming and outgoing cables. The arrangement shall be subject to the approval of PEA.

Wiring between inter-panel shall be made and routed through vertical raceways of the switchboards and cabinets. Such wiring shall also be terminated and reconnected in terminal blocks in order to permit convenient separation of individual panels or cabinets.

All incoming and outgoing cables shall enter the switchboards and the cabinets through cable slots in the floor underneath the switchboards and the cabinets.

Splices or tee connections shall not be permitted in control wiring or instrument leads.

Any control boards or cabinets that are split for shipment shall have terminal blocks adjacent to the split and shall be provided with wiring required to interconnect the split units.

6.1.3.1.8 Indicating Lamp

All indicating and pilot lamp assemblies shall be of the light-emitting diode (LED), complete with integrally mounted resistors, The indicating light assemblies shall be suitable for use with 125 V DC, switchboard type with colour caps. The colour caps shall be red, green, white, blue or yellow as required. All lamp bulbs shall be interchangeable, and shall be replaceable from the front of the panels.

6.1.3.1.9 Light Box

Each light box, for indication of line or bus to be energized, shall be of switchboard type. Each light box shall have a white translucent nameplate with machine-engraved, black lettering illuminated by backlighted with two lamps of 6 watt each. Each nameplate shall be engraved in accordance with the drawing entitled: "Nameplate Schedule Diagrams".

Each light box shall be 25 mm. high by 50 mm wide.

All lamp bulbs shall be interchangeable, and shall be replaceable from the front of the panels.

6.1.3.1.10 Test Switch

Test switches shall be of the separate type as specified. Separate test switches shall be of the switchboard, back-connected type, finished in dull black for front-of-panel mounting. All test switches shall be arranged to isolate completely the instruments from the instrument transformers and other external circuits and provide means for testing either from an external source of energy or from the instrument transformers by means of multiple test plugs which shall be provided for the purpose. A sufficient number of test plugs to make a complete test on one meter or instrument shall be furnished for each type of test switch. All test switches shall be arranged so that the current transformer secondary circuits cannot be open-circuited in any position while the test plugs or cover plugs are being inserted or removed.

Test switches and multiple test plugs shall be ABB, flexitest switches, type FT-1 or equivalent.

6.1.3.1.11 Terminal Block

The switchboards and interposing relay cabinets shall be provided with terminal blocks for termination of all wiring devices mounted in the switchboards and cabinets and all external circuits. Terminal blocks shall be of non-flammable, non-hygroscopic insulating material, rated for 600 V and conform to IEC 60947-7-1 and IEC 60947-1 standards. Except as otherwise specified, terminal blocks shall be furnished with two sizes; one size shall accept the conductor of 1.5 to 4.0 sq.mm, the other one shall be sized to accept the conductor of 2.5 to 6.0 sq.mm. Insulating barrier between adjacent terminal shall be integral part of the terminal block. Terminals shall have adequate current carrying capacity. All terminal blocks and terminations shall be grouped according to circuit functions. Each terminal block shall have removable white marking strip for marking circuit designation. One spare blank marking strip shall be furnished with each terminal block. The terminal blocks shall be well arranged in order that they permit safe wiring works on any terminal while all adjacent terminals are live.

The terminal blocks provided for CT circuit shall be of spring loaded screw-on type and they shall be provided with sliding switch bridge and test socket screws.

The terminal blocks provided for control, protection circuits and other circuits shall be of screw-on type. It shall be designed in such a way that after the terminal block is unscrewed, the wire is still engaged to the terminal block. All CT and VT wires, as well as control and protection circuits shall be terminated with blade type of cable lugs.

The arrangement of all terminal blocks shall be such that incoming and outgoing leads can be easily arranged for connections to terminals. Terminal blocks shall be located so that the accessibility to them will not be lessened by interference from structural members or panel instruments. Ample space shall be provided to terminal blocks for termination of all external circuits.

6.1.3.1.12 Nameplate

Nameplates shall be furnished and mounted by the Contractor. Each assembly, each piece of equipment mounted on an assembly, and each power and control circuit shall be provided with a nameplate. All nameplates shall be of laminated plastic material, black on the surface with a white internal layer. Lettering shall be machine-engraved into the nameplate to form white letters against a black background. All panel mounted nameplates shall be in accordance with the respective drawings showing nameplate schedule. A sample nameplate, showing the style of engraving to be used shall be submitted to PEA for approval. Nameplate engraving shall be subject to the approval of PEA.

6.1.3.1.13 Symbol and Mimic Bus

All symbols, devices and painted mimic buses, 10 mm in width, shall be provided on control switchboard and control and protective relay switchboard to form single line diagrams which will simulate actual electrical connections as indicated on the drawings entitled “Control Switchboard and Protective Relay Switchboard Equipment Layout” and “Control and Protective Switchboard Equipment Layout”. Mimic disconnect devices for ground switches shall be electrically operated to automatically position themselves in accordance with their respective ground switches. The mimic buses shall be painted on the front of the panels with lacquer or enamel. Color of mimic buses shall be as follows:

1) 115 kV - Light Orange
2) 33 kV - Dark Green
3) 22 kV - Blue

6.1.3.1.14 Control, Selector, Cutoff and Pushbutton Switches.

The control, selector, cutoff and pushbutton switches shall be of the multistage voltage type, rated 600 V, continuous duty, for both AC and DC services. Each contact shall be of the readily renewable, self-cleaning type and shall be of the wipe type. A rectangular front-of-the-panel escutcheon plate shall be furnished and engraved showing the switch positions of control, selector, cutoff and pushbutton switches. The switch identification shall be engraved on the escutcheon plate, or if necessary, on a separate adjacent nameplate furnished by the Contractor.

Details of individual switch shall be as described below:

1) <u>Breaker Discrepancy Control Switches (BDCS)</u> Each breaker discrepancy control switch shall be of the momentary contact, with fixed, modern, black handle with mechanical target engraved “Control on”, “Control off”, and shall also be engraved “on” and “off” which shall show the last function of the switch. Each switch shall include integrally mounted with the light-emitting diode complete with a series resistor.

2) <u>Discrepancy Control Switches for 115 kV Motor Operated Disconnect Switches (DSDCS)</u> Each discrepancy control switch shall be of the momentary contact type, with fixed, modern, black

handle with mechanical target engraved "Control On" "Control Off", and shall also be engraved "On" and "Off" which shall show the last function of the switch. Each switch shall include integrally mounted with the light-emitting diode complete with a series resistor.

3) Synchronizing Selector Switches (SS) Each synchronizing selector switch shall be of the maintained contact type, three-position "Automatic" "Normal" "Manual", complete with a key used as a handle, removable at "normal" position only to ensure that on one set of potentials can be applied to the synchronizing equipment at any one time.

4) Recloser Cutoff Switches (79CO) Each recloser cutoff switch shall be of the momentary contact type, three position " on" "normal" "off" with spring return to the normal position, with fixed, modern, oval black handle. Each switch shall be complete with an indicating red-light-emitting diode complete with integrally mounted resistor.

5) Transformer Differential Cutoff Switches (87T-CO) Each transformer differential cutoff switch shall be of the maintained contact type, two-position "on" "off", with fixed, modern, oval black handle. Each cutoff switch shall be complete with an indicating red light-emitting diode complete with an integrally mounted resistor.

6) Bus Differential Auxiliary Tripping and lockout Relay Cutoff Switches (86B-CO) Each differential auxiliary tripping and lockout relay cutoff switch shall be of the maintained contact type, two-position "on" "off", with fixed, modern, oval black handle. Each cutoff switch shall be complete with an indicating red light-emitting diode complete with an integrally mounted resistor.

7) Breaker Failure Cutoff Switch (50BF-CO) Each breaker failure shall be of the maintained contact type, two-position "on" "off", with fixed, a modern, oval black handle. Each cutoff switch shall be complete with an indicating red light-emitting diode complete with an integrally mounted resistor.

8) Pushbutton Switches (PB) Each pushbutton switch shall be of the heavy duty type and constructed for definite over-travel in both directions. Each shall be dust-proof, fully shrouded to prevent accidental operation.

9) Line Current Differential Cutoff Switch (87L-CO) Each line current differential cutoff switch shall be maintained contact type, two-position, "on" "off" with fixed, modern, oval black handle. Each cutoff switch shall be complete with an indicating red-light-emitting diode complete with integrally mounted resistor.

10) Direct Transfer Trip Cutoff Switch (86TT-CO) Each direct transfer trip cutoff switch shall be maintained contact type, two-position, "on" "off" with fixed, modern, oval black handle. Each switch shall be complete with an indicating red-light-emitting diode complete with integrally mounted resistor.

All switches shall be rated 20A, and shall be of the direct control switch function type without using the interposing relays. These switches shall be for use with the control switchboards in clause 6.1.3.1.1, and all cutoff and pushbutton switch functions for transformer protection, bus protection, breaker failure protection, auxiliary tripping and lockout relay contacts and relay resetting which are mounted on the "Control and Protective Relay Switchboards" and "Protective Relay Switchboards". These switches shall also be for use with the "Swing Rack Type Control Board" for 115 kV substation connected by tie line.

The total number of contacts and total number of contact tabulations shall be adequate for their required functions but minimum number of contacts and contact tabulation shall be at least as indicated on the Dwg. NO. OOT15N sheet #1 of #2.

In case of conventional control and protection are combined in the same switchboard, there shall be included with control switch functions, symbols and mimic buses, an annunciator assembly, and metering equipment for each bay in addition to the protective relaying system which is indicated on the drawing entitled: "Control and Protective Relay Switchboard" for each substation. The breaker discrepancy control switch, discrepancy control switch for 115 kV motor operated disconnect switch, synchronizing selector switch and recloser cutoff switch shall be the same as described above except that each switch shall be rated 10A and shall be of the indirect control switch function type and shall be accomplished the switch functions by using the interposing relays.

The total number of contacts and total number of contact tabulations shall be adequate for their required functions but minimum number of contacts and contacts tabulations shall be at least as indicated on the Dwg. NO. OOT15N sheet #2 of #2.

If the schemes for control, protection, and other equipment as proposed by the Contractor and approved by PEA, required additional contacts than those listed in this Specification and shown in the above drawing (OOT15N sheet #1 and sheet #2) the Contractor shall furnish these extra contacts and contact tabulations without additional cost to PEA.

6.1.3.1.15 Digital Voltmeter

Each voltmeter shall be flush mounted, back connected, dustproof, fully tropicalized, digital switchboard type for mounting one a steel panel. Each meter shall be suitable for operation with the instrument transformers shown on the drawing under both normal and short circuit conditions.

Each meter shall be for measuring the 115 kV line voltage with 3 VT's or 115 kV bus voltage with 1 VT as required and as specified for each substation. For measuring 115 kV line voltage, there shall be 3 VT's for each line except that the bus voltage, there shall be 1 VT connected with bus phase "B" and ground. Although the measuring of the bus voltage shall be phase-to-ground, the reading voltage displaying on the meter shall indicate phase-to-phase voltage.

Except as otherwise specified, the digital meters shall be approximately 96 mm x 48 mm.

Each digital voltmeter shall have the following characteristics and requirements:

Alphanumeric display	:	4 digits, red Light-Emitting Diode (LED)
VT ratio for each bus	:	$115000/\sqrt{3}$: 115 V // $115\sqrt{3}$
Decimal point	:	adjustable at front panel
Power supply	:	125 V DC, grounded wye

6.1.3.1.16 Digital Power Meter

Each power meter shall be flush mounted, back connected, dustproof, fully tropicalized, digital switchboard type for mounting on a steel panel. Each meter shall be suitable for operation with the instrument transformers shown on the drawing under normal and short circuit conditions.

Each power meter shall be capable of measuring and monitoring all electric quantities of the power system.

Each meter shall have the following characteristics and requirements:

Alphanumeric display	:	LCD with back lighting illumination
Parameter Setting	:	by a keypad on the front panel and complete with communication port
Power System	:	Three-phase, Three wire and Three-phase, Four wire (Balanced and Unbalanced loads)
Current input	:	1 A or 5 A
Voltage input	:	110 V or 115 V (Line-to-Line Voltage)
CT and VT Ratio	:	programmable
Measurement/Display	:	1) r.m.s. phase voltage, Line-to-ground (V_a, V_b, V_c, $V_{average}$)
	:	2) r.m.s. line voltage, Line-to-line (V_{ab}, V_{bc}, V_{ca}, $V_{average}$)
	:	3) r.m.s. phase current (I_a, I_b, I_c, $I_{average}$)
	:	4) active power (P_a, P_b, P_c, P_{total})
	:	5) reactive power (Q_a, Q_b, Q_c, Q_{total})
	:	6) apparent power (S_a, S_b, S_c, S_{total})
	:	7) import and export active energy (kWh_{total})
	:	8) power factor (PF_a, PF_b, PF_c, PF_{total})
	:	9) frequency
	:	10) others (if any)
Accuracy Class		
- r.m.s. phase voltage	:	0.5% of reading + 0.05% of FS
- r.m.s. line voltage	:	0.5% of reading + 0.05% of FS
- r.m.s. phase current	:	0.5% of reading + 0.05% of FS
- active power	:	0.5% of reading + 0.05% of FS
- reactive power	:	1.5% of reading + 0.05% of FS

- apparent power	:	0.5% of reading + 0.1% of FS
- import and export active energy	:	0.5% of reading + 0.05% of FS
- power factor	:	1.5% of reading
- frequency	:	0.05% of reading
Maximum demand	:	phase current (I_a, I_b, I_c), total active power (P_{total}), total reactive power (Q_{total}) and total apparent power (S_{total}), every 15 minute
Communication interface	:	LAN/Fiber Optict
Power supply	:	125 V DC
Insulation test voltage one minute	:	2 kV (r.m.s.)
Operating temperature	:	0 ^{o}C to 50 ^{o}C

Each digital power meter shall include the followings:

(1) Instruction manual

(2) Software package (s) for setting parameters and readout data via communication port.

Any features and necessary components to accomplish the necessary functions of the digital power meter shall be provided as required by the meter functions, whether such features or devices are not itemized herein or not.

6.1.3.1.17 Annunciator

Each annunciator system shall be of the solid-state type consisting of an annunciator module, input/out module, a connection module, a power supply module, a flashing device, and an annunciator horn relay. Each annunciator horn relay shall be wired to initiate the common horn. One common horn shall be furnished for each substation. The annunciator system shall operate from DC source with rated voltage 125 V DC.

Each annunciator system shall be compact and integrally mounted in a dustproof, back connected, flush-mounted switchboard type cabinet. Each annunciator shall have 16 alarm points including push buttons for the following functions: “Silence the alarm”, “Acknowledged”, “lamp reset” and “lamp test”. Each window shall be provided with a light-emitting diode and shall have a nameplate, covered with a translucent material, writing with black letters. Each alarm point shall be designed to operate either with field contact that closed for alarm or open for alarm.

A red group pilot lamp for indication of annunciator operation and a white indicating light assembly for monitoring availability of annunciator potential shall be furnished, separately mounted and wired with each annunciator system. They shall be suitable for mounting on the control board panel face.

The alarm horn shall be of the vibrating type, and shall be suitable for surface mounting inside the switchboard.

Each horn shall be furnished, mounted and wired inside the switchboard as specified and wired complete with a horn switch with 125 V DC rating and shall be also be mounted and wired inside the switchboard.

All signal inputs and outputs of annunciator modules shall be provided with optical couplers and RC filter circuits for high voltage surge protection.

Each annunciator shall be provided with a self-supervision system for continuously monitor the hardware and the software of the unit. The self-supervision shall also monitor and supervise the operation of the power supply module.

Each annunciator assembly shall be equipped with a serial interface at the rear port to provide communication with the remote computerized control system.

Each shall be provided with an event register, which stores at least last five events in chronological order. The event register can be read and displayed on the front panel or via the serial interface.

Each power supply shall be of the DC-to-DC converter regulated type and designed to protect it from high voltage and surge and to provide transient surge isolation between the station battery and the sensitive electronic components of the annunciator system. Each power supply shall be provided with necessary equipment to protect it from overloads that occur on the output side of the power supply. Each power supply shall include input reversed polarity protection and overvoltage and short circuit protection on the logic voltage supply. In the event of a short circuit on the power supply output, no damage will occur to the power supply.

Each annunciator system shall be designed for continuous operation at any voltage from 80 per cent to 120 per cent of rated voltage as specified and at a range of ambient temperatures of 10°C to 50°C and 0 to 94% humidity.

The annunciator operational sequence shall be manual lamp reset type and shall conform to the following table:

Designated Event	Visual		Audible
	Annunciator Lamps	Group Pilot Lamp	
Normal	Off	Off	Off
Alert	Bright flashing	On	On
Acknowledged (Horn Reset)	Steady On	Off	Off
Return to Normal	Steady On	Off	Off
Return to Normal before Acknowledge	Bright flashing	On	On
Acknowledged (Horn Reset)	Steady On	Off	Off
Reset	Off	Off	Off
Functional	Bright flashing	On	On

Each annunciator shall be designed so that the closing of a trouble contact shall flash the annunciator lamp, light the group pilot lamp and sound the alarm.

The operator shall then be able to silence the alarm, stop flashing and extinguish the group pilot lamp by pressing the horn reset pushbutton and extinguish the annunciator lamp by pressing the lamp reset pushbutton, provided the trouble contact has been opened.

Operation of the lamp reset pushbutton shall not cause the alarm to sound. Release of the pushbutton shall not cause the alarm to sound again whether or not any trouble contacts are still closed. Operation of an annunciator lamp shall not interfere with or cause false operation of any other annunciator lamp whether operated simultaneously or in sequence.

Wrong operation of any pushbutton shall not cause malfunction to the correct operation of the system.

Operation of the test pushbutton shall simultaneously simulate inputs and exercise the logic of each alarm point.

6.1.3.2 Protection System (IED Protective Relay)

Protective relays shall operate in conjunction with a SCPS equipment.

Protective relays shall be of IED type. Auxiliary ones such as undervoltage, trip circuit supervision etc… could be of electromechanical or static technology.

The substation is organized with a centralized control building for the whole of site.

All equipment of 115 kV/MV substation will be fed by Auxiliary or 125 V DC supply. All the equipment shall operate satisfactorily and shall not be subject to deterioration in the range of 80 to 110% of the nominal supply voltage.

For the lines, a full scheme IED distance protection shall be furnished to provide the primary pilot protection scheme for all substations, except the switching substations, which shall be protected by a line current differential primary pilot protection.

The backup protection for both types of primary pilot relaying, shall each be a directional overcurrent protection. They shall be directional phase and ground overcurrent relays for protection of phase and ground faults.

The transformers will be protected by differential relay of the IED type including restricted earth fault protection.

The busbar will be protected by a differential relay of the IED type protection, including breaker failure protection.

Equipment shall be protected against electrical and electro-magnetic disturbance and shall particularly comply with IEC 60255-27 and IEC 60255-26 standards.

6.2 DETAILED REQUIREMENTS

These requirements shall be considered as a minimum to be satisfied.

The protective relay shall be of the IED type with a documented past service period of not less than two years.

The protection system for transmission lines shall take into consideration the grounding network practice of the project. All transformers (Dyn or Yyn vector group) are solidly grounded on MV network, meanwhile PEA will improve in the future the low-resistance grounding method by the addition of a resistance in the neutral connection.

The system objective maximum fault clearance times are as follows:

- 100 ms: maximum fault clearing time of 1st step of distance protective relay
- 100 ms: maximum fault clearing time of busbar protection

In the event of a failure to interrupt fault current by the line Circuit breaker, the breaker failure must trip all the necessary adjacent circuit breakers within 250 ms starting from the primary protection release the trip command.

6.2.1 Documentation

The supply shall include, whether explicitly mentioned or not, all elements and drawings necessary to co-ordinate and ensure the correct function of the referred protection in compliance with the specifications.

In addition to all components the Contractor shall supply the necessary documents, calculations and settings, related to the relays and to the primary network, to prove the correct function of the protection equipment according to the specifications.

6.2.2 Equipment Structure

The different components shall be implemented to satisfy the following general requirements:

- Protective relays shall be suitable for operation in the local climate condition,
- Protective relays shall not be responsive to mechanical shocks,
- Parts installed in the open air shall be protected against sun radiation, humidity and dust,
- Protective relays and associated auxiliary equipment shall be of standard construction,
- Protective relays shall be supplied by an experienced and reliable manufacturer,
- Protective relays shall be fitted into protection boards as specified elsewhere,
- Applicable type test certificates in accordance with IEC international standards shall be submitted,
- Insulation of all the related circuits shall comply with IEC60255 and shall not be less than 2 kV for all the interfaces,
- Static and microprocessor based devices shall be tested on all interfaces, except serial communication ports according to IEC60255-26,
- Protection class of the enclosure for all relays or protection systems shall not be inferior to IP52, when finally installed,
- Relay equipment shall be arranged to produce a perfect contact,
- For each relay circuit, power supply shall be provided with DC/DC converter,
- Miniature circuit breakers shall be provided with each control circuit for both AC and DC control circuits, each miniature circuit breaker shall be equipped with two electrically separated normally closed control for alarm at the annunciator and at SCPS.
- Protection equipment shall be designed not to produce any overvoltage in case of switching of contacts at secondary AC and/or DC control or supervisory alarm circuits,
- Internal auxiliary relays, switches, terminals, push buttons, etc., shall be clearly identified by labels,
- Double stack terminals on the protection circuit will not be accepted,
- Terminal blocks shall include 20% spare of each type of terminal used (exception for test blocks).
- The contractual language i.e. English shall be used for setting and data input means as well as for the description of all the main relay interfaces.

Control circuits including potential and current transformer secondary circuits, batteries, DC controls, AC auxiliary power supplies, supervisory alarms and communication circuits connected to the function of the protection equipment shall be protected against conductive, electrostatic and electromagnetic influences of transients of neighbouring circuits.

Each protective relay shall provide the required number of electrically separate normally open contact adequately for it functions for tripping the breaker of all types of faults, initiating the breaker failure relaying, the annunciator, remote alarm at SCPS, blocking the breaker closing circuit and etc.

Both ends of each cable connecting relays to voltage and current transformer secondary circuits, batteries, DC control, AC auxiliary power, supervisory alarms, tripping and communication circuits, shall be marked with slip-over ferrules of different colours and numbering.

6.2.2.1 Relay Front Design

The front of all IED Protective relays shall be clearly marked with important information. Using the contractual language the function of the relay and the name of the protected feeder shall be clearly recognisable. Additional indicators on the front of the relay, with an adequate description in the contractual language, shall allow phase identification and type fault on every protection equipment as well as every operation step if more than one exists.

At all Protective relays the actual setting at every part of the relay, the tripping alarm as well as all the supervisory and monitoring alarms, the latter for electronic relays, shall be clearly visible without opening the relays.

Indicators shall allow identification of the function activated, the alarm of the supervisory and monitoring of the Protective relay as well as the alarm of the auxiliaries at the alarm boards. Each indicator, whether of the electrical or mechanical type, shall be capable of being reset by hand without opening the relay.

Each cubicle, where protective relay shall be located, shall be illuminated internally for maintenance purposes, and the lamp shall be controlled by the door.

6.2.2.2 Bay Control Unit (BCU)

Refer to Sub-Clause Bay Control Unit 8.3.8 for Hardware Requirement.

6.2.2.3 I/O Interface

All signals shall be processed by the SCPS from the SCPS Systems.

6.2.2.4 Trip circuit

All the relays used for tripping shall still operate if the DC supply voltage is equal to 80% of the rated voltage.

The entire control and signalling circuits of the CBs shall be continuously supervised in both opened and closed CB positions. The design of this supervision shall prevent the CB to trip in case of failure of any component of the referred supervision circuit.

No time delay for the tripping contacts will be accepted. Master trip relays shall have a maximum tripping time equal to 10 ms.

The tripping contacts of protective relays without autoreclosing shall be self reset when no further fault conditions are present, whereas the signalling and block of closing order to the CB remains until the operator resets the relay manually. An exception shall be made for the event recorder signalling contacts.

All trips due to substation internal faults shall result in a lock-out (i.e. Busbar protection, transformer differential, Buchholz etc.). Trips due to external faults (i.e. line faults, backup earth-fault) shall not cause lock-out.

A cutoff switch shall be provided on tripping circuit of each protective relay (main or back-up) associated with differential busbar or differential transformer protection (breaker failure included). Position of this switch shall be monitored by SCPS system.

All tripping control circuits for the CB shall be interrupted for the qualitative and quantitative tests. These circuits shall be located at the same test block provided to test the relay with currents and/or voltages.

6.2.2.5 Instrument transformers

If modules of relays connected to the CT's current circuits can be removed, the design of these parts shall prevent an open circuit at the secondary side of the CT's in any case.

All current transformer and voltage transformer wirings, entering the control and relay panel, shall terminate directly on terminal blocks. The type and design of these terminal blocks shall be approved by PEA.

The terminal block shall be in accordance with the requirements of Clause 6.1.3.1.11.

The characteristics of current transformers for the protection described in these specifications are the minimum requirement to be fulfilled.

Before manufacturing of the current transformers, the Contractor shall submit for approval a verifiable calculation based on the design short circuit of the substation using a time constant approximate 45 ms for the network. This is necessary to demonstrate that the offered protection shall be stable for faults outside it's zone, shall trip within the required tripping time and shall have enough sensitivity to work together with the offered CT's.

This requested calculation shall define the maximum admissible CT rated output, knee point voltages for all taps, enabling changes of the current transformers without additional costs to PEA.

6.2.2.6 Wiring, Setting and Testing

The Contractor shall supply, before elaborating the wiring diagrams, block diagrams in one drawing for each type of feeder protection. These block diagrams shall include schematic information concerning trip circuits, control circuits, secondary circuits of voltage and current transformers with polarity marks, DC power supply, supervisory alarms and teleprotection circuits, etc. These block diagrams shall be updated during the factory test, erection and commissioning phases.

The protection system shall be completely wired, tested and inspected at the factory before shipment.

Wiring used within the switchboard shall conform to NEMA standard and shall be in accordance with the requirements of Clause 6.1.3.1.7 (Wiring) and Specification No. RSUB-015/2560 (Rev. 1.0) – SMALL WIRING.

The only work necessary to be performed at site shall be the connection of the external devices, the commissioning procedure and the site tests.

Test devices shall be provided for relay test facilities. Each test device shall be furnished with each relay and arranged to isolate completely the relay from instrument transformers and other external source of energy or from instrument transformers by means of multipole test plugs which shall be provided for the purpose. A sufficient of number of test plugs to make a complete test on one relay shall be furnished for each type of test device. All test devices shall be arranged so that the current-transformer secondary circuits cannot be open-circuited in any position while test plugs are being inserted or removed.

It shall be possible to perform complete test of a protective relay, interposing relays, if any, and circuit breaker by injection of Analog values through the test blocks, without disconnecting any wire or connector.

6.2.2.7 DC-Supply

The power supply shall be based on 125 V lead-acid station battery.

All relays shall be equipped with a self-monitoring alarm system, especially for DC supply and abnormal level of stabilised DC voltages but not necessarily limited to only these two. The DC supply of all the Protective relays and communication shall be monitored by means of an auxiliary contact of the related mini CB's which will provide an alarm in case of fault on the DC supply.

The DC supervision relays shall indicate a delayed, independent and separate alarm for each supervisory relay and also a local and remote alarm in case of a missing DC supply and DC/DC converter failure of a protective relay DC supply.

6.2.2.8 Requirement for IED Protective Relay

6.2.2.8.1 Hardware and Software Requirement

Necessary hardware and software for commissioning shall be provided. All cables between the PC, test equipment and protection shall be supplied.

The software manuals shall give clear details of every action to be performed in its use. The handling of the IED relays by the service personnel shall be possible without manual.

A protocol with the parameter settings and addresses shall be supplied for each relay including drawing as well as a proposed programme of alarms and output contacts.

A copy of the setting shall be placed after the commissioning on the protection board, with the addresses, labels and parameters finally set on the relays.

Addresses and input values for the binary I/O, LEDs and command relays shall be included on the drawings for the specific uses of the relays on this project.

Hardware and software used for the setting, and configuration of the protective relay in all its aspects shall be included. IED protective relay without the appropriate software will not be accepted.

Main protective functions according to software library in each IED protective relay shall be configured and standardized by protective relay manufacturers, relay suppliers or panel builders including additional functions and logic diagram for details design criteria to be required. Any software modification at site to meet PEA functions shall not be accepted by PEA. All main and backup protective functions of multi-function relays shall be configured and activated by relay factory or panel builder factory before delivery the relays to site work. The activated protective functions shall be ready to use and work properly anytime even they are not used at the present time. The re-configured additional required relay functions at site shall not be accepted by PEA.

The IED protective relay supplied shall have a documented service experience in plants or substations of at least two years, including hardware, software, transportation, installation, commissioning, etc.

The features of the IED relays to be supplied shall include:

- Programmable scheme logic
- Remote setting/interrogation
- Serial communication interface
- Time-tagged event/disturbance record
- Measured quantities displayed
- Self-monitoring (Hardware/Software)

All main Protective relays shall have 4 setting groups. Backup overcurrent Protective relays shall have at least two setting groups.

6.2.2.8.2 Interface Requirements

All features of the relay (relay setting, configuration, etc.) shall be accessed through a Front Panel User interface provided. The user shall be allowed to navigate around the menu by using arrow keys or push buttons.

All IED relays shall be delivered with a serial interface for the PC (located on the front panel) and one additional interface for the integrated SCPS. In case of IED relays it shall be possible to set the parameters from a remote control centre by modem and also be able to request data from the relays. Through the serial interface the PC shall be able to retrieve the following minimum information, archive set or modified.

Communication with SCPS will be based upon IEC 61850.

Proprietary or other standardized widespread protocols are acceptable, since interoperability with the system is guaranteed. Interfacing devices shall be prohibited.

For IED relays which are not manufactured by the company providing the SCPS, the interoperability with the SCPS will have to be clearly demonstrated.

The protection scheme(s) shall include all hardware and software to allow remote setting/configuration/fault analysis from:

- A dedicated PC or laptop, with a direct link to the relay
- From a remote access facility (from the manufacturer's office, or from an engineering department).

These latter facilities shall be conveniently secured.

The main requirements applicable to communication with the relay shall be the following:

- On and Off line communication
- Relay Settings
- Relay configuration (I/O's, programmable scheme logic, fault recording programming …)
- Switching of setting group
- Extract disturbance records
- Access to relay monitored parameters

Access to relay display and setting parameters will be keyed by different authorization levels (password).

The parameter setting of the relay shall be remotely controlled from the station control level.

6.2.2.8.3 Disturbance records requirements

The relay shall include an internal disturbance recorder, with sufficient analog channels to record three-phase currents and/or three-phase voltages, residual current and/or residual voltage depending on the relay model. Main protective relays shall have capacity to record at least 16 logic channels and backup protective relays shall have capacity to record at least 8 logic channels.

The internal disturbance recorder shall have the capability to store at least the last 5 disturbance records with a minimum total storage capacity of 3 seconds (typical). These records shall be stored in the relay memory, backed by a battery or non-volatile memory. Battery low voltage alarm facility shall be provided for monitoring of status of the battery.

For all main protective relays the channels and the trigger source shall be configurable, and triggering by external equipment shall be possible.

Records shall be saved in files of COMTRADE format and could be extracted from remote communication and processed on the SCPS engineering workstation.

6.3 115 kV DEDICATED PROTECTION

In addition to dedicated protection devices described below, auxiliary tripping relays and auxiliary tripping and lockout relays (94P, 94L, 94BU, 94BF, 86T, 86B, 86BF, 86L) shall be provided with transformer protection, bus protection, direct transfer tripping and breaker failure protection, distance relay, current differential relay, backup protection.

Each auxiliary tripping and lockout relay shall be of the high-speed type, DC voltage operated, electrical reset with cut-off contact provided to interrupt the operating coil. All contacts shall be electrically separate contacts and rated to carry 30A, 300V, for 3 seconds, 5A, 300V, continuous, and be capable of interrupting of 0.2A of inductive current (L/R $\leq$40 ms) in a 125 V DC control circuit. These contacts shall be used for tripping, lockout the circuit breakers, initiating the breaker failure relaying, the annunciator, remote alarm at SCPS and etc.

Loss of DC control circuit shall be monitored by loss-of-potential DC alarm relay. (27XB, 27XR). Each relay shall be provided with an auxiliary relay, standard speed with slow dropout characteristics. Each auxiliary relay shall be furnished with two (2) electrically separated normally closed contacts. These contacts shall dedicated to:

- initiate the annunciator
- initiate SCPS.

These relay shall also be furnished with two (2) electrically separated normally open contacts for future use. Similarly, loss-of-AC control supply shall also be monitored by a loss-of alarm relay (27 XM). Each relay shall also provide the contacts for alarms similar to loss-of-DC alarm relay.

6.3.1 Line protection

6.3.1.1 Line differential protection (87 L)

The required current differential protective relay shall be fully IED and suitable for 2 terminals lines and/or line-cable.

Each line current differential relay shall be used as primary pilot protection and with a dedicated fibre optical cable as a communication link to permit high speed simultaneous intertripping of the breakers at both ends of the line. The reclosing of the line shall be done through a sychrocheck relay.

The backup protection of the line shall be protected by a directional phase and ground overcurrent relays with at least four (4) inverse time curves and one (1) definite time characteristics.

In case of fault on the protected feeder, the protection shall send an intertrip order to the remote terminal to ensure fault clearing at both ends of the protected line.

In case of the line is fed from a breaker and a half switching station, the protective relay shall be provided with separate inputs for each set of line CT's. Stub protection function shall be provided in this case and shall be based on low impedance biased differential protection principle.

In certain cases, the line differential protection may be connected where line CT ratios at either end of the protected line are different. A CT correction factor shall then be provided. CT saturation shall not result in any relay misoperation for internal or external faults.

The relay shall fulfil the following requirements:

- A phase segregated current differential, providing high speed and selective detection of all type of faults, including resistive faults,
- Dual redundant signalling channels allowing segregation of the protection signals,
- Dual slope percentage bias or an alpha plane restraint, tripping characteristic, ensuring stability for through fault conditions with both slope settable,
- The relay shall be designed to work within the signalling bandwidth of a basic 56/64 kbp/s pulse code modulated channel (PCM), or via electrical interfaces conform to ITU-T G.821, or G.703 standard. If a dedicated fibre optic cable does not make the link between the 2 relays, the Contractor shall make sure that the relay communication requirement is consistent with the substation's telecommunication facilities and with the telecommunication network they are connected to.
- The configuration and setting of the relay shall be possible from the front panel interface, or by remote communication means.
- Freely configurable intertripping signals shall be provided which can be transmitted over the protection communication channel from one end of the line to the other.

The recloser (79) and check synchronism (25 & 27/59) function shall be selectable for the following modes in the same time:

- Live bus/dead line
- Dead bus/live line
- Live bus/live line
- Voltage difference
- Frequency difference
- Angle difference

The recloser shall be activated by the internal protection and/or by all external protection order.

High speed and delayed single or three-phase cycle followed by minimum 1 low speed cycle shall be possible.

The dead time setting range shall be adjustable approximately between 0.2 to 2.0 seconds. The reclaim time setting range shall be adjustable between 1 to 300 seconds.

In the event that the reclosing relay is used with a synchro-check relay or voltage check relay, the reclosing relay shall be capable of completing its reclosing cycle with a maximum time delay of 5 seconds imposed by the synchronism-check relay or voltage check relay.

If the reclosing relay is not inherently capable of operating with a supplemental device with a 5-second pick-up then one extra timer shall be provided for this purpose.

Each reclosing relay may be combined with synchro-check relay.

The synchronism-check relay shall ensure that reclosure will proceed only if the synchronism conditions are met, line voltage and bus voltage are in normal condition, at the same frequency, equal and in-phase. Closing angle and operation times shall be independently adjustable. The synchrocheck relay operation shall be initiated by the reclosing relay.

A control cutoff switch (87L-CO) with separate red indicating light (LED) shall be provided with each set of relays to segregate the auxiliary tripping relay (94L) from the line current differential relay. In addition to the above requirement, a direct transfer trip cutoff switch (86 DTT-CO) shall be provided to segregate the auxiliary tripping and lockout relay (86L) and shall also initiate the transfer trip relay (DTT) for sending the signal to trip the remote end line via the optical fibre cable.

Internal Disturbance recorder : in case of fault the relay shall able to store four cycles of pre-fault and at least seven cycles of post-trip data. This includes as well the voltages and currents as internal relay information. Each event shall be tagged with date and time and stored in a non-volatile memory in chronological sequence.

In addition the relay will comprise:

- Communication channel supervision,
- Continuous self-monitoring with watchdog contact.

6.3.1.2 Distance Protection (21/21 N) and Direction Overcurrent Protection (67/67N)

The design of this protection device shall fulfil at least the following requirements:

Each distance relay shall be of the full scheme and IED type. Each relay line terminal shall utilize a distance relay as a pilot protection for all combinations of phase faults and ground faults. Each distance relay system shall be designed for use with a teleprotection equipment to permit high speed simultaneous intertripping of the circuit breakers at both ends of the line. The communication link shall be by means of a fibre optical cable. The pilot tripping and reclosing schemes shall be in accordance with the requirements of Clause 6.3.1.1.

The directional phase and ground overcurrent relays shall be of the IED type and shall be used as a backup protection. Each relay system shall be provided with at least four (4) Inverse Time Curves and one definite time characteristic. Each directional unit shall be voltage polarized which shall be incorporated in each relay system.

At least four (4) distance stages with impedance set polygon characteristics for forward and reverse measurement shall be implemented.

Each distance relay shall be suitable for protection of long or short overhead line or cable, double circuit lines, heavily loaded line, and with line weak infeed.

The time delay for each zone shall be independent, and the operating time of the relay shall be less than 25 ms.

To ensure correct measurement under earth fault conditions, the relay shall be earth compensated with both residual and a angular compensation for the proposed scheme OHL or cable.

VT supervision shall be included for monitoring the VT secondary voltage and to detect low voltage or a blown-fuse in VT circuit or all left open fuses of voltage supply to the relay system.

VT supervision will block the trip of the distance protection. The logic for this feature if based on zero component voltage and current shall not be influenced by magnetising inrush current during energization of power transformers.

The power swing-blocking feature shall be able to block one, two, three or all zones. Power Swing Blocking function shall be overridden under the presence of an earth fault.

Each distance relay shall operate properly with high values of source impedance. It shall be capable of measuring all faults with minimum fault current of 0.2 time of rated current. The maximum continuous operating current rating of the distance relay shall not be less than 2.0 times of rated current.

The measuring element shall be adjustable between 0.25 to 150 ohm per phase with 1A current rating and 115 V secondary voltage rating.

In any substation where there are more than one transmission lines in parallel, effective means for fault detection shall be provided for each distance relay with either one or all the lines in operation.

The required distance relay shall be suitable for operation with capacitive voltage transformers.

CT saturation shall not result in any relay misoperation for internal or external faults.

The relay shall not misoperate for current reversals that may occur during the clearing of external faults.

System logic for switch onto fault protection (SOTF) shall be implemented in the distance relay. The SOTF feature shall be for a settable time 0 to 1 sec (remain for a time not exceeding 0.5 sec) after the relay detects the local circuit has closed. This feature will block the autoreclosure scheme and the tripping will trip instantaneously regardless of whether the fault is located at the near end or the remote end of the line. Any starting, measuring via distance comparators or any current level detector, will initiate the tripping in this logic.

Stub protection function shall be provided for One and Half substation arrangement. This feature shall be used to protect the remaining live portion of a primary circuit on which an disconnector has been opened.

A logic for teleprotection schemes shall be regarded among the following topics according to the scheme used:

- Permissive Underreach Transfer Trip (PUTT),
- Permissive Overreach Transfer Trip (POTT),
- Zone 1 extension,
- Blocking Overreach scheme. (BOR)

The logic scheme of the supplied teleprotection logic shall be submitted in block diagrams with clear indication of the send logic, trip logic, open terminal end and weak end logic.

Reclosure and Check Synchronism functions

The recloser (79) and check synchronism (25 & 27/59) functions shall be selectable for the following modes in the same time:

- Live bus/dead line
- Dead bus/live line
- Live bus/live line
- Voltage difference
- Frequency difference
- Angle difference

The recloser shall be activated by the internal protection and/or by all external protection order,
High speed and delayed single or three phase cycle followed by minimum 1 low speed cycle shall be possible.

The dead time setting range shall be adjustable approximately between 0.2 to 2.0 seconds. The reclaim time setting range shall be adjustable between 1 to 300 seconds.

In the event that the reclosing relay is used with a synchro-check relay or voltage check relay, the reclosing relay shall be capable of completing its reclosing cycle with a maximum time delay of 5 seconds imposed by the synchrocheck relay or voltage check relay.

If the reclosing relay is not inherently capable of operating with a supplemental device with a 5-second pick-up then one extra timer shall be provided for this purpose.
Each reclosing relay may be combined with synchrocheck relay.

The synchronism check shall ensure that autoreclosure will proceed only if the synchronism conditions are met, line voltage and bus voltage are in normal condition, at the same frequency, equal and in-phase. Closing angle and operation times shall be independently adjustable. The synchro-check relay operation shall be initiated by the reclosing relay.

The recloser shall be coordinated with the line differential protection's recloser so that for a fault on the line, a single reclosing cycle is initiated. As a consequence, both reclosers may work on a parallel basis (with the first acting recloser inhibiting the remaining one), or with a master/follower configuration.

Fault Locator

The distance from the relaying point to the fault location will be measured and displayed (in km) by the incorporated fault locator units. The algorithm in this case shall take into consideration the pre-fault load current.

Disturbance Recorder

In case of fault the internal Disturbance Recorder shall record and store four cycles of pre-fault and at least seven cycles of post-trip data. This includes as well the voltages and currents as internal relay information. Each event shall be tagged with date and time and stored in a non volatile memory in chronological sequence.

Integral user interface shall allow easy access to Analog fault data and numerical input or output status.

The EEPROM shall be a non-volatile area of the memory, and will fulfil the storage and maintain the information within it even if the DC supply is removed. This area of the memory shall be copied to the working RAM after a DC power up, but only written to and read from, if setting changes are updated or a fault condition occurs.

The synchronisation from a common remote clock and locally through the substation control unit by means of a general synchronising signal or by a manual menu guided instruction shall be possible.

6.3.1.3 Backup protection (67-67N)

Phase and ground directional overcurrent relays shall be used to provide backup protection in conjunction with the primary protection in Clause 6.3.1.1 and 6.3.1.2 for transmission lines against phase and ground faults. Each directional unit shall be voltage-polarized.

The voltage-polarizing source shall be drawn from auxiliary transformers (included in the relay) connected to line VT. At least 4 Inverse Time curves (IEC 60255) and 1 definite time shall be provided. Each relay shall have a current setting range of 0.1-2.5In and shall be used with 1A rated secondary current CT.

Operation indicator with reset pushbutton shall be incorporated in each directional overcurrent phase and ground faults protection for indication of the relay operation.

6.3.1.4 Tripping and interposing supervision relay (95)

Supervision relay shall be used for monitoring important control and signalling circuit such as circuit breaker or disconnector circuits. The supervision relay shall be able to detect interruptions, too high resistances cause by galvanically bad connections, increased transfer resistance in the contacts, welding of the control contact, loss of control voltage and failure of the relay itself.

6.3.1.5 Voltage circuits failure (27)

The fuse failure relay shall monitor the output of voltage transformer and will block the trip of distance protection and give an alarm in case of VT fuse failure. The 3-phase voltage shall be monitored.

6.3.1.6 Transformer Protection 115 kV/MV

The protection of power transformer can be divided into two main groups able to detect:

- Internal faults, such as Short-circuit between windings, short-circuit between turns, Ground faults, Tap changer failure and transformer tank oil leaks.
- External faults, such as Power system phase faults, Power system ground faults, Over-load and Over-excitation.

The main protection scheme required for power transformer internal phase and ground faults shall be based on a differential Protective relay. The detection of short-circuits between turns shall be carry out by the use of a Restricted Earth fault protection. This function should be included in the differential Protective relay.

As a standard protection fitted to all oil immersed transformers, a Buchholz relay will detect all insulation breakdowns inside the transformer tank, causing either the formation of gas or surges of oil flow from the tank to the expansion vessel.

All faults detected by these relays will trip the HV and MV circuit breakers.

The overcurrent Protective relay shall be used as back-up protection for internal and external phase and ground faults.

6.3.1.6.1 Transformer Differential Protection (87 T – 64 REF)

The transformer differential Protective relay required shall be of IED type design with all main functions individually configurable by the user.

A cut-off switch shall be provided on tripping circuit of each protective relay (main or back-up) associated with transformer differential protection (breaker failure included).

Position of this switch shall be monitored by SCPS system.

The protective relay required shall be a biased differential current type (87T) able to protect 2 winding transformer. Restricted Earth fault protection (87REF) shall be provided as part of the relay. Internal vector group compensation and line current transformer ratio correction shall be performed through the dedicated software of the relay. No interposing relays shall be accepted by PEA.

The Internal Disturbance and Events recorder shall be able to measure and store three voltage and Three current by winding. In addition, Analog channels shall be provided to measure and store fault current in the neutral(s). The relay shall be able in case of tripping events to store the input data for 1 s with 2 periods pre-fault data.

The Internal Disturbance and Events recorder shall provide the possibility of external binary signal acquisition for the purpose of indication and fault recording (Buchholz, O/C, E/F). Each event shall be tagged with date and time and stored in a non-volatile memory in chronological sequence.

The IED relay shall be controlled by self-control routines (e.g. every 10 s) to avoid false function and to permit early detection of any fault inside the relay.

6.3.1.6.2 Back-up Protection (50/51, 50G/51G)

The overcurrent protection device installed on both sides of the transformer and neutral connection, as a back-up protection, shall be IED independent relay elements able to measure phase and ground faults.

At least one Definite Time and four selectable Inverse Time curves for the phase and ground elements shall be provided according to IEC 60255-151.

- Standard inverse curve,
- Very inverse curve,
- Extremely inverse curve,
- Long time inverse curve
- Definite time

All setting will be entered by means of a built-in keypad or external portable computer.

All logic events and Analog information shall be stored in memory and shall be transferred to the SCPS or PC for post analysis.

In the front of the relay at least 3 LED’s shall be able to indicate the following functions: Trip, alarm, warning, healthy.

6.3.1.6.3 Static voltage regulator control relay (90)

The tap changer operation shall be controlled automatically by voltage regulating relay, continuously monitored and initiated the tap changer mechanism. The relay shall have the following facilities:

- Integral line drops compensation.
- Inverse or definitive time characteristics.
- In case of several transformers in parallel, reverse reactance or circulating current compensation shall be taken in consideration.

- Under voltage, over voltage and over current supervision.
- Alarms.

6.3.1.6.4 Mechanical Functions

Following functions are the minimum to be provided: Buchholz alarm, Buchholz trip, oil flow operated, oil pressure relief device of the OLTC, temperature monitor thermometer, thermal replica and magnetic type oil level.

All necessary tripping relays associated with the transformer, should be provided e.g:

- Buchholz protection,
- Transformer pressure relief device
- Transformer sudden pressure relay
- LTC diverted switch pressure relief device
- LTC diverted switch sudden oil flow
- Winding temperature sensors.

Operating signal of these different sensors and protections shall be routed to the binary inputs of the main integrated Differential protection.

6.3.1.7 Busbar Protection (87B) (for Double Bus – Single Breaker)

Each busbar shall be protected by a low impedance IED busbar protection, designed for high-speed and selective protection of busbar installation. The hardware shall be based on a central unit communicating to various line units through optic fibre. No hardwiring/analog interfacing between units shall be accepted so as to minimize any potential interference with substation environment. In case of busbar fault, the protection shall trip and lockout all breakers which connected with the faulty bus, on both sides of the transformer and trip and lock-out the bus coupling breakers.

The protection scheme shall include an integrated check zone feature with independent fault criteria detection. The check zone operation principle is independent from isolator status. Tripping takes place only if zone and check zone detectors are operating simultaneously.

The protection shall be suitable for use on a bus with up to all connected feeders and shall have the following properties:

- High sensitivity and selectivity for internal faults and high stability for external faults,
- All three-phase shall have the same pickup setting for the different current. This is to ensure the same sensitivity for all three-phases,
- Phase-to-phase and phase-to-ground faults in solidly grounded system or resistance grounding.
- The protection shall be able to operate on CT's having a wide range of different ratio,
- The function of the protection shall be blocked if a measuring circuit is faulty,
- Except on PEA special request, no special performance for CT's supplying the protection shall be required,

- Tripping time less than 20 ms,
- Event recorder with resolution of not more than 1 ms shall be provided,
- Self-checking and supervision shall be continuously monitored,
- Extension of busbar protection shall be possible, and the protection cubicle provided shall already be wired for the entire substation.

A cut-off switch shall be provided on tripping circuit of each protective relay (main or back-up) associated with differential busbar (breaker failure included).

A control switch (87CO) with a separate red indicating lamp (LED) shall be provided with each set of relays to segregate the auxiliary tripping and lockout relay from the differential relays as necessary to prevent false tripping due to the bypassing of the current transformers. The busbar differential relay shall be provided with a supervision unit, which shall be used to detect an unbalance current, or voltage in the differential measuring circuit due to spill current or open CT circuits.

The red lamp (LED) shall light to indicate that the trip circuit from the differential relays to the auxiliary tripping relay is open.

Each busbar differential relay shall be furnished with three (3) electrically separate normally open contacts in addition to those required by the bus differential protection scheme.

6.3.1.7.1 Busbar Protection (87B) (for Every Bus Scheme except Double Bus – Single Breaker)

Each busbar shall be protected by a high impedance differential relay with shunt resistor or a low impedance IED busbar protection. The busbar differential relay required shall be of microprocessor-based /digital type and electronic solid-state plug-in type shall be accepted.

6.3.1.7.2 Bus AC wiring supervision relay (95B)

Providing continuous supervision of the bus wires in high impedance type busbar protection scheme, detecting open circuited bus wires as well as open circuited main current transformer.

6.3.1.8 Breaker failure protection (50BF)

The breaker failure protection will be separated or integrated in the other protective relaying system as required, and shall be of IED type design with functions individually configurable by the user.

The breaker failure protection for breaker and a half bus with or without transformer shall be of the separated type.

In case of currents sensing elements (Buchholz) are not available, external signal inputs performed via binary inputs shall be incorporated in a tripping logic using auxiliary control of the CB.

The relay shall be sensitive to detect fault 0.2 to 2 times of the rated current, adjustable in steps of less than to 01 times of this currents.

A breaker failure relaying shall be provided for each circuit breaker.
All Protective relays of the dedicated feeder shall initiate the breaker failure relaying in case of fault.

Lockout relays shall be provided to prevent reclosure, either manual or automatic, until lockout relays are reset.

Breaker failure Protection components shall be as follows:

6.3.1.8.1 Current Detector Relays (50BF).

Current detector relays shall be of IED type, non-directional instantaneous overcurrent relays with fast-resetting time of less than 12.5 milliseconds when the current drops to 90 per cent of the pickup. Each shall contain either two-phase units with 0.2-1.6 A pickup range and one ground unit with 0.05-0.4 A pickup range or three-phase units with 0.2-1.6 A pickup ranges.

A control switch (50BF-CO) with a separate red indicating lamp (LED) shall be furnished with each set of the relays, to segregate the auxiliary tripping and lockout relay from the current detector relay.

6.3.1.8.2 Breaker Failure Timers (62BF).

Breaker failure timers shall be adjustable for use with current detector relay above. The setting range shall be from 0.05 to 1.0 seconds in step of not more than 10 ms.

6.4 MV DEDICATED PROTECTION

Each MV switchgear shall be designed for the control, metering, protection and annunciation. The switchgear shall also furnished all information to the remote control location for SCPS via SCPS equipment which are incorporated in each switchgear section.

A redundant power supply card is not needed for a relay of 22 or 33 kV systems.

6.4.1 Outgoing feeder

Each outgoing feeder shall contain the following metering and relaying systems:

- 3 phasesovercurrent protection [50/51] and/or 67, using 3 independent stages
- 1 Ground Fault overcurrent protection [50G/51G] and/or 67N, using 3 independent stages
- Reclosing Relay having a minimum of 4 shots (79),
- Breaker Failure Relaying System,
- Event and Disturbance Recorder,
- Metering System,

shall be fully integrated.

The phase and ground overcurrent protective relays and breaker failure current detector relay shall be of IED type design.

At least one Definite Time and four selectable Inverse Time curves for phase and ground elements shall be provided according to IEC 60255-151.

- Normally inverse curve,
- Very inverse curve,
- Extremely inverse curve,
- Long time inverse curve
- Definite time

All setting shall be entered by means of a built-in keypad or external portable computer. Comprehensive data accumulated in the memory for post fault analysis shall be retrieved through the serial interface into a personal computer.

In the front of the relay at least 3 LED's shall be able to indicate the following functions: Trip, alarm, warning, healthy.

The protection of all outgoing feeders shall be provided with a Local on-off function that can be operated from HMI.

a) The reclosing function shall be initiated by both Overcurrent and Earth Fault protections.
The reclosing relay shall be capable of performing 4 (four) different shots, associated with 4 independent times.
    - 1st shot instantaneous
    - 2nd shot selectable 0.1 to 10 s
    - 3rd shot selectable 0.2 to 60 s
    - 4th shot selectable 0.2 to 120 s
    - Dead time and reclaim times shall be adjustable.

b) Each under frequency relay shall be furnished to perform the load shedding scheme. Each relay shall be provided with four steps frequency settings by using a selector switch, 5 position, "OFF", "step#1", "step#2", "step#3", and "step#4" for the purpose of tripping the outgoing feeders as required. The switch shall be engraved on the escutcheon plate with the following modes:
    - OFF,
    - ON 1 = f1
    - ON 2 = f2
    - ON 3 = f3
    - ON 4 = f4

It shall only be possible to set the position of the settable switch locally.

The load shedding equipment shall not start the autoreclosing function. Restoration after load shedding sequence shall be done manually, by a function "UF step 1 to step 4 reset".

The setting range for each steps shall be comprised between 50 and 45 Hz in step of approximately 0.02 Hz.

Time delay to allow a co-ordination between the different steps, settable between 0.2 to 10 s for each step shall be provided.

Logic selectivity should be used wherever possible to reduce clearance time of fault.

The function shall be guaranteed with voltage levels of +10% to -40% of the rated voltage.

The function shall be blocked if the voltage is less than 60% of the rated voltage.

The accuracy of under/over frequency protection shall be 20 ms.

c) Breaker failure relay shall be initiated by Protective relay, for each CB.

d) The current setting range shall be comprised between 0,1 to 1,3 In. Timer shall be adjustable between 0,05 s to 5 s. Metering, measuring active and reactive energies shall have an accuracy of 0.5 and 1% respectively.

e) In addition 1 undervoltage relay and 1 overvoltage relay (due to the presence of capacitor banks) shall be provided.

The setting range for both shall be 10 to 150 V by step of 0.5V.
High Impedance Fault (HIF) function for MV Line shall be at only selected sites specified by PEA. HIF relay shall detect high impedance faults such as contact of tree branches and animals, downed conductor to concrete, asphalt, gravel, sand and dry or wet grass, etc.

6.4.2 Incoming feeders

Each incoming feeder and bus-section shall be protected by a three-phase with instantaneous and time-delayed overcurrent and a ground fault protection [50/51, 50G/51G].

These relays shall be identical as the aforementioned paragraph.

One set of instantaneous overcurrent (50 ARC) detector relays shall be provided to operate in conjunction with the arc detection protection as called for in the Specification No. RSUB-004/2560 (Rev. 1.0) – 22 kV – INDOOR METAL-ENCLOSED AIR INSULATED SWITCHGEAR.

6.4.3 Capacitor Bank feeder

Capacitor Bank feeder shall be protected by:

- 3 Phases overcurrent protection,
- 1 Earth Fault Overcurrent protection,
- Under and Overvoltage relay

The phase-to-phase and phase-to-earth Overcurrent protection, undervoltage and overvoltage relays shall be identical as those described in paragraph “outgoing feeder”.

In case of overvoltage occurs to the capacitor banks over the presetting voltage value, the overvoltage (59) shall initiate the auxiliary tripping and lockout relay (86) to trip and block closing of the vacuum switches (or SF6 breakers) and also cutoff the VT supply to the power factor controller so that the power factor controller will return to it neutral stage for stopping the operation.

The neutral connections of the Double Star arrangement of the capacitor bank shall be monitored by one overcurrent relay (Unbalance protection) via a bushing current transformer (see Specification Shunt Capacitor Bank NO. 14).

The current unbalance relay (60) shall be furnished with two-stage operation : the first stage shall provide the alarm and the second stage shall provide contacts for tripping and alarm the capacitor bank switching device.

7. COMMUNICATION SYSTEM REQUIREMENTS

7.1 GENERAL REQUIREMENTS

The communication requirements shall be based on IEC 61850 standards, in particular IEC 61850-3: General Requirements, 61850-5: Communication Requirements For Functions and Device Models, IEEE 1615: Recommended Practice for Network Communication in Electric Power Substations and IEEE 1613: Standard Environmental and Testing Requirements for Communications Networking Devices in Electric Power Substations. The following shall be covered by these standards:

Communication system

1) Communication network
2) Configuration requirements
3) Communication performance and quality of service requirements
4) Data and information management requirements
5) Communication network and system management requirements
6) Access control and cyber security requirements
7) Environmental and testing requirements

7.2 FUNCTION HIERARCHY, INTERFACE, AND TOPOLOGY

As described in Clause 4.2 System Hierarchical Structure, the SCPS architecture is based on multi-tier hierarchical structure. As a minimum, the structure consists of: Level 1 – Station Level, Level 2 – Bay Level, and Level 3 – Process Level or Physical Device Level.

Where data communication interfaces using DNP3.0 protocol are necessary, DNP3.0 over IP shall be used over the Substation LAN.

Any such interface shall be implemented using serial-optical converters to achieve electrical isolation against common-mode voltage and transient failure phenomena. This applies only to serial communication lines that leave protective enclosures.

Means shall be provided in substations to ensure that the connections between the SCPS and the multiplexers that provide access to PEA communications channels are optically isolated to avoid possible SCPS and/or multiplexer damage due to surge, electromagnetic interference, and ground potential problems especially during power system fault conditions.

Considering the RS-232 communication ports in these connections, whether at the SCPS or multiplexer, the Contractor shall supply and install media converter, as well as all necessary lengths of multimode optical fibre cable. The RS-232 port is the communication port to a control centre via fibre optic cable. As an alternative, the SCPS or CGW may be supplied with built-in optical communication ports, where these optical ports connect to multiplexers.

Where applicable, the optical SCPS or CGW ports shall meet the following requirements:

1) 2.5 kV optical isolation
2) Electrical EIA RS-232 DB-25 or DB-9 male connector (DTE-DCE selectable)
3) Optical connector supporting ST or LC multimode
4) Power budget of 12 db (optical fibre cable 62.5/125 micron)
5) Data rate from 300 to 19,200 bps
6) Auto-powered from RS-232 interface
7) Environmental capability of 0 to 50 °C, 5 to 95% relative humidity

In case Auto-powered from SDH is not practical, the external power supply shall be provided and supplied by DC-Power supply at communication cabinet (48 V + 20%). The converters shall extend full-duplex data transmission between SCPS and SDH over one optical fibre.

For high reliability, topology of an SCPS shall have Station Bus Redundancy, with which each Bay Unit (BU), and each station device are connected to at least two different switches. A large SCPS shall follow a Station Bus–Ring Network Topology with Station Bus Redundancy The topology is shown in Fig. 4.1.

7.3 COMMUNICATION NETWORK

The communication network infrastructure shall satisfy the following requirements:

1) Access control and cyber security especially for remote access
2) Configuration, system and network management
3) Deterministic predictable network (collision-free environment) with the utilization of a dedicated managed Ethernet Switch
4) Deterministic real time network capability

5) Environmentally hardened network devices and components, rated for operation in HV substation environment
6) Flexibility and scalability for system change or expansion
7) Fully duplex communication backbone using high speed 1Gbit/s optical fibre ring Ethernet local area network (LAN) topology
8) Fully duplex Ethernet communication connection to IEDs using either 100Base Fx (Preferred) or 100BaseT
9) Integration of intelligent devices
10) Priority queuing support
11) Simultaneously support multiple applications including virtual LAN (VLAN) support
12) Time synchronization over Ethernet.

Internet protocol suite (IPS) shall be used for the transfer of operational and non-operational data as well as configuration management. The followings shall be considered:

1) Development plan for IP address allocations. PEA will manage the IP addressing. Details on PEA IP addressing management is in Annex 6.
2) Private and fixed IP addressing shall be employed on the substation network.
3) SCPS connected to an enterprise or WAN must pass through a properly configured router with firewall and cyber security measures as described in Clauses 8.4.3 System Access Control and Cyber Security Management and 11.5 Substation Access Control and Cyber Security measures. However, the provision of the router with firewall is not under the scope of this specification, and shall be supplied by PEA ICT Division.

7.3.1 Communication Network Device – Ethernet Switch

Hardened fully managed real-time Ethernet Switch shall be provided as part of the IEC 61850 Station Bus–Ring Local Area Network (LAN). The Ethernet Switch should be of the hardened Industrial Type with a proven track record in an environment similar to the one encountered in Thailand, and fit with a standard 19-inch rack cabinet. The use of integral Ethernet switch within, and as part of the substation IEDs is strictly not permitted. All Ethernet switches shall be certified and type tested as protection grade devices.

The main characteristics of the Ethernet Switch shall be designed for continuous operation in a high voltage substation shall conform to the industrial environment: IEEE1613 - class 2 “error free” performance for real-time control and EMI immunity and IEC61850-3 Type test. And the requirements stated in Clause 4.6 System Security. Ethernet Switch at a station bus level shall be L3 type, and those at a process bus level shall be L2 type.

Managed switches shall be provided capabilities that deal with communications network faults, different classes of IEDs, and priority issues. Some of these capabilities and related industry standards are bulleted below:

1) IEEE 802.1d and IEEE 802.1p: Prioritization to allow real-time, critical messages to get through, Priority queuing / tagging support
2) IEEE 802.1Q: VLAN to allow isolation of critical IEDs from non-critical IEDs Shall be provided, for L3 switches.
3) IEEE 802.3x: Full-Duplex operation for collision free operation, Back pressure and flow control
4) IMGP Multicast Filtering (Snooping mode): Layer 3 multicast traffic filtering for multicast intensive protocols, for L3 switches
5) Multicast propagation control, for L3 switches
6) Loss-of-link management
7) Remote monitoring, port mirroring, and diagnostic support
8) Support for MAC filtering and port lockout

The Ethernet switch manufacturers specify the recommended maximum number of devices per ring. This number is usually between 20 and 30 devices. So, in case of large substations with a lot of devices, the LAN must be split into several small rings. Ethernet networks allow multiple network configurations, even a mixture of different topologies. In most cases the simple ring and the multi-ring collar topology should be the best option. In any case, the proper architecture should be designed for each installation in terms of network security and cost.

Each Managed Ethernet Switch shall be provided with a minimum of at 20 % spare communication ports.

Network Redundancy using IEC 62439

1) IEC SC65C WG15 published IEC 62439 “Highly Available Automation Networks”
2) IEC 62439-3 Clause 4 Parallel Redundancy Protocol PRP
3) IEC 62439-3 Clause 5 High Availability Seamless Ring HSR

The basic requirements of the managed Ethernet switch are:

Table 7.1 (a) – Industrial Ethernet Switch Requirements

Requirement	Comments
Network Device Type	1) Fully Managed Ethernet switch 2) Fanless 3) Modular Design
Auxiliary Supply	1) 125VDC nominal voltage (substation DC system) 2) Minimum range 80-120% of nominal voltage
Temperature Range	1) Extended temperature range operation 2) -40 to +85 ºC (IEC 61850-3)

Requirement	Comments
EMC and Environmental Type Tests	1) EMI-hardening 2) Protection Graded 3) IEC 61850-3 and IEEE 1613 4) Type test certificate to be provided as evidence
Mounting	1) Panel 2) DIN rail 3) Rack-Mount
Port Speed	1) 1 Gbps (Station Bus Backbone), 100 Mbps (IED connection)
Port Type	1) 1000Base FX (For Backbone) 2) 100BaseTX (For Segment or IED)
Switching Method	1) Store and forward
Switching Delay	1) < 10 µsec (100 Mbps)
Priority Queues Number	1) Minimum 2
Backbone Media	1) Optical fibre (at the process level) 2) RJ45 Copper (at the station level)
Backbone Interface (Station bus communication)	1) SFP LC type optical fibre connector
Segment or IED Interface (within panel	1) RJ45 port 2) Option for ST optical fibre connector (multi-mode optical fibre)
SCADA monitoring and management	1) Switch should compliant with IEC 61850-90-4 MMS bridge modelling
Network Management Tools	1) SNMP or MMS with the latest version 2) Web-based 3) Remote Monitoring
Cyber Security	1) User passwords 2) SSH/SSL encryption 3) Encrypted authentication and access security 4) MAC based port security 5) VLAN (IEEE Std 802.1Q
Others	The switch shall support transmissions of GOOSE messaging.
Quality Assurance	1) ISO 9001:2000

Table 7.1 (b) – L3 & L2 Switch Requirements

Requirement	Comments
Operating Temperature	- 40 to + 85 ºC
Power Supply	Dual redundant, load sharing, hot-swappable
Ethernet Module	Field replaceable
Ports	High density: 28 ports, all gigabit capable RJ45 with a secure copper connector, or fiber for future expansion
Fiber Type Connector	ST, or LC
Network Switch and Time Synchronization	Where applicable: IEEE 1588 Power Profile Transparent Clock Boundary Clock Ordinary Clock - GPS input time source synchronization - Best Master Clock algorithm support - IEEE 1588 / IRIG-B Conversion
Coating	Conformal coating to prevent mould / corrosion

7.3.2 Communication Network Device – Media

The selection of the network media in the substation shall consider the followings:

1) Required data speed/throughput
2) Linear distance
3) Physical routing
4) Electromagnetic interference (EMI) and ground potential rise (GPR) susceptibility
5) Number of network-connected devices
6) Substation wiring practices/procedures
7) Fibre Monitoring: All fibre media should support DDM (Digital Diagnostics Monitoring) and follow industry-standard SFF-8472.

The communication media to be used in the substation shall be copper and/or optical fibre as depicted in Figure 7.2.

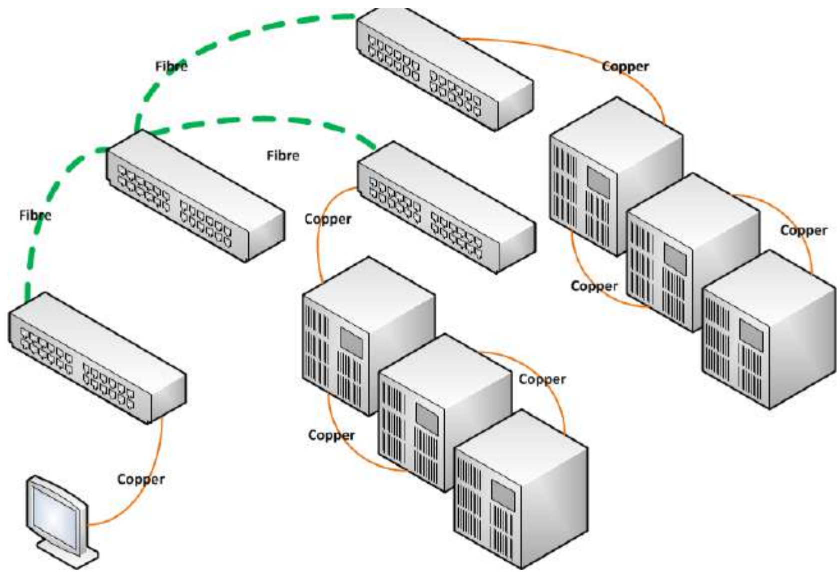


Figure 7.2 – Substation Network Media

The type of the optical fibre to be used in the substation as the network backbone interface (station bus communication) shall be as the following:

Table 7.2 - Fibre Optic Cable Specifications

Optical Fibre Type	Wavelength	Speed	Connector
1000Base-X, Single mode glass	1310nm	1 Gbps	ST or LC (SFP)

Other requirements of the optical fibre cabling are:

1) Vermin proof with mechanical protection
2) Redundant spare optical fibre cable shall be provided as per project specific requirements
3) 100% spare optical fibre cores in each cable shall be provided, i.e., full redundant fibre cores should be provided in each cable
4) Optical fibre cables lay in PVC conduit if mechanical protection is not provided.
5) Power budget calculation shall be approved by PEA

The copper cable used in the network segment inside a panel shall be UTP or STP Ethernet cable (depend on the induced and radiated noise within the panel) as the following:

Table 7.3 – Copper Cable Specifications

Rating	Name	Connector	Speed	Standard
CAT 5	100 BASE TX	RJ45	100Mbps	IEEE Std 802.3-2005 and EIA/TIA 568A/B
CAT 5E (Preferred)	100 BASE TX	RJ45	100Mbps	IEEE Std 802.3-2005 and EIA/TIA 568A/B
CAT 6	100 BASE TX	RJ45	100Mbps	IEEE Std 802.3-2005 and EIA/TIA 568A/B

Alternatively, multi-mode optical fibre may be used in the network X, subject to Ethernet switch port availability and PEA approval, as the following:

Table 7.4 – Fibre Optic Cable Specifications, an Alternative to Table 7.3

Optical Fibre Type	Wavelength	Speed	Connector
Multi-mode glass	850nm, 1310nm	100Mbps	ST

7.4 COMMUNICATION SERVICES TO BE SUPPORTED

Communication services to be supported are summarized in Table 7.5:

Table 7.5 – Communications Systems to be Supported

Service Model	Description	Services	Requirement
Server	Represents the external visible behaviour of a device. All other ACSI models are part of the server	ServerDirectory	
Application Association	Provision of how two or more devices can be connected. Provides different views to a device: restricted access to the server's information and functions	Associate Abort Release	
Logical Device	Represents a group of functions; each function is defined as a logical node	LogicalDeviceDirectory	
Logical Node	Represents a specific function of the substation system, for example, over voltage protection	LogicalNodeDirectory GetAllDataValues	
Data	Provides a means to specify typed information, for example, position of a switch with quality information, and timestamp	GetDataValues SetDataValues GetDataDefinition GetDataDirectory	
Data Set	Allow to group various Refer to Data set data together	GetDataSetValue SetDataSetvalue CreateDataSet DeleteDataSet GetDataSetDirectory	

Service Model	Description	Services	Requirement
Substitution	The client can request the server to replace a process value by a value set by the client, for example, in the case of an invalid measurement value	SetDataValues	
Setting Group Control	Defines how to switch from one set of setting values to another one control and how to edit setting groups	SelectActiveSG SelectEditSg SetSGValues ConformEditSGValues GetSGValues GetSGCBValues	
Reporting and Logging	Describes the conditions for generating reports and logs based on parameters set by the client. Reports may be triggered by changes of process data values (for example, state change or dead band) or by quality changes. Logs Logging can be queried for later retrieval. Reports may be sent immediately or deferred (buffered). Reports provide change of state and sequence-of-events information exchange	Buffered RCB: Report GetBRCBValues SetBRCBValues	
		Log CB: GetLCBValues SetLCBValues	For Measurement Only
		Unbuffered RCB: Report GetURCBValues SetURCBValues	Option
		Log: QueryLogByTime QueryLogAfter GetLogStatusValues	Option

Service Model	Description	Services	Requirement
Generic substation events (GSE)	Provides fast and reliable system-wide distribution of data; peer-to-peer exchange of IED binary status information GOOSE means Generic Object Oriented Substation Event and supports the exchange of a wide range of possible common data organised by a DATA SET GSSE means Generic Substation State Event and provides the capability to convey state change information	GOOSE CB: SendGOOSEMessage GetGoReference GetGOOSEElementNumber GetGoCBValues Set GoCBValues	
		GSSE CB: SendGSSEMessage GetGsReference GetGSSEElementNumber GetGsCBValues Set GsCBValues	Not Implemented
Transmission of Sampled Values	Fast and cyclic transfer of sample, for example of instrument transformer	Multicast SVC: SendMSVMessage GetMSVCBValues SetMSVCBValues	Future Not Implemented
		Unicast SVC: SendUSVMessage GetUSVCBValues SetUSVCBValues	Future Not Implemented
Control	Describes the services to control, for example, devices or parameter setting groups	Select SelectWithValue Cancel Operate CommandTermination TimeActivatedOperate	
Time and Time Synchronization	Provides the time base for the device and system	Services in SCSM	
File transfer	Defines the exchange of large data blocks such as programs	GetFile SetFile DeleteFile GetFileAttributeValues	

7.5 COMMUNICATION PROFILE

Communication profiles the Contractor must comply with are Application (A) Profile, and Transport (T) Profile, which can be found in the following services:

1) Client/Server services (Core ACSI Services)

2) GOOSE/GSE Management Services
3) Time Synchronization

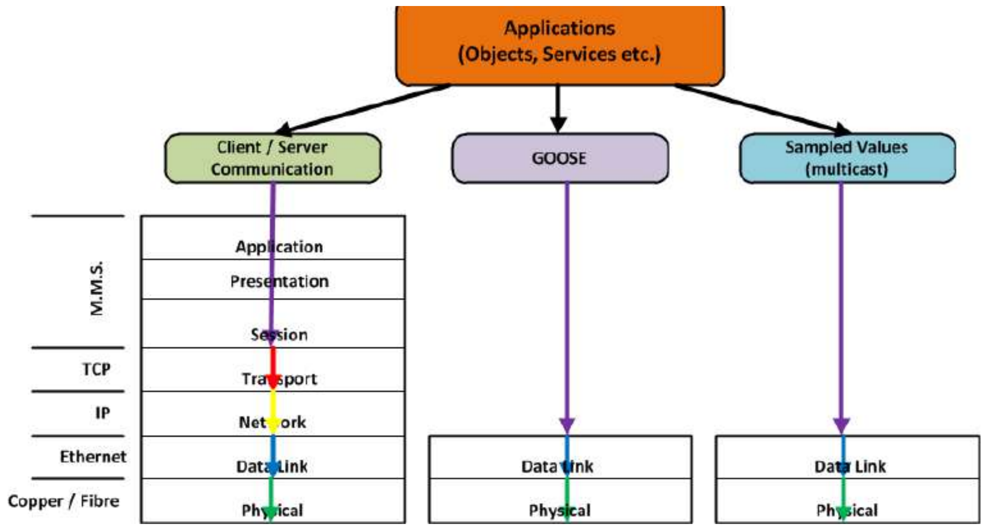


Figure 7.3 – Communication Profile for the Substation

7.5.1 Communication Profile – Client/Server Services

The client/server communication profile shall be used when declaring support for the services shown in the following tables of IEC 61850-8-1.

1) Table 2 Service Requiring Client/Server Communication Profile
2) Table 3 Service and Protocols for Client/Server Communication A-Profile
3) Table 4 Service and Protocols for Client/Server Communication T-Profile

7.5.2 Communication Profile – GOOSE/GSE Management Services

For the GSE Management and GOOSE communication profile when declaring support for the services, refer to Table 6 Service Requiring GSE Management and GOOSE Communication Profile of IEC 61850-8-1.

For service and protocols for GSE Management and GOOSE communication A and T profiles, refer to Tables 7 and 8 of IEC 61850-8-1, respectively.

7.5.3 Communication Profile – Time Synchronization

Time synchronisation for the SCPS shall be accomplished using NTP protocol with direct interface to the Ethernet network through connectionless user datagram protocol (UDP) at transport layer.

This communication profile shall be used for any implementation claiming conformance to this standard and declaring support for objects containing an attribute of type TIMESTAMP.

7.6 INTRA-SUBSTATION AND REMOTE CONTROL CENTER COMMUNICATIONS

Communications between substations, and between a substation and a remote control center shall be via a secured router/CGW. Engineer WAN shall be installed at all substation to facilitate fault investigation and event record view via remote access to IED including the disturbance recorder.

The communications should comply with IEC 61850, Part 90-1 for communications between substations, and Part 90-2 for communications between substation and a control center.

In case that IEC 61850, Part 90-2 has not been released yet, the Contractor shall propose communications between a substation and a control centre for PEA approval.

7.7 STATION TIME SYNCHRONIZATION

Time synchronisation of all IEDs and IEC 61850 based SCPS components in the substation shall be accomplished via NTP Server and modulated IEEE 1588 or IRIG-B with GPS master clock receiver(s).

The Contractor shall make sure that synchronization across a given SCPS system, via NTP together with IEEE 1588 or IRIG-B, shall work properly.

Time synchronisation server shall provide the time source for time synchronisation of all SCPS components. The time shall be distributed to all substation IEDs via the station bus. The expected time stamp resolution of devices shall be 1ms (IEC 61850 Time Performance Class T1) and the expected accuracy (±) between network devices shall be 0.1ms.

One (1) GPS satellite disk and receiver shall be provided for time synchronization purposes at each SCPS system station site. The physical connection and installation of the GPS hardware components shall simple, not requiring any RF or GPS expertise. Any software for configuring or operating the unit shall be provided with the system.

The basic requirements of the Time Server are:

Table 7.6 – Time Server Specifications

Requirement	Comments
Device output protocol type	1) NTP Server (for network connection, with RJ45 Ethernet Interface) 2) IEEE 1588 or IRIG-B (for direct-wired connection)
Auxiliary supply	1) 125VDC nominal voltage (substation DC system) 2) Minimum range 80-120% of nominal voltage
EMC and environmental type tests	1) Withstand substation EMI 2) EMI-hardening
Protocol for NTP server	1) NTP 2) Internet protocol suite standard for time synchronization 3) Network Time Protocol v4.0 or higher 4) Should be compatible with IEEE 1588/IEC 61588 standard
Time source	Redundant Global Positioning Satellite (GPS) system receivers with antennae and wiring
Expected accuracy (±) between Network devices	1) 0.1ms (Expected Time Synchronizing of IED Clocks – one order of magnitude better than IED time stamp resolution) 2) Note: Typical Accuracy 3) 1-2 ms (NTP) 4) 1 microsec (IEEE 1588 or IRIG-B)
Interface	1) Ethernet (NTP, and IEEE 1588) 2) Direct-Wired Co-axial (IRIG-B)
Maintainability requirement	1) Maintenance port to perform the management, configuration, test and maintenance functions 2) Possibility to verify the time server accuracy and precision 3) Possibility to diagnose and troubleshoot problems
Other requirements	High precision clock discipline algorithms to counter inaccuracies caused by jitter and wander

Time synchronisation between devices which require high accuracy equal or less than 0.1 msec. shall be accomplished via IEEE 1588 or IRIG-B, direct-wired synchronization network.

BCU, MU, Smart I/O and TRU units must support both NTP, and IEEE1588 (PTP) or IRIG-B protocols.

7.8 SUBSTATION CONFIGURATION LANGUAGE (SCL)

A standard configuration language SCL, (Substation Configuration Language), based on the XML (Extensible Markup Language) shall be used to define the characteristics of each IED with regards to communication configuration, data model and parameters. SCL is a file format for describing communication related IED (Intelligent Electronic Device) configurations and IED parameters, communication system configurations, switchyard (function) structures, and the relations between them. The main purpose of this format is to exchange IED capability descriptions, and SA system descriptions between IED engineering tools and the system engineering tool(s) of different manufacturers in a compatible way; see Fig. 7.4.

SCL types are classified with different suffixes including ICD, CID, SSD, and SCD as described, previously, in Clause 4.14.1: IEC 61850 Configuration functions for Tools and Process.

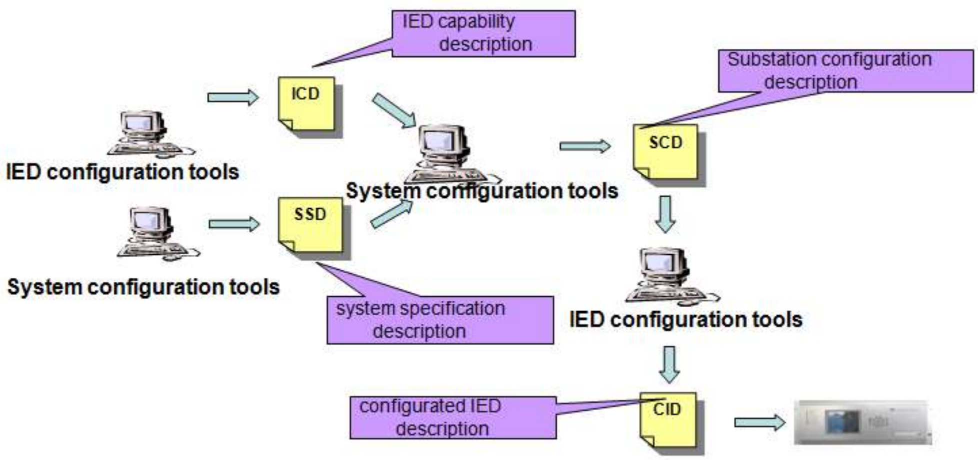


Figure 7.4 – IED and System Configuration Tools and SCL

The SCL shall describe a model of:

1) The primary (power) system structure: which primary apparatus functions are used, and how the apparatus are connected. This results in a designation of all covered switchgear as substation automation functions, structured according to IEC 81346.
2) The communication system: how IEDs are connected to subnetworks and networks, and at which of their communication access points (communication ports).
3) The application level communication: how data is grouped into data sets for sending, how IEDs trigger the sending and which service they choose, which input data from other IEDs is needed.
4) Each IED: the logical devices configured on the IED, the logical nodes with class and type belonging to each logical device, the reports and their data contents, the (pre-configured) associations available; and which data shall be logged.
5) Instantiable logical node (LN) type definitions. The logical nodes as defined in IEC 61850-7x have mandatory, optional and user defined DATA (here abbreviated DO) as well as optional services, and are therefore not instantiable. In this document, instantiable. LNTypes and DOTypes are defined as templates, which contain the really implemented Dos and services.
6) The relations between instantiated logical nodes and their hosting IEDs on one side and the switchyard (function) parts on the other side.

7.8.1 IED Configuration

Any IED supporting the IEC 61850 standard will be accompanied by a configuration file with ICD (IED Capability Description) which defines capacities of the IED. This file will start each project with the installation values, such as addresses, initial parameter values, etc. generating a new CID (Configured IED Description) file.

7.8.2 System Configuration and Specification

The Contractor shall provide all relevant SCL files including System Specification Description (SSD), Substation Configuration Description (SCD), and make sure for IED can be automatically configured from the power system design.

The SCPS configuration shall be done via a management application, as described in Clause 8.4.6 SCPS System and IED Configuration Management. All IEDs shall be configured using SCL-compliant tools, files, and procedures as described in IEC 61850, Part 6.

7.9 COMMUNICATION PERFORMANCE

The following communication system performance requirements shall be observed, verified, published and declared:

1) Message performance
2) System performance

Individual components should be supplied with certificates indicating the worst case performance that that component should meet e.g. the Protective relay will operate within a maximum of so many milliseconds. Overall system performance should be guaranteed by the Contractor in the details statement of work and should provide detailed test procedures to describe how the performance will be measured.

7.9.1 Communication Message Performance

The seven message types specified must meet the following performance requirements:

Table 7.7 – Message Type

Message Type		Description	Typical use	Performance
1		Fast messages – Simple binary code containing data, command or simple message. Triggers the receiving IED to respond immediately.		
	1A	Fast messages for Trip (Note: For Performance Class P2/P3, the total transmission time shall be below the order of a quarter of a cycle)	Trip command to XCBR, intertrip and scheme discriminations	P1 – 10ms P2 – 3ms P3 – 3ms
	1B	Fast messages for Others	Fast response function other than trip command such as interlocking, blocking, etc.	P1 – 100ms P2 – 20ms P3 – 20ms
2		Medium speed messages	Calculated r.m.s. values	<100ms
3		Low speed messages containing complex messages that may require time tagging	Slow speed auto-control functions, transmission of event records, set point, etc.	<500ms
4		Future Raw data messages	Voltage & current phasor from instrument transformer with sampling rate of 480 Hz. These values are for protection & control usage	P1 – 10ms P2 – 3ms P3 – 3ms
5		File transfer functions Time synchronization messages	Lowest priority. Transfer large file of recording, information, setting etc.	>1000ms
6	T1	Control and Protection Events	Used to synchronize internal clock of IED in SCPS. Include all station, bay and process level IE	±1ms
	T2		T1 -Time tagging of events T2 -Time tagging of zero crossings and data for distributed	±0.1ms
7	T3	Instrument transformer	Time tagging for sampled values for protection and control purposes	±25μs
	T4			±4μs
	T5			±1μs
		Command messages with access control	Used to transfer control for security	>1000ms

Table 7.8 – Message Performance

Performance Class			
P1	Distribution with low requirements	M1	Quality metering up to the 5th harmonic
P2	Transmission bay	M2	Quality metering up to the 13th harmonic
P3	Transmission bay with top performance requirements	M3	Quality metering up to the 40th harmonic

The definition of the transfer time for the communication message performances is explained in the Figure below. The given performance times are referring to the total transfer time "t" that includes the IEDs internal processing time as well as the transmission time used over the communication network.

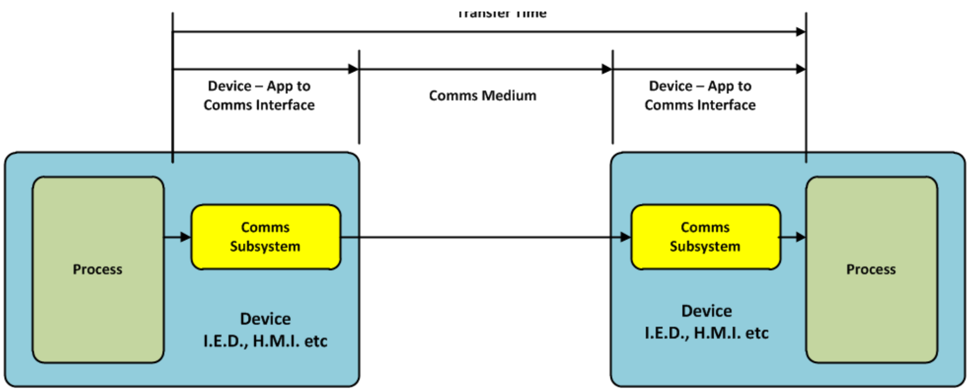


Figure 7.4 – Transfer Time Definition

7.9.2 Communication System Performance

The following parameters shall be measured at station-operator HMI level to evaluate system performance for worst case scenario which includes normal, abnormal, emergency, and post-fault state of operations.

Typical values measured at the station-operator HMI or the Station Level Operator Interface (SLOI) is listed in the following table:

Table 7.9 – HMI Performance

Parameters	Performance
Exchange of display (first reaction)	<1.5 s
Presentation of a binary change in the process display	<1 s
Presentation of Analog change in the process display	<1.5 s
From order to process output	<1 s
From order to updating the display	<2 s

7.10 COMMUNICATION SYSTEM AVAILABILITY

The Contractor shall refer to Clause 4.3 System Performance of this specification, and IEC 61850-7, for details on communication system availability.

7.11 COMMUNICATION SYSTEM MAINTAINABILITY

The SCPS designs that do not required periodic preventive maintenance and inspection are preferred by PEA. If periodic maintenance is required, it shall be possible to perform all such work in the field without requiring the associated media, and/or the communication system to be off.

The Contractor shall refer to IEC 61850-7, for details on the maintainability.

7.12 IEC 61850 ACSI CONFORMANCE STATEMENTS

Refer to Tables A.1-A.4 of IEC 61850-7-2 for the IEC 61850 ASCI Conformance Statement for PEA requirements, i.e.

1) ACSI Basic Conformance Statement
2) ACSI Models Conformance Statement, and
3) ACSI Service Conformance Statement.

7.13 INFORMATION MANAGEMENT SYSTEM

The structure of information management system for the SCPS is depicted in Figure 7.5.

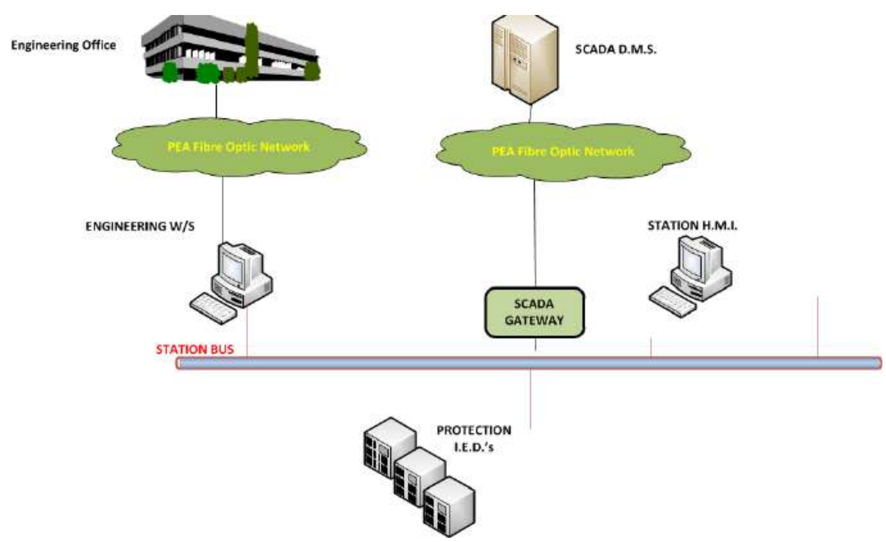


Figure 7.5 – Information Management System

The Information Management System shall consist of:

Table 7.10 – Substation Data and Information

Topic	Comment
Substation Data and Information	The substation data types are; Operational Data: Typical instantaneous measurements values (current, voltage, frequency), indications & status change/event that are conveyed to SCADA master station and Station-operator HMI/SLOI Non- Operational Data: All other non-instantaneous substation information, such as oscillography waveform records, fault data, configuration files and all information from IED Control Commands: Control command messages sent by operators and control processes to optimise and restore the state of power system IT Infrastructure Data: All communication & network-related data such as network & device status, activities, etc. Data priority and time requirements shall be determined with operational data and control command at the highest priority.
Communication Infrastructure	1) Networked communication architecture using Ethernet and Web technology 2) Network devices and time synchronisation 3) Substation clients such as Engineering Workstation 4) High speed database server - Data Historian (Real-time database) and Relational Database 5) Network and system management system
Applications Utilising the Information	1) SCPS functions and applications 2) SCADA 3) Condition-based (optional) and self-monitoring of primary and secondary equipment 4) Network and system management 5) Configuration and setting management 6) Fault handling, analysis, evaluation & diagnostics 7) Alarm and event handling and analysis 8) Trending 9) Asset maintenance and management
Users/Clients (both local and remote users) of the Information and Applications	1) SCADA gateway and control centre 2) Substation Operator through Station-operator HMI/SLOI 3) Engineering Workstation 4) Protection System Engineering 5) Operation & Maintenance 6) Asset management

Topic	Comment
	7) Planning
Substation Access Control and Cyber Security	1) Access Control such as user ID authentication, password management, access management 2) Cyber security measures

Table 7.11 – Sources of Substation Data

Topic	Comment
Sources of Substation Data	1) IED 2) Sensor 3) Allow IED data sharing with other multiple clients connected to the communication network.

7.14 REDUNDANCY

The Contractor shall comply with IEC 61850-3 Reliability Requirement. The communication systems shall have no single point of failure. In case of failure, the communication systems shall be operable according to the "graceful degradation" principle.

In addition, when technology is available, switch topology should be the Station Bus-Ring type, as described in Clause 7.2, and should support High Availability Seamless Ring (HSR) protocol, and/or Parallel Redundancy Protocol (PRP). In other cases, the switch topology might follow other appropriate topologies with redundancy described in Clause 7.2 Function Hierarchy, Interface, and Topology.

Full power redundancy with support for two power supplies shall also be provided. These power supplies can be of the same type, or of mixed voltage type to ensure reliability through diverse power sources.

7.15 CABLE MANAGEMENT

The Contractor shall provide all interconnecting wires, cables, connectors, LAN cables, and other wiring required by the SCPS.

The Contractor shall submit the results of the survey of the cable route and equipment installation location, including workshop drawings and installation procedures, to PEA for approval before installation.

All necessary cabling works with the substation building such as installation of cable trays, cable ducts, cable ladders and support or any other such work to facilitate cabling between the equipment under the scope of this specification and PEA equipment shall be considered as part of the scope of work for the Contractor. PEA will not be responsible for any future claims for minor works within the substation building to facilitate cabling.

The LAN supporting the distributed BCU, Protective relays and MU shall utilize fibre optic cables, shall provide to be glass type to satisfy the distribution distances and overall performance requirements and shall be approved by PEA.

Regarding metallic cable, all metallic cables and wiring shall use copper conductors and have flame retardant insulation.

All wiring shall be neatly laced and clamped.

All wire and cable connectors and terminators shall be permanently labelled for identification. All connection points for external cables and wires shall be easily accessible for connection and disconnection and shall be permanently labelled. Conductors in multi conductor cables shall be individually color-coded. As shown in Table 7.18.

Table 7.12 – The Color of Cable shall be installed the SCPS

Signal	Color of Cable						
	Cable	Phase A	Phase B	Phase C	Neutral	Positive/ Line	Negative/Neutral
Digital Input	Orange	-	-	-	-	-	-
Digital Output	Orange	-	-	-	-	-	-
Analog VT	-	Brown	Black	Grey	Light Blue	-	-
Analog CT	-	Brown	Black	Grey	Light Blue	-	-
Ground	Green- Yellow Or Green	-	-	-	-	-	-
DC Circuit	-	-	-	-	-	Brown	Grey
AC Circuit 1 Phase	-	-	-	-	-	Brown	Light Blue

To provide mechanical protection and physical segregation from protection and control cables, communication fibre shall be installed in HD white conduit. Where the fibre is installed within the substation, a dedicated fibre trough shall be provided for fibre optic cables. The designer shall prepare a fibre trough layout as part of the detailed design.

The Contractor shall refer to Specification No.15 for details of wiring of a copper cable.

8. SYSTEM COMPONENT REQUIREMENTS

8.1 GENERAL REQUIREMENTS

This section describes hardware specifications for the various modules and subsystems that comprise the SCPS system. These are not functional specifications, but are specifications regarding other required qualities of hardware that make it acceptable for use in PEA systems.

8.2 INTELLIGENT ELECTRONIC DEVICE (IED)

8.2.1 Introduction

The IEDs are devices incorporating one or more processors with the capability to receive or send data/control from or to an external source. BCU and IED Protective Relay are equivalent to one processor incorporated in an IED.

The IEDs specified in the specifications are for the followings:

1) IED Protective relay or devices
2) Control devices, i.e. station and bay control devices
3) Recorders

The Contractor shall submit performance test report and interoperability test report, from independent testing laboratories, to confirm the units are interchangeable and are capable of meeting certain performance criteria.

All major IEDs, especially Protective relays, shall undergo and pass product acceptance testing before being accepted for use or put in service in any PEA substation.

All Protective relays shall be designed and tested according to International Electro-technical Commission (IEC). As a basic requirement, the Protective relays shall comply with the standards referred to in Annex 2.

The Contractor shall refer to relevant PEA Product Acceptance Procedure and Process for detail procedures and requirements.

8.2.2 Markings and Labelling Data

The data to be made available by the manufacturer shall be based on IEC 60255-1.

Clearly inscribed labels or markings shall be provided on the devices to describe the manufacturer name, model number, application and ratings. In addition, device function or designation label mounted on the panel shall be provided near or close to the devices.

8.2.3 Device Electrical Parameter Values

The standard device electrical parameter values are:

Electrical Parameter Requirements	Standard Values
Nominal/Rated Auxiliary Operating Voltage (large range)	125 VDC
Operative Ranges Auxiliary Operating Voltage (80% to 110% range)	88 to 138 VDC
Rated DC Burden (Watts)	To be declared by the manufacturer
Total Device Accuracy (%) (Protective relay of Device)	± 5%
Total Device Accuracy (%) (Control Device)	± 1%

The device shall be suitable for operation using substation auxiliary DC system. The device shall not mal-operate on DC auxiliary supply interruption or application/restoration, or when energized from inverted polarities. The device shall also be stable and not affected by slow decay, surges, dips, ripples, spikes, capacitive coupling, DC earth fault, transient and switching disturbances. Indication shall be made available in the event of DC failure.

The standard nominal range of ambient temperature is -10°C to 55°C. The device shall also be able to withstand the internal environment and temperature in the Distributed Prefabricated Relay Housing, even in the event of air-conditioner system failure.

8.2.4 Instrument Transformer Requirements

Please refer to relevant PEA guideline on CT requirements. The instrument transformer (CT and VT) requirements shall be declared and calculated by the manufacturer, in order to maintain the expected steady state and transient performance of the protection device/relay. The protection device/relay shall operate correctly during CT saturation and CT transients. The protection device/relay shall also operate correctly during VT transients and ferro- resonance phenomena.

The protection current transformer star point is located towards the protected circuit or equipment. Current transformer is earthed at one point only.

Device Constructions

The device construction requirements are:

Construction Requirements	Details
Device Housing	Flush Mounted
Front Cover	Optional requirement. Facility to reset indication without opening the front cover. Clearly visible device indications without opening the front cover.
Enclosure Degree of Protection (Front)	IP 51
Enclosure Degree of Protection (Rear)	To be declared by the manufacturer
Duty	Suitable for tropical climate
Nominal ambient temperature range	- 10 °C to 55 °C
Relative humidity	Up to 93%
Maintainability	Removable modules/cards to facilitate easy replacement and testing. Isolating transformer input module with galvanic separation from environment and make before break current input facility.
Terminals	Able to accept wires; 2.5 to 4mm2 for Voltage and Current inputs 1.5 to 2.5mm2 for Binary I/O terminals
Disturbance/EMI reduction (Earthing terminal)	Earthing point or terminal at rear of the device
Microprocessor/DSP Type	To be declared by the manufacturer
Sampling Rate/Frequency range	To be declared by the manufacturer
A/D Conversion	To be declared by the manufacturer
A/D Bit Resolution	To be declared by the manufacturer
Memory Type	Non-volatile. Settings not to be lost in the event of supply failure.

8.2.5 Technological Conformance and Mechanical Requirements

The electrical technological and mechanical hardware tests and standards for the devices are:

Electrical Technological Conformance and Mechanical Requirements	Standards	Type Test Descriptions
Mechanical Stress – Vibration and Shock Stress	IEC 60255-21-1	Vibration test
	IEC 60255-21-2	Shock and bump test
	IEC 60255-21-3	Seismic Test
Insulation	IEC 60255-27 IEC 60255-1	High Voltage Test and Impulse Voltage Tests.
Electromagnetic Compatibility – Immunity	IEC 60255-26	Damped oscillatory wave test
	IEC 60255-26 IEC 61000-4-4 Class 4	Fast transient test
	IEC 60255-22-5 IEC 61000-4-5 Class 3	Surge Test
	IEC 60255-22-6 IEC 61000-4-6 Class 3	Conducted radio interference test
	IEC 60255-26 IEC 61000-4-2 Class 3	Electrostatic discharge test
	IEC 61000-4-11 for AC IEC 60255-3 and IEC 60255-26 for DC	Variations and interruptions in AC and DC auxiliary voltages
	IEC 61000-4-3 Class 3	Electromagnetic fields
	IEC 61000-4-8 Class 5	50Hz power frequency magnetic fields
Electromagnetic Compatibility – Noise Emission	CISPR 11, Class A, Group I. IEC 60555-2	Conducted RF interference on power supply terminals and radiated interference. Harmonics for AC supply
	CISPR 14	Flicker

During product application, the manufacturer shall provide the device type test certificate or reports in accordance to relevant international standards. The test shall include IEC 61850-10 conformance test. If not available, type test shall be performed and witnessed by PEA representatives. All cost shall be responsible by the Contractor.

The Contractor shall refer to PEA Product Acceptance Procedure and Process for Technological Conformance type test reports to be made available during Product Acceptance.

8.2.6 Operating and Reset Time

The required operating and reset time of the protection device are:

Protection	Maximum Operating Time	Maximum Reset Time
Main Line Differential Protection	40 ms	40 ms
Maximum Fault Clearing Time	150 ms	
Note: 1) CB operating time is assumed to be less than 40 ms for 275kV & 500kV system voltage and 50 ms for 115kV system voltage. 2) Relay operating time includes relay fault inception detection time, microprocessor time and relay output contact time. 3) Telecommunication carrier send/receive time (from relay to relay) is assumed to be less than 20 ms. 4) Telecommunication transmission delay is assumed to be less than 10 ms. 5) Handle a delay variation or asymmetric delay of not more than 0.25ms		

8.2.7 User Interface for Protection Device

The Human Machine Interface (HMI) for protection device shall be provided as a user or operator interface. The HMI provides device parameter display, device operational record/status display and device interrogation facility.

The basic requirements of the HMI are:

Basic Requirements	Details
Human Machine Interface (HMI)	Alpha-numeric message display, Liquid Crystal Display (LCD) with integrated keypad to display information. Backlighting with auto dimming facility to be provided.
Information Navigation	User friendly HMI hierarchical navigation structure
Mounting/Location	Front of the device
View or Display	1) View or display device settings and configurations 2) View or monitor service and measurement values 3) View or display event and fault information 4) View or display IED internal events 5) View or display device information/status
Local Information and Indication View	Fault information depending on IED functions, for example; 1) Zone (For Distance Protection Function) 2) Faulted Phase 3) Trip Time 4) Relay event records and status 5) Measurements under normal load conditions
Change or modify	1) Change or modify device settings and configurations 2) Change or modify device setting groups

Basic Requirements	Details
Testing and Monitoring	1) Testing and commissioning assistance 2) Monitoring of device self-supervision status
Memory Type	Non-volatile. Settings view not to be lost in the event of supply failure.
Keypad Operation	No device tripping or operation due to updating, changing or modifying of device settings and/or configurations
Password	Password restriction forchange or modify the IED setting/configuration and commissioning assistance

8.2.8 User Interface for Control Device

The HMI for control device shall be provided as a user or operator interface. The HMI provides bay single line diagram mimic, device parameter display, device operational record/status display and device interrogation facility.

The basic requirements of the HMI are;

Basic Requirements	Details
Human Machine Interface (HMI)	Alpha-numeric message display, Liquid Crystal Display (LCD) with integrated keypad to display information. Backlighting with auto dimming facility to be provided.
Information Navigation	User friendly HMI hierarchical navigation structure
Mounting/Location	Front of the device
View or Display	1) View or display device settings and configurations 2) View or monitor service and measurement/metering values 3) View or display event and relevant fault information 4) View or display IED internal events 5) View or display device information/status 6) View or display bay single line diagram mimic for bay control device
Device Control	1) Control switching devices with necessary software interlocking for bay control device 2) Select-before-execute command procedure 3) Control mode selection (Local/Remote) 4) Interrogate or access device information/status 5) Programmable logic control
Local Information and Indication View	1) Bay Indications 2) Fault information depending on IED functions 3) IED event records and status 4) Measurements under normal load conditions

Basic Requirements	Details
Change or modify	1) Change or modify device settings and configurations 2) Change or modify device setting groups
Testing and Monitoring	1) Monitoring of device self-supervision status 2) Testing and commissioning assistance
Memory Type	Non-volatile. Settings view not to be lost in the event of supply failure.
Keypad Operation	No device tripping or operation due to updating, changing or modifying of device settings and/or configurations
Password	Password restriction for change or modify the IED setting/configuration and commissioning assistance

8.2.9 Relay Indicator

The relay indicator shall be provided to display or indicate the relevant relay local operational information. The indications shall be visible with or without front cover mounted. The indication shall be stored and will not be lost in the event of DC supply failure.

The basic requirements of the relay indicator are:

Basic Requirements	Details
Indication Type	LED
Fixed Indication	1) Trip 2) Alarm 3) Fail/healthy
Indication Reset Operation	All indication only can be reset by Pushbutton or Keypad
Reset Facility	Optional if front cover is provided. Facility to reset indication without opening the front cover.
Indication Auto Update	Always indicate last fault information

8.2.10 Event Recording

The basic requirements of the relay event recording are:

Basic Requirements	Details
Number of Event Record	Capacity of at least 100 event records, and at least 5 records of oscillographic recordings
Timed & Date	Time & date stamped by relay real time clock
Relay real time clock	Resolution 1 ms or less
Memory Recording Sequence	First in first out (FIFO)

Basic Requirements	Details
Display View	LCD display Remote/PC access via the appropriate communication facility
Chronological Event Record	1) Relay tripping 2) Binary I/O operation or change state 3) Relay internal algorithm pickup/drop-off 4) Relay internal events 5) Relay self-supervision/monitoring state 6) Setting change
Memory Type	Stored in non-volatile memory

8.2.11 Fault Recording

The basic requirements of the relay fault recording are:

Basic Requirements	Details
Number of Fault Record	To be declared by the manufacturer. Minimum 5 fault records.
Timed & Date	Time & date stamped by relay real time clock
Recording Duration	1) Dynamic fault record duration up to 5.0 second 2) Pre and post fault duration
File Format	COMTRADE format (IEC 60255-24)
Sampling Frequency	1) To be declared by the manufacturer 2) Minimum 1 kHz
Memory Recording Sequence	First in first out (FIFO)
Number of Analog and Binary Channels	To be declared by the manufacturer
Oscillographic Recording and Event Information	1) Voltage waveform 2) Current waveform 3) Zero sequence voltage & current 4) Activated element 5) Binary Input and Output Status 6) CB status
Triggering	1) Protection start or trip 2) Binary input (manual/external triggering)
Display View	1) Relay Interrogation and Analysis Software Tools 2) Software type to be declared by the manufacturer

8.2.12 Fault Locator (For Line Protection)

The basic requirements of the relay fault location are:

Basic Requirements	Details
Distance to Fault Measurement	Impedance loop
Fault Distance display	1) kilometre line length (km), or 2) Percentage of line length (%)
Optional Fault Distance display	Impedance line length (ohm primary or secondary)
Other options	Zero sequence mutual coupling compensation activation for parallel double circuit lines

8.2.13 Measurement/ Metering Function

The basic requirements of the relay measurement/metering function are:

Basic Requirements	Details
Measurements under normal load conditions	1) Load current 2) Operating voltage 3) Power
Display View	1) LCD alpha-numeric display 2) Remote/PC access via serial communication facility
Other Optional Features	Able to display in primary or secondary value on system voltage and current

8.2.14 Self-Supervision and Monitoring

The basic requirements of the device self-supervision and monitoring function are:

Basic Requirements	Details
Self-supervisions and monitoring	1) Power on diagnostic and self-check routine 2) In service internal continuous self-monitoring device operation check 3) IED specific supervision functions, 4) **Busbar Protection -** Current Transformer Supervision 5) **Busbar Protection** - (Low Impedance IED) Isolator Position Supervision 6) **Line Protection** - Voltage Transformer Supervision 7) **Line Protection** - Telecommunication or 8) Teleprotection Supervision
IED Internal Failure Detection	1) Hardware 2) Software

Basic Requirements	Details
Indication Status	1) LCD display/view 2) LED indication display 3) Watchdog self-supervision (device faulty) contact 4) Remote from Engineering Workstation or ISPS

8.2.15 IED Clock Circuit and Time-Stamping Capability

IEDs shall be equipped with a real-time clock, with full calendar support (including leap year). Clock resolution shall be governed by IEC 60870-4, Table 7 Class TR4. Clocks shall have an accuracy of ±2ppm and shall not drift more than twenty (20) ms per hour. If necessary, IEDs shall employ software algorithms to counter inaccuracies and drift resulting from crystal ageing.

All IEDs that need to maintain precise time for time-stamping shall be capable of supporting IEEE 1588 time-synchronization by the Time Data Server, maintaining acceptably low drift in time between synchronizations, and time-stamping events with a precision of +/-0.5ms relative to the GPS source.

IEDs shall support local setting of time and date from the front port or HMI panel. This feature is intended only for use in unusual circumstances, such as the loss of HMI synchronization or for IED testing. This set of values shall be maintained by the IED until overridden by a successful time-synchronization from the HMI.

Except for synchronization, the IED's real-time clock shall be completely independent of outside sources, so that the IED can continue to properly handle its time related applications, should the time-synchronization mechanism fail.

8.2.16 Performance

The Contractor needs to provide PEA documentation on the performance characteristics of the IED. The document shall include conformance testing of the IED with Part 10 of, IEC 61850 (Conformance Test), and shall include additional performance characteristics such as time synchronization and time-stamp accuracy, control reaction time, and operation and reliability criteria.

The IEC 61850 Conformance Test Certificate from an independent laboratory shall be provided as evidence and part of the tender submission. The laboratory shall be accredited by UCA International Users Group with ISO/IEC17025 certification with certification. The IEDs shall not show any non-conformance to IEC 61850 Parts 3, 6, 7-1, 7-2, 7-3, 7-4 & 8-1, and 9-2 (2011).

Each IED unit shall communicate with up to control centres at a time (this may vary depending on the amount of information that wants to be sent to each station).

The device shall also be stable and not affected by slow decay, surges, dips, ripples, spikes, capacitive coupling, DC earth fault, transient and switching disturbances. Indication shall be made available in the event of DC failure.

8.3 COMMUNICATION EQUIPMENT AND SYSTEM

8.3.1 Substation LAN

Operation of the Substation LAN shall comply with the IEC 61850 Ethernet profile using TCP/IP. Substation LAN shall support 10/100 Mbps for bay level and 1/10/100 Mbps for process level, with consideration of whether 1Gbps is technically and economically appropriate.

All connections to Substation LAN shall be made using ST connectors. Unless otherwise specified, the Substation LAN shall use multi-mode cable and be sheathed for protection against abrasion and cuts. Fibre optic cable shall be terminated and routed according to best industry practices. All materials shall be industry standard, commercially available, and supportive of the open systems concept. A service loop shall be provided at connection points to allow flexibility for future equipment upgrades.

The Substation LAN design shall not require any routine engineering administration or manual reconfiguration to remedy an equipment failure or to facilitate failure recovery.

The Substation LAN shall be designed to ensure that, in the event of a single LAN cable or LAN interface module failure, none of the SCPS system functionality shall be lost and at most one IED server (e.g. BCU) shall be isolated from the HMI.

Two redundant Substation LANs shall provide the principal means for data exchange among intelligent station components at both the station and bay levels. Each LAN shall consist of Ethernet network segments, Ethernet Switch, and TCP/IP communications software that conform to the IEC 61850 network profile. Fibre-optic network media shall be used throughout the station facility. Copper media shall not be used within individual enclosures, Fibre-optic shall be provided. Each device connected to the network shall be specified to have one or two network ports, used as follows:

1) Where two ports are used, one shall be connected to each Substation LAN. The way these two connections are used is described under the ‘Dual Substation LAN Connections’ heading.
2) Where one port is used, it will be connected to an assigned Substation LAN, as determined by system design.

Substation LAN for Operator Interface (HMI): The HMI unit shall conform to UL approved safety standards and be certified to FCC Class B. The statistical MTBF for the HMI unit shall be not less than 50,000 hours, when analysed at 75% loading and 25°C. The equipment shall be capable of operating under the specified ambient conditions for indoor equipment.

8.3.2 Communication network Cable

The LAN supporting the distributed SCPS processing unit, BCU, MU and IED, i.e. protective relays, meters, etc. shall utilize fibre optic cables which may be of glass as necessary to satisfy the substation plant distribution distances and overall SCPS performance requirements.

All necessary connectors, extenders, optical fibre cable and LAN assembly devices to meet the overall installation requirements shall be provided.

<u>Connectors</u>

All LAN cables shall be installed at Station level, Bay level and Process level.

A type of connector shell be provided the ST type connector for Station level Devices and Ethernet switch bay level and process level.

<u>Construction of Optical Fibre cable (OFC)</u>

Characteristics of the OFC shall be the graded index multimode optical fibre conforming to the requirement of IEC Publication No.60793-2-10, 60794-1 and DIN VDE 0888-3. The fibres shall be high grade pure or doped silica. The OFC shall withstand at least 150 kg force without breaking or damaging the fibres in the cable. The permissible bending radius shall be no greater than 20 times the outside diameter of the cable.

1) **Outdoor type**: For Structure of the OFC shall have high mechanical strength to protect the fibres from external forces, be easily installed without requiring any special care or equipment, and shall be suitable for installation in cable trench. The OFC shall meet the minimum specifications, requirements are as follows:
   a. Multiple fibre cores
   b. Central strength member
   c. Corrugated steel armoured or steel wire armoured

2) **Indoor type**: All Optical fibres cables shall be designed by duct construction are connected to Remote cabinets, Control cabinets or Protective relay cabinets. The Optical fibre patch cord shall meet the minimum specifications, requirements are Multimode

   a. The LAN supporting the distributed SCPS HMI to Ethernet switch: All necessary connectors, extenders, terminators and LAN assembly devices to meet the overall installation requirements shall be provided. All LAN cables shall be designed by duct construction are connected to HMI cabinets.
   b. Bay Level and Process Level Devices: The Optical fibres cables supporting the distributed SCPS processing unit and IEDs, i.e. protective relays, meters etc. shall utilize fibre optic cables which may be of glass overall SCPS performance requirements. All necessary connectors, extenders, terminators and Optical fibres cables assembly devices to meet the overall installation requirements shall be provided.

8.3.3 Optical Fibre Distribution Unit (FDU)

Distribution cable and drop cable is connected in between the optical fibre distribution unit (FDU), which is an important part of the whole optical distribution network (ODN). FDU is very flexible on capacity and coupling interface configuration requirements. Outdoor FDU are provided the enclosure is made of high-quality steel sheet, surface

1) Plastic spray
2) Wall mount and pole mount available.
3) Inlet cable can either be loose tube cable or slotted cable.
4) Outlet cable can either be optical fibre cord or drop cable by Contractor.

8.3.4 Ethernet Switch

Please refer to Clause 7.3.1 Communication Network Devices- Ethernet Switch.

8.3.5 HMI Units based on Industrial Computer

The HMI unit shall conform to UL approved safety standards and be certified to FCC Class B. The statistical MTBF for the HMI unit shall be not less than 50,000 hours, when analyzed at 75% loading and 25°C. The equipment shall be capable of operating under the specified ambient conditions for indoor equipment.

The HMI unit shall be manufactured by IBM, Dell, Hewlett Packard, or an equivalent source approved by PEA. The equipment shall be warranted to work in PEA electrical substation environments. Full repair services shall be available in THAILAND for the selected equipment.

The HMI unit shall connect to both Substation LANs through separate fibre optic interfaces, using connectors is described under the 'Dual Substation LAN Connections' heading.

Aside from hardware requirements, the equipment shall incorporate the required system software. Refer to the Software Requirements.

The HMI units based on an Industrial Computer shall meet the minimum specifications as All HMI hardware, unless the contractor believes that the specifications are not sufficient for meeting requirements or that the specifications can be better oriented to available, mainstream products. In either case, the contractor shall submit a counterproposal to PEA, accompanied by reasons for the proposed changes.

As a minimum, the HMI hardware shall consist of the following equipment, including processor, hard disk drive, LED monitor, keyboard, and cursor positioning device. The equipment shall be designed for continuous operation in a high voltage substation environment.

All HMI hardware shall be latest available technology and shall have prior approval from the PEA before making orders by the Contractor.

One Personal Computer (PC), which is a 19-inch rack mounted industrial type, shall comply with the minimum requirements stated in Annex 3.

8.3.6 Communications Gateway (CGW)

The CGW shall support a data rate of 10/100/1000 Mbps Ethernet port. The CGW interfaces with the SDH WAN through a fibre optic Ethernet port, or can interface with PEA backbone network.

The CGW module, which interfaces the FO Ethernet port to the SCPS system, shall connect on the other side to both Substation LANs through separate fibre optic interfaces. Use of the two connectors is described under the 'Dual Substation LAN Connections' heading.

PEA will provide one (1) independent communications circuit to the SCADA/DMS control centre. The Contractor will be responsible for establishing end-to-end communications with the SCADA/DMS control centre. The CGW shall also support necessary signals that are transmitted via other PEA's networks, not via SCADA, such as Battery Monitoring signals that are transmitted via PEA's LAN.

The CGW hardware shall be latest available technology and shall have prior approval from PEA before making orders by the Contractor. The CGW shall either be a PC or a Microprocessor Controller. The CGW shall be delivered at least as follows,

1) 1 GHz Intel Processor (or equivalent)
2) 1 GB SDRAM of main memory (or better)
3) 250 GB 24/7 server-type hard disk
4) Real-time clock, calendar with battery backup, and support for time-synchronization.
5) Auto-restart capability.
6) Diagnostics, on-site installation, and validation.
7) Protocol configuration
8) Security Service

In case that the Contractor proposes a microprocessor-based IED to work as the CGW, the proposed IED shall at least have performance equivalent to the CGW function specified above.

<u>**Communication Gateway Ports (CGWP)**</u>

The CGW shall be provided with the following communications Configurable ports:

1) Two RS-232 serial ports for remote primary and secondary (backup) SCADA/DMS communications or DAC Simulator. These ports shall be configured for serial DNP 3.0 communications protocol.
2) Two Ethernet ports for remote primary and secondary (backup) SCADA/DMS communications or DAC Simulator. These ports shall be configured for Ethernet the DNP3.0 over IP communications protocol. The serial or Ethernet fibre optical ports are preferred. Otherwise, to optically isolate, the media converter or Optical Line Driver shall be provided.

3) One Ethernet port for remote SCPS diagnostic and configuration maintenance activities using, for example, suitably configured PCs (such as the Contractor-supplied PC consoles)
4) One port for local time synchronization of the SCPS's internal clock using a suitable time code standard.
5) Two Fibre optical Ethernet ports for substation LAN, one shall be connected to each Substation LAN.
6) One port for local CGW configuration.

Each port shall support multiple protocols on an individually assigned basis and function independently such that the performance of each port shall not be degraded by simultaneous activity on all other ports.

Serial communication parameters such as baud rates (300 to 19,200 bits per second, although the operational rate shall initially be set at 9,600 bps.), number of data bits, parity, transmission retries, synchronous or asynchronous data formats etc. shall be configurable.

8.3.7 Communication Interface

Where data communication interfaces using DNP 3.0 protocol are necessary, DNP3.0 over IP shall be used over the Substation LAN.

Means shall be provided in substations to ensure that the connections between the SCPS and the multiplexers that provide access to PEA communications channels are optically isolated to avoid possible SCPS and/or multiplexer damage due to surge, electromagnetic interference, and ground potential problems especially during power system fault conditions.

A communication port between PEA SCADA control centre and fibre optic cable at the SCPS or multiplexer is RS-232, as specified in 7.2.

8.3.8 IED Bay Control Unit (BCU)

BCU servers have data acquisition and control responsibilities within the SCPS system. In the systems to be delivered under this technical specification, they connect to traditional I/O points on the back end (e.g. status contacts, counter contacts, analog inputs, and control outputs). On the front end they are presented as IEC 61850 data models, just as though they originated from true IEC 61850-compatible sources. The data from these models shall be selectively delivered to the HMI's Local Repository according to station needs.

The BCU servers shall be capable of storing and executing programmable logic applications. In support of a distributed processing environment, they shall be capable of interconnecting with other BCU servers via IEC 61850 GOOSE messaging to acquire status and commands and to provide the same in return. In this way, multiple units can cooperate perform bay interlocking and automation applications. All parameters, configurations, programs, software, and process data shall be stored in non-volatile memory, along with revision control information.

8.3.9 Merging Units (MU's)

The Merging Unit is a physical unit used for time-dependent combination of current and/or voltage data from secondary converter. A merging unit can be a component part of the instrument transformer or a separate unit.

Typical locations for MU shall be as follows:

1) MV switchgear: low-voltage compartment of each cubicle (mounted on MV switchgear).
2) HV switchgear: marshalling cubicles/junction boxes, local control cabinets.
3) HV/MV power transformer: local control cabinets.
4) Automatic switching capacitor bank: local control cabinets.

The MU work as a bridge between primary equipment (such as electronic CT/VT or traditional electro-magnetic CT/VT) and bay level IEDs for signal capturing and transmission based on IEC61850-9-2LE or IEC60044-8. MU can be used to convert Analog signals to digital signals for electro-magnetic CTs/VTs and dispatch them to different relays and controllers after data synchronization. Signal type accessed through merging unit can be:

1) Digital sampling data outputs from electronic CT/VT or simulator (Now digital sampling output module is available in relay testing equipment such as Omicron).
2) Analog signals from electro-magnetic CT/VT or simulator.
3) Switching signals from intelligent primary equipment.

The MU shall, at least, comply with the following requirements:

1) The nominal frequency range must be wide enough to allow for the analysis of all expected transients.
2) Sampling Rate: 4000 samples/sec at 50Hz
3) The maximum Number of Event Recorded shall be at least 8,000 time tagged event records
4) Operating Temperature Range
    a. -25 °C to +55 °C (continuous)
    b. -40 °C to +70 °C (96 hours)
5) Voltage Measurements Composite Error: the composite error is the sum of the errors between the input and output of the device. It includes both the ratio and phase error
    a. Typical measurement application range: < 0.25% for 0.8 Vn to 1.2 Vn
    b. Typical protection application range: < 1.5 % for 0.1 Vn to 1.2 Vn
6) Current Measurements Composite Error
    a. Typical measurement application range: < 0.25% for 0.6 In to 1.2 In
    b. Typical protection application range: < 2.5% up to 40 x In
7) Ambient Humidity Range: shall comply with IEC 60068-2-78: 2001, and IEC 60068-2-30: 2005
8) Corrosive Environments: shall comply with IEC 60068-2-42: 2003, IEC 60068-2-43: 2003

9) High Voltage (Dielectric) Withstand & Impulse Voltage Withstand Test: shall comply with IEC 60255-27: 2013
10) Surge Withstand Capability: shall comply with IEEE/ANSI C37.90.1: 2002
11) Vibration Test: shall comply with EN 60255-21-1:1996
    a. Response: class 2
    b. Endurance: class 2

8.3.10 Smart I/O

The Contractor shall refer to Clause 5.3.2 I/O Point Types, Clause 5.3.3 I/O Point Counts and ANNEX 4 for details of Smart I/O.

8.3.11 Interface, Electromagnetic, and Environmental Compatibility

The BCU servers and any affiliated data acquisition or control modules shall be considered protection grade equipment. They shall be type-test certified as meeting the 'Compatibility Test Criteria' for (1) interfaces, (2) electromagnetic compatibility, and (3) environmental issues. Refer to the 'Clause 1.3 ENVIRONMENTAL CONSTRAINTS AND ELECTROMAGNETIC COMPATIBILITY' heading for specific requirements.

8.3.12 Printing Facility

The Contractor shall provide printers (for the stations that require them) and all necessary installation components (e.g. LAN interfacing, cabling, connectors). The printers shall be located in close proximity to the operator interface [HMI] units. The printers shall be an A4 color laser printer.

8.3.13 Control Circuit Requirements and Internal Wiring Conductor

All BCUs or MUs and Protective relays shall be house in a dust proof cover, class IP51, with a transparent front and shall be provided with test switch blocks.

Low voltage circuit breaker with auxiliary contact and suitable breaking characteristics shall be provided for protection of each measuring and control circuit in each panel. Potential circuits, current circuits, trip circuits and auxiliary supply shall be connected to test switch block.

8.3.14 Communication Port

All communication ports have galvanic insulation that isolates the electrical communication cables from the internal electronic. It protects the units against induced disruptions in the communication cables.

Ethernet:

1) For optic for 10/100 Mbps shall be provided at station level devices and bay level devices.
2) For optic for 1/10/100 Mbps shall be provided at process level devices.

Addressing:

For security reasons static IP addressing is used in the IEDs. Therefore, the allocation of addressing will be done in the engineering phase and each IED will have a fixed IP Address which identifies it into the substation.

The change of the IP address or network mask of any IED is performed from the local HMI in the device or with standard telnet commands. The Contractor shall be provided also a configuration tool but as it uses telnet commands this can be done also with any telnet session.

The CID file contains an IP address in the communications section. This IP address should be the same configured in the IED. For security reasons if the IP address in the uploaded CID is not the same configured in the IED, the CID file will not be validated. So the IP address contained in the CID file does not configure the address in the IED and it is use to check it and prevent the upload of a CID file to a wrong IED.

8.3.15 Console Furniture

The L-shape console furniture shall conform to the proposed HMI shall be designed in accordance with generally accepted ergonomic principles regarding the height and orientation of the monitors, the keyboard, and the mouse.

One (1) L-shape desk or two (2) separate computer desks with one (1) operator chair shall be provided and shall have a full depth of at least 70 cm, a depth of approximately 40 cm in front of the monitor, and a free flat area with a minimum size of 100 cm in length by 70 cm in depth.

The L-shape console furniture shall be situated in the substation control room, in a location approved by PEA. The proposed design, dimensions and materials of the desk and chair shall be subject to PEA review and approval.

A communication cabinet should also be provided for housing Ethernet Switch; the communication cabinet should be a standard 19-inch rack type.

8.3.16 KVM Switch

The Contractor shall provide communication between a monitor, keyboard, mouse connecting to The HMI-server cabinets in a communication room, by using a KVM Switch. The contractor shall submit a recommendation and request PEA approval.

The KVM Switch shall be located in Communication room with the HMI by multimode fibre optic cable and the following requirements:

1) Functions: A Dual-function KVM/USB console switch combined with a USB hub available to each connected computer.
2) Hot-plug Ability: The physical keyboard, mouse, and monitor are all hot-plug attachable to the KVM Server Console Switch. The KVM Server Console Switch detects when a physical

keyboard or mouse is installed or removed. Upon installation, the KVM Server Console Switch will reset and initialize the keyboard or mouse to the current state of the selected server. Supported Monitor Modes. The KVM Server Console Switch allows the use of colour VGA, SVGA, XGA.

3) Operation: The Module 1x4 USB/PS2, One HDMI KVM Switch provides four-port keyboard, video, and mouse (KVM) and a stereo audio switch combined with a two-port USB hub. And One HDMI KVM Switch provides for HDMI monitor, As a KVM switch, the computers can be accessed from a single keyboard, mouse, and monitor console.
4) Supports: DOS, the Window 98SE/Me/NT4.0/2000/XP/7 or the latest and better version
5) Video Resolutions Supported: Maximum Resolutions: 1920 x 1080
6) Controls PCs Supported: PS/2 keyboard, PS/2 mouse and HDMI monitor Controls PCs with one PS/2 keyboard, PS/2 mouse and monitor.
7) Console and Computer Connectors
    a. Keyboard Connector: USB
    b. Video / Monitor Connector: HDMI
    c. Mouse Connector: USB
8) Supported Fibre Extender Length: Multimode (Transmitter & Receiver) 50 meters maximum.

8.3.17 Bay Marshalling Cubicles for MU&Smart I/O Equipment

8.3.17.1 GENERAL

One nos. of bay cubicle shall be provided for each incoming line bay and transformer bay.

In addition to the requirements specified elsewhere in the specification, the cubicles shall have two distinct compartments and shall include:

1) One incoming AC line of 600V XLPE copper cable 4C x 25/10 mm2 in 31/2” C through cable trench supply from AC Distribution Board to connect Main CB of 400V, 3 phase, 63A, and minimum eight outgoing MCBs of 400V, 3 phase, 16 A. CBs shall conform to IEC: 898-1987 and IS: 8828.
2) One incoming DC line of 600V XLPE copper cable 2C x 25 mm2 in 1” C through cable trench supply from DC Distribution Board to connect Main CB of 250V, 63A, and minimum four outgoing DC CBs of 250V, 20 A. CBs shall conform to IEC: 60364-1.
3) A minimum of 180 nos. of terminal blocks (refer to General Specification number 1) suitable for connecting 4/2.5 mm2 IEC01 copper cable and 4 mm2 IEC01copper cable shall be provided with mounting arrangement, channels, end plates, end locks, cable raceways etc. in vertical formation for CT/ VT and other control wiring.
4) There shall be 6U DIN rails rack mounted type, 12C x12C fiber optic patch panel and patch cord organizer installed inside cubicle.
5) Ani-condensation heaters, automatically controlled for preventing harmful moisture condensation. Necessary CB(s) shall also be provided to protect the heaters.

6) Two ventilating fans, automatically controlled by thermal controller placed at the hottest part of the cubicle. Necessary CB(s) shall also be provided for these fans.
7) Illumination lamp (LED with fixture) shall be provided along with door operated switch.

8.3.17.2 MARSHALL & CONTROL CUBICLE

A. Constructional Details of Bay Marshalling Cubicle:

General Considerations

In addition to the requirements specified elsewhere in the specification, the cubicles shall be constructed with the following requirements:

1) Cubicles shall be of metal enclosed, outdoor floor mounted, and fixed-standing type.
2) All cubicle frames shall be fabricated using suitable mild steel structural sections for pressed and shaped cold-rolled sheet steel of thickness not less than 2.5 mm. Frames shall be enclosed in cold-rolled sheet stainless steel of thickness not less than 2.0 mm. Doors and covers shall also be cold rolled sheet stainless steel of thickness not less than 2.0 mm. Stiffeners shall be provided wherever necessary.
3) All panel edges and cover / door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.
4) The complete structures shall be rigid, self-supporting, free from flows, twists and bends. All cut-outs shall be true in shape and devoid of sharp edges.
5) All cubicles shall be of dust and vermin proof construction and shall be provided with a degree of protection of IP: 54 as per IS 2147.
6) A copper earthing bar shall be provided at the bottom part of the cubicle. The earth bus shall have sufficient cross-section to carry the momentary short circuit and short time fault currents to earth without exceeding the allowable temperature rise.
7) Suitable arrangement shall be provided at each end of the horizontal earth bus for bolting to earthing conductors.
8) Suitable arrangement shall be provided in the earthing bar to connect earth wires from the Terminal Blocks.
9) The hinged doors shall be earthed through flexible earthing braid.
10) The cubicle shall have minimum dimensions of 1650 mm (H) (including base frame of the size (50x50 x4) mm x 900 mm (W) x 600 mm (D).

B. Material and Manufacturing:

In choosing materials and their finishes, due regard shall be given to the humid tropical conditions under which equipment shall work, and good proven practices shall be followed as approved by the PEA. Some relaxation of the following provisions may be permitted where equipment is hermetically sealed but it is preferred that tropical grade materials should be used wherever possible:

Metals: Iron and steel are generally to be painted or galvanised as appropriate. Indoor parts may alternatively have chromium or copper-nickel plating or other approved protective finish. Small iron and steel parts (other than stainless steel) of all instruments and electrical equipment, the cores of electromagnets and the metal parts of relays and mechanisms shall be treated in an approved manner to prevent rusting.

Screws, Nuts, Springs, etc: The use of iron and steel shall be avoided in instruments and electrical relays wherever possible. Steel screws shall be zinc, cadmium or chromium plated, or when plating is not possible owing to tolerance limitations, shall be of corrosion-resisting steel. Instrument screws (except those forming part of a magnetic circuit) shall be of brass or bronze. Springs shall be of non-rusting material, e.g., phosphor-bronze or nickel silver, as far as possible.

Rubbers: Neoprene and similar synthetic compounds, not subject to deterioration due to the climatic conditions, shall be used for gaskets, sealing rings, diaphragms, etc.

The Contractor shall submit for PEA approval of thermal calculations, ventilation fans sizing and the required air flow for thermal control limited to roughly maximum inner temperature (Ti) of 55 degree Celsius. Two ventilating fans plus one thermal controller shall be equipped with two relays provide assisted convection depending on the inner temperature (Ti) Variable speed fans are preferred and they shall “kick-in” if the temperature in the cubicle reaches 40 degree Celsius

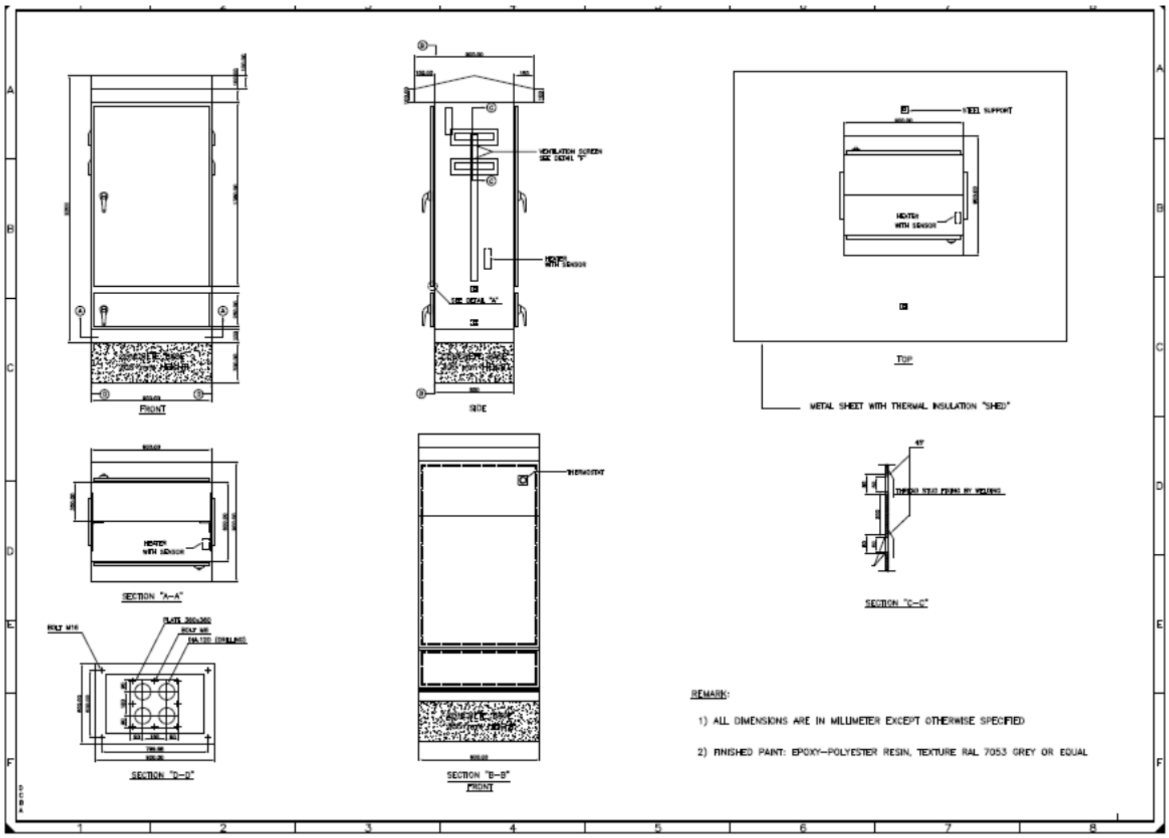
The material of the cubicle frame shall be mild steel and accessories such as side/back panels, door, handles, nameplate indicating the type of the marshalling control cubicle, brackets, bolts, nuts, washers, etc. shall be 304 stainless steel or higher grade. The cover shall be of hinge door type complete with sealing gasket. The gasket shall be thermal insulating type, suitable for outdoor operation. The stainless steel sheet of all types of marshalling control cubicle shall be of at least 1.6 mm thickness and shall be painted. The colour of painting shall be chosen to provide the maximum degree of reflection and of polyester type. Other types of painting can be accepted subject to PEA approval. The size and dimension of marshalling control cubicle shall be as shown in Figure 8.1. The designation of the type of marshalling control cubicle on the nameplate shall be engraved or neatly marked with permanent ink. The mounting accessories for supporting structure shall be supplied.

C. Internal Equipment:

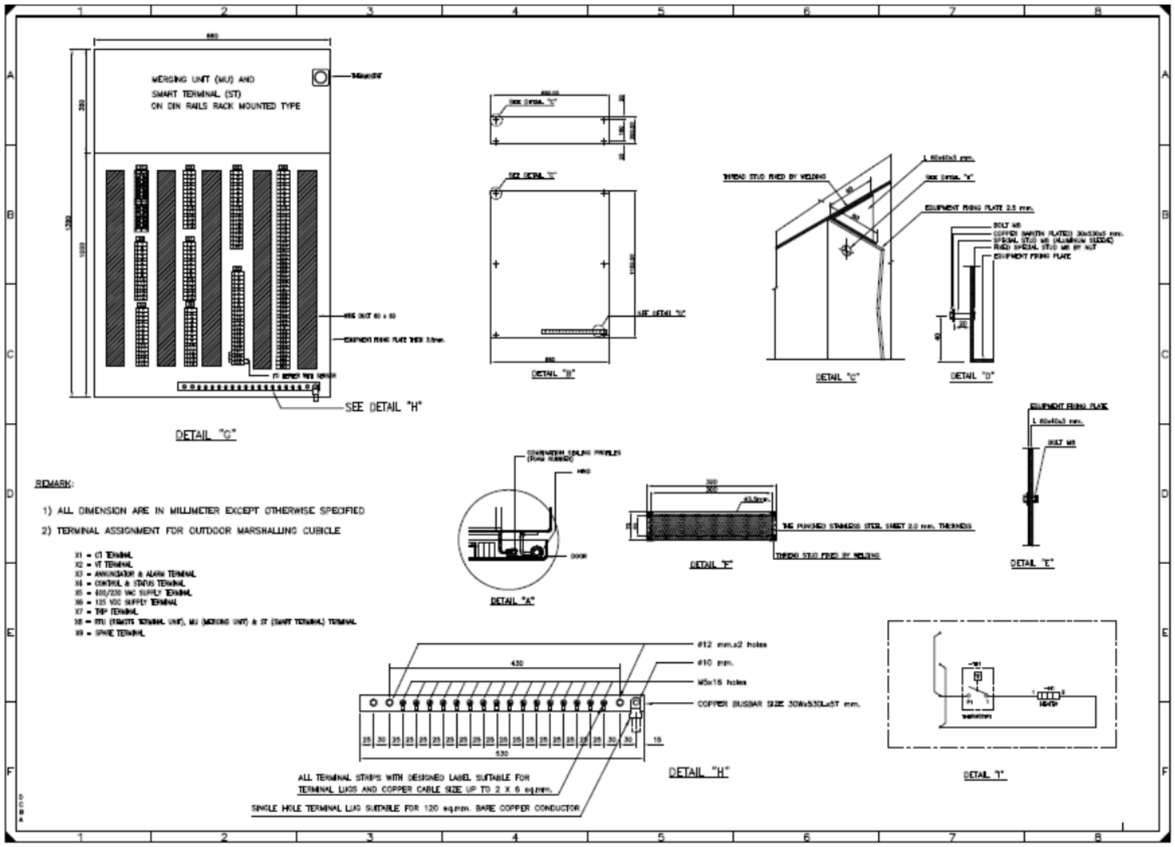
Inside each marshalling cubicle shall be equipped with nonflammable thermosetting material terminal blocks with the quality suitable for using in outdoor cubicle (refer to General Specification number 1). Each designation on the terminal blocks shall be machine-lettered, stamped, engraved, or neatly marked with permanent ink on the removable marking strips provided for each terminal block.

Terminal block shall be provided with terminal lugs or bent lugs. The terminal lugs or bent shall be provided with ten (10) percent but not less than five (5) additional terminal lugs/bent lugs as spares.

The arrangement, wiring, installed equipment and other details of marshalling control cubicle shall be as shown in the typical installation drawings of Figures 8.1 and 8.2.



Drawing 8.1 – Size and Dimension of a Typical Marshalling Control Cubicle



Drawing 8.2 –Typical Details and Terminal Block Layout of Marshalling Cubicle

D. Temperature Rise

Full provision shall be made for solar heat gain on all outdoor apparatus and any differential temperatures attained as a result of the impingement of solar heat.

In such cases where the Contractor is unable to guarantee the permitted maximum temperature reached under site conditions, taking account of solar heating, then sunshades shall be provided for PEA approval. Sunshades need not be provided on outdoor plant or equipment provided the manufacturer can satisfy the PEA that the materials employed will not be adversely affected or the temperature rise due to internal heat generation plus that due to solar radiation will not exceed the equipment design temperature. However equipment requiring manual operation shall be provided with sunshades to ensure that surface temperatures will not exceed 50°C.

The maximum temperature attained by components under the most onerous service conditions shall not cause damage or deterioration to the equipment or to any associated or adjacent components.

E. General Construction

Unless otherwise specified and cubicles, shall be of floor-mounted and free-standing construction and be in accordance with the enclosure classification specified elsewhere. The base the free-standing cubicles are mounted on shall be Grade A concrete of a minimum thickness of 30 cm. All cubicles in any one location shall be identical in appearance and construction.

Overall height, excluding cable boxes, shall not exceed 2.5 m. Operating handles and locking devices shall be located within the operating limits of 0.95 m and 1.8 m above floor level. The minimum height for indicating instruments and meters shall be 1.5 m unless otherwise approved by PEA.

All cubicles shall be vermin-proof. All cable entries to equipment shall be sealed against vermin as soon as possible after installation and connecting-up of the cables for PEA approval.

All cubicles shall be provided with a natural air circulation ventilation system. Notwithstanding the fact that two variable speed fans shall be installed, all control equipment shall be designed to operate without forced ventilation in the event of total fan failure.

For outdoor equipment, metal to metal joints shall not be permitted and all external bolts or screws shall be provided with blind tapped holes where a through hole would permit the ingress of moisture. For harsh environments, all nuts, bolts and washers shall be tropicalised as appropriate.

Door sealing materials shall be provided suitable for the specified site conditions. Doors shall be fitted with handles and locks. Where walk-in type panels are supplied the door shall be capable of being opened from inside the panel without the aid of a key after they have been locked from the outside. Hinges shall be of the lift-off type, and shall permit the doors when open, to lie back flat so as not to restrict access. Means shall be provided for securing the doors in the open position.

Cubicles and cubicle doors shall be rigidly constructed such that, for example, door mounted emergency trip contacts can be set so that mal-operation will not be possible due to any vibrations or impacts as may reasonably be expected under normal working conditions.

The bottom and/or top of all panels shall be sealed by means of removable gasket steel gland plates. Gland plates for bottom entry shall be at least 250 mm above the floor of the cubicle.

Panels shall be suitably designed to permit future extension wherever appropriate or specified.

Each cubicle shall include double front doors (the outer one being lockable and contain no active components) and rear access doors internal power sockets and door-operated internal lighting, and be clearly labelled with the circuit title at front and rear, with an additional label inside the panel. Panel sections accommodating equipment at voltages higher than 125 V (nominal) shall be partitioned off and the voltage clearly labelled. Each relay and electronic card within panels shall be identified by labels permanently attached to the panel and adjacent to the equipment concerned. Where instruments are terminated in a plug and socket type connection both the plug and the socket shall have permanently attached identifying labels. Instrument and control devices shall be easily accessible and capable of being removed from the panels for maintenance purposes. Terminations, wiring and cabling shall be in accordance with the requirements of this section of the specification.

For suites of panels inter-panel bus wiring shall be routed through apertures in the sides of panels and not via external multicore cabling looped between the panels.

All cubicles, whether individually mounted or forming part of a suite, shall incorporate a common internal copper earthing bar onto which all panel earth connections shall be made. Suitable studs or holes for PEA approval shall be left at each end of the bar for connection to the main station earthing system and possible future extension.

Earth connection between adjacent panels shall be achieved by extending the bar through the panel sides and not by interconnecting external cabling.

Where intrinsically safe circuitry is routed from a hazardous area to a safe area instrument panel, it shall be connected through Zener Barriers located in the safe area (instrument panel) of suitable rating and mounted on an insulated earthing busbar having facilities for connection of a separate dedicated outgoing cable to a "clean earth" system.

The interiors of all cubicles, desks and panels shall be painted matt white. All cubicles, or panels mounted external to control and apparatus rooms shall be fitted with thermostat controlled anti-condensation heaters.

F. Anti-Condensation Heaters

All cubicles shall incorporate thermostat controlled electric heaters capable of providing movement of sufficient heated air to avoid condensation. The apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energised while the apparatus is in operation.

The cubicle anti-condensation heaters shall be fed from AC 230 V 1 phase and neutral supply, manually switched by a two-pole switch with red lamp, mounted on the back of the board, panel or cubicle and buswired through the board. Labels shall be provided on the switch stating "Heater Supply". Heater terminals shall be shrouded and labeled "Heater". Motor anti-condensation heaters where fitted shall be fed from a 230 V 1 phase and neutral supply buswired through the board. The supplies shall individual MCB's and will be switched by auxiliary contacts on the contactor and isolated by auxiliary contacts on the contactor isolator

Heaters shall be shrouded and located so as not to cause injury to personnel or damage to equipment. The heaters shall have individual humidity stat and thermostatic control and shall be arranged to cut off when the cubicle internal temperature exceeds between 30 – 35°C and humidity less than 30%. A master heater circuit switch shall be provided on the inner door panel with an indicating lamp to show whether the supply is on or off. The location of the heater circuit switch and indicating lamp shall be either on a common panel or in such a location that it does not require moving when extensions are provided. The heaters shall operate from the specified 1 phase AC supply. Isolation facilities for AC supply shall be provided in each panel.

G. Drawings and Documents:

1) Drawing for Approval Drawing, Final Drawing, Documents and CD-ROM shall at least comprise of the followings:

Item	Drawing Title
1	Outline Drawing
2	Details of internal view of marshalling control cubicle

2) Documents for Reference
   a. Fabrication, painting and finishing processes
   b. Catalogue of internal equipment

H. Instruction Manual:

Instruction manual shall consist of all necessary information and shall comprise at least the documents as specified in this Section Bay Marshall Cubicle.

8.4 ENGINEERING WORKSTATION AND HMI/SCPS-Server

8.4.1 Engineering Workstation Functions

The Engineering Workstation (EWS) shall be a laptop computer with the specifications listed in Annex 3, and be provided as part of the project scope:

1) to ensure secure information flow within the substation and remote engineering system
2) to manage the SCPS, communication network and substation information; and,
3) to provide applications utilizing the substation information,

The main features of the Engineering Workstation shall be:

1) Analysis of alarm, events and historical trending
2) Data Historian (Real Time Database) to gather, validate, organize & archive substation data and information from multiple distributed IEDs
3) Dedicated Engineering Interface separate from Station-operator HMI/SCPS-Server / Station Level Operator Interface (SLOI)
4) Local single central point of access of the SCPS and all IEDs within the substation
5) Management of substation configurations, settings and IEC 61850 communication services
6) Monitoring and management of communication network, primary and secondary equipment
7) Panel mounted with all components powered from substation auxiliary DC system without a DC/AC inverter
8) Power system fault information handling, analysis, evaluation & diagnostics
9) Provision of accurate, timely and trusted substation information for supporting effective decision making, engineering, operation & maintenance, fault investigation & diagnostics, and asset management, and planning processes
10) Seamless communication and interrogation with substation IEDs
11) Substation documentation management

12) Value added user specific applications developed utilising the substation information
13) Web-based remote access and applications with system access control and cyber security measures

The Engineering Workstation functions are primary and secondary functions:

Primary Functions

1) Data Historian & Analysis
2) Communication Network Management
3) System Access Control and Cyber Security Management
4) SCPS Monitoring, Diagnostics and Maintenance
5) Substation IED Interrogation and Monitoring
6) SCPS and IED Configuration Management
7) GOOSE Messaging Management
8) Disturbance and Fault Information Handling, Analysis and Evaluation

Secondary Functions

1) Engineering HMI/SCPS-Server
2) Web Server and Interface
3) Substation Status Display
4) Sequence of Events and Alarm Analysis
5) Trending and Historical Analysis
6) Automatic Fault Report Generation and Notification
7) Substation Equipment Monitoring
8) Substation Documentation Management

Standard applications will:

1) Provide an easy-to-use, user-configurable & graphics client interface that allows users to view, interact with the graphical displays featuring real-time/historical data to be displayed at the client desktop
2) Provide a platform that allows users to write complex process calculations & modular applications with minimal code-writing and eases the process of applying these calculations to multiple units and processes
3) Perform calculations on real-time data. Among the calculations are:
    a. Totalizer
    b. Efficiency calculations
    c. Communication applications (e.g. paging, alarming, emailing),
    d. Complex if-then-else and nested logic calculations
    e. Other calculations required to realize the Data Historian applications
4) Provide a scheduler to execute module applications in a timely manner, and handle updates and abnormal behaviour.

8.4.2 Communication Network Management

The Communication Network Management application shall be provided as a management tool to commission, monitor, maintain, troubleshoot, and reconfigure the communication channels and end devices.

The Communication Network Management function shall manage and monitor the status information of the substation communication network, SCPS components together with IED communication interface and communication network devices. The operation and failure of the function shall not affect the substation communication network.

The major functions of the Communication Network Management are as follows

1) Display in graphical format the communication network architecture SCPS components & IED communication interface and network devices
2) Graphical display of network, SCPS communication interface and network device information, status, alarm, usage and performance
3) Display network, communication interface and network device information such as IP addresses, make, type, etc.
4) Assist during communication network and network device commissioning
5) Ability to configure the communication network architecture and network devices such as IP addresses
6) Ability to reconfigure or modify the communication network architecture and network devices
7) Able to manage intelligent connection to the Data Historian to optimise the EWS server capacity or loading
8) Monitor, analyse and display the communication network, all relevant protocols (e.g. MMS, GOOSE, SMV, etc.) and network devices status, performance (e.g. network congestion and bottlenecks), time synchronisation, resource usage, statistics, etc.
9) Generate, trigger and display the relevant monitoring alarms, indication, reports (periodic and on-request), etc.
10) Identify and diagnose the communication network and network device problem and failure such as loss of communication media connection and Ethernet switch failure
11) Assist in providing solution to resolve the problem and failure
12) Provide historical information about the communication network and network device performance

8.4.3 System Access Control and Cyber Security Management

The System Access Control and Cyber Security Management application shall be provided:

1) to manage and control the user access points (local and remote) to the Engineering Workstation. Unauthorized user or illegal entry shall be prevented from accessing the Engineering Workstation.

2) to adequately secure and protect the Engineering Workstation and the substation network against any cyber attack

The function shall also be consistent with PEA ICT security policy.

The major features of the System Access Control and Cyber Security Management function are as follows:

Table 8.1 – Security Management

Level	Access
Guest	• View or browse the Engineering Workstation display, but no direct access to IEDs or network devices is permitted • View the Engineering Workstation data, but not permitted to change or delete data
Operator	• View or browse the Engineering Workstation display • Able to connect, access and perform engineering tasks with IEDs or network devices • Able to view activity log
System Administrator	• Able to perform as Operator level • Able to perform additional administrative features such as resetting the activity log, and configure Engineering Workstation, IEDs and network devices

The system will allow access to, and/or manipulation of the following:

Table 8.2 – User Access Functions

Feature	Description
Password Management	• User access password identification and verification • Password ID management by System Administrator
Access Management	• User ID authentication • User authorisation level management by System Administrator • Minimum of three user authorisation permission levels to be provided:
Information and User Log and Audit Trail	• Automated user log and audit trail in terms of who & when has accessed the system, which user authorization level accessed the system, what activity was performed (e.g. create, edit, delete, etc.) • Automated information log and audit trail in terms of how it is handled or changed, who has access to the information, and the protection level • Data Historian record and configuration changes
Network Intrusion Detection System (IDS)	Monitor, detect, and respond to unauthorised activity by internal and external intrusion

Feature	Description
Virus Protection	Anti-virus solution to prevent the introduction of malicious virus, codes, worm, spy ware and Trojan horse etc. on the Engineering Workstation
Backup and Recovery	• Create backups • System recovering from backup • Methodology and procedures to be addressed by Engineering Workstation developer
Firewalls	• Guard against external threats • Placed at router or security perimeter of the SCPS • Router and security firewall are supplied as part of ICT scope

Please refer to Annex 7 for details of cyber security requirements**.**

8.4.4 SCPS Monitoring, Diagnostic, and Maintenance

The SCPS Monitoring, Diagnostics and Maintenance application shall be provided;

1) to assist in providing solution to resolve the problem and failure
2) to continuously monitoring the condition, health, status and performance of the SCPS components and IEDs
3) to generate, trigger and display the relevant monitoring alarms, indication, reports (continuous, periodic and on-request), etc.
4) to graphically display the monitored system and device information, status, alarm, signal and performance
5) to identify, analyse and diagnose the SCPS components and IEDs problem and failure
6) to support condition-based maintenance of SCPS components and IEDs
7) to provide historical information about the SCPS components and IEDs performance

The application of IED's IEC 61850 Logical Node nameplate and health data shall be investigated and to be incorporated in the function.

8.4.5 Substation IED Interrogation and Monitoring

The Substation IED Interrogation and Monitoring application shall be provided;

1) to access on-request, communicate, monitor and interrogate substation IEDs (in particular Protective relay or device) using the various proprietary IED manufacturer native software and protocol. A user-friendly web-based graphical user interface, accessed via Internet browser, shall display the respective substation IEDs in hierarchical tree-view structure based on substation object hierarchy. User may traverse the hierarchy and click an IED node to automatically establish transparent connection and "launch" the selected IED proprietary native software. Allow remote access via Internet browser.
2) to access, retrieve and manipulate IED individual setting parameters, data and group settings using IED native software

3) to access, retrieve and manipulate IED configuration function logic using IED native software or engineering tools
4) to manage IED settings and configurations
5) to access and retrieve all IED information such as IED events, alarm and indication records, fault records, oscillography waveform records, configuration files, etc. using IED native software or engineering tools
6) to retrieve, collect, archive, analyse and manage the IED information
7) to provide option of archiving the IED files in "BLOB" format in Data Historian

8.4.6 SCPS System and IED Configuration Management

The SCPS Systems and IED Configuration Management application shall be provided;

1) to manage, maintain and archive all the Substation Configuration Language (SCL) files using System and IED Configuration engineering tools as follows:
    a. Library of approved IED Capability Description (ICD) files
    b. System Specification Description (SSD) files (if available)
    c. Substation Configuration Description (SCD) file
    d. Configured IED Description (CID) files (if available)
2) to provide capability to automatically update the SCL files during installation and commissioning
3) to manage and control the revision or version of the SCL files including and comparing different versions of the configuration file databases
4) to configure the substation IEDs based on generated System Configuration Description (.SCD) file specific for the substation
5) to provide capability of distributing configuration files from single point of access to various substation IEDs and ensuring version consistency among them
6) to provide automated information log and audit trail of the configuration change or revision

8.4.7 GOOSE Messaging Management

Generic Object Oriented Substation Event (GOOSE), supports the exchange of a wide range of possible common data organized by a DATA-SET and is used to very rapidly exchange input and output data mainly of relays of trip, CB position and block, etc. The data exchange is based on publish/subscription. The IED in the same GOOSE can receive data from subscription, and also send data from publish.

The implemented GOOSE shall support the following functions:

1) Publish-subscription model: The publish/subscription structure is the best solution that one publisher sends data to several subscribers. It applies in the data communications with large data flow and high requirements for real-time.
2) Real-time: GOOSE message transmission is mapped to the data link and physical levels directly without network and transmission levels after the application level is coded by ASN.1. It shall

use the advanced Ethernet technologies such as VLAN, priority and multicast, etc, to assure the real-time of message transmission.

3) Transmission mechanism: is based on a sliding window flow control in which at least 5 frames mechanism is required

4) Retransmission mechanism: Every message has the time allowed to live parameters in retransmission series used to inform the longest queuing time for next retransmission time. If none new message is received within the intervals, the subscribers will judge GOOSE chain scission.

The GOOSE Messaging Management application shall be provided as follows:

Table 8.3 – GOOSE Message Management

Function	Description
IED Configuration Management	1) Managing configuration of IED data & peer-to-peer GOOSE messages (Publisher-Subscriber) data flow between multiple IEDs 2) Support browsing and modifying; a. IED data sets and control blocks b. GOOSE publication & subscription c. GOOSE parameters
IED Performance Management	1) Monitor the overall performance of GOOSE messages between multiple IEDs 2) Support the following functions: a. Monitoring of data quality & transfer time b. Reporting of GOOSE performance c. Historical/Trending of GOOSE message information d. Diagnostics of GOOSE messages problems e. Perform GOOSE message simulation to check functional performance against the specifications in IEC 61850

8.4.8 Disturbance and Fault Information Handling

The Disturbance and Fault Information Handling, application shall be provided;

1) to provide IEC 61850 disturbance recorder handling function Logical Node RDRE

2) to automatically retrieve, transfer (through IEC61850 file transfer services) or upload fault or disturbance oscillography waveform in COMTRADE file format (IEC 60255-24) from all substation IEDs. The followings are the information to be handled from the files;

   a. Voltage waveform
   b. Current waveform
   c. Zero sequence voltage & current
   d. Activated element
   e. Binary Input and Output Status

f. CB status

3) to collect and archive the fault or disturbance COMTRADE files in Data Historian for further analysis and evaluation
4) to provide application software to perform fault or disturbance analysis and evaluation using the retrieved COMTRADE files

The user-friendly fault or disturbance analysis and evaluation application software shall provide the following functions;

1) View & modify database records
2) Performing communication, analysis, updating parameters & reporting simultaneously
3) Fast scrolling, drag and drop of & zoom function operation
4) Creating/modifying user profile to save customized setting fault
5) User's annotations superimposed on signal trace
6) Amplitude modification with channel stretching handles
7) Time and waveform amplitude delta measurement by means of two cursors
8) Display the digital event information in a sequence of event recorder format
9) COMTRADE import/exports into same or different formats (e.g. Microsoft Excel)
10) Multiple analysis windows for parallel analysis of two records at the same time whether
11) Extended printout capabilities allowing the user to print whole or partial records with the desired resolution
12) Troubleshooting guide & diagnostic for database & communication error
13) Support fault locator algorithm (optional)
14) Comprehensive on-line help function

8.4.9 Engineering HMI/SCPS-Server

The Engineering HMI/SCPS-Server shall be provided as a graphical user interface for engineers;

1) to access the Engineering Workstation
2) to utilise all the Engineering Workstation functions and applications, and
3) to perform the engineering-related works

8.4.10 Web Server and Interface

The Web Server shall provide user-friendly web-based graphical user interface, accessed via Internet browser;

1) to deliver secure, accurate & timely SCPS information to multiple users
2) to incorporate interactive web-based applications to the user interface
3) to allow remote access from multiple users with different authorization level

8.4.11 Substation Status Display

The Substation Status Display application shall provide web-based display of substation single line diagram with switchgear status, measured value and alarm indication. However, no switchgear control operation function shall be allowed.

The status includes:

1) Circuit breaker and disconnector/isolator open/close position
2) Transformer tap change position
3) Voltage and current measurements. r.m.s. voltage and current to be calculated if necessary.
4) Live/dead indication of lines/busbars – dimmed when dead

8.4.12 Sequence of Events and Alarm Analysis

The Sequence of Events (SOE) and Alarm Analysis application shall provide the intelligent capability to analyse substation events & alarm. The events and alarm shall be able to be retrieved from Data Historian based on chronological event and alarm lists at any time for the past 1 year. The application shall support;

1) identification, analysis and evaluation substation events
2) "root cause" alarm analysis
3) assist in making correct decision for rapid substation restoration subsequent to tripping, based on the analysis of substation events and alarm
4) provide historical substation events and alarm information analysis
5) Filtering functions of SOE and alarm according to;
   a. Alarm object, class and text description
   b. Bay
   c. Data & time
   d. Device
   e. Function

8.4.13 Trending and Historical Analysis

The Trending and Historical Analysis application shall be provided to view, trend & analyze accurate operational (real time or historical) process data with high accuracy (actual time stamp) & dependability. The historical data (at least for the past 1 year) shall be able to be retrieved from Data Historian.

The trending view shall support X-Y trending of historian points where X is the date and/or time and Y is a numeric value and/or digital state. The graphical display shall support;

1) logarithmic trending of numeric values
2) updates in real-time
3) user configuration of trend components
4) click and drag zooming

5) adding markers Updates in real-time
6) historian points to be trended alongside non historian points
7) multiple trending of IED values

8.4.14 Automatic Fault Report Generation and Notification

The Automatic Fault Report Generation and Notification application shall be provided to automatically deliver accurate, timely and trusted fault & disturbance information to the appropriate personnel.

This information will be used by operation and maintenance personnel for;

1) fast notification of power system fault location, type and alarm indication
2) assist in making fast decision for rapid substation restoration

The notification and fault reporting shall be delivered through communication means such as email, SMS, etc.

8.4.15 Substation Equipment Monitoring

The Substation Equipment Monitoring application shall be provided;

1) to continuously monitor and trend the condition, health, status, and performance of the substation equipment such as primary equipment and substation auxiliary AC/DC supplies
2) to graphically display the monitored equipment information, status, alarm, signal, trend and performance
3) to generate, trigger and display the relevant monitoring alarms, indication, trending, reports (continuous, periodic and on-request), etc.
4) to identify, analyse and diagnose the substation equipment problem and failure
5) to assist in providing solution to resolve the substation equipment problem and failure
6) to provide historical information about the substation equipment performance
7) to support condition-based maintenance of substation equipment

8.4.16 Substation Documentation Management

A web-based Substation Documentation Management system shall be provided to locally manage all substation documentation such as technical drawings and manuals, for engineering, operation and maintenance purposes. The documentation shall be collected and archived using open standard relational SQL database software.

The documentation management system shall be user-friendly web-based graphical user interface, accessed via Internet browser, displaying the documents in hierarchical tree-view structure based on customised documentation classifications.

The documentation management system shall be able to perform the following functions;

1) Add folder
2) Upload folder

3) Uploading/Downloading documents
4) Rename documents/folders
5) Search folder
6) Search documents
7) Printing
8) List documents in excel format
9) Select, preview and display document (without manual opening the individual documentation native software)

8.4.17 Software Requirement

A suite of operating and application software shall be provided;

1) to support the development & implementation of the Engineering Workstation functional requirements
2) to deploy PEA customised solution based on agreed requirements between PEA and the supplier to solve the unique requirements of the Engineering Workstation, to provide the following system performance:

Table 8.4 – Software Requirements

Requirement	Example
Security	Prevent unauthorized user, virus attack & mal-operation of the software etc.
Availability	Provide smooth operation to continues in the event of a failure (e.g. communication)
Reliability	Provide tools to monitor software performance, failover capability
Scalabilty	Enable the addition device/hardware for future expansion of the SCPS system without total re-engineering process
Maintainability	Easy installation, configuration trouble-shooting and maintenance of the system

8.4.18 Hardware Requirement

All hardware shall be provided;

1) to support the software, EWS functional requirements & IEC61850 development
2) with industrial grade equipment certification and type test
3) suitable for harsh and rugged HV substation environment
4) taking advantage of the latest industrial standard components and technologies
5) with capability to perform processing and storage capacity
6) to ensure complete visibility of the parameters in IEC61850 based SAS
7) all components powered from substation auxiliary DC system without DC/AC inverter

Failure of any Engineering Workstation subsystem shall not affect the operation of other SCPS components and IEDs.

The hardware requirements of the individual Engineering Workstation components are:

Table 8.5 – Engineering Requirements

Server/ Equipment	Processor Detail
Data Historian & Web Server	1) Up-to-date industrial grade processor systems with embedded applications 2) Provide even cooling of all components 3) Withstand temperature up to 55°C 4) Capable of "hot swap" of components when failure occurs 5) Storage Backup facility 6) Shielded for EMI/RFI protection 7) Consider for scalability (redundancy) on: a. Power supply b. Processor c. Communication ports d. Hard disk/storage such as RAID technology
Application Server	1) Off-the-shelf standard industrial grade server with the latest processing & storage capability to ensure smooth development 2) & operation of EWS applications
Interface Node	1) Off-the-shelf industrial stand-alone embedded processor box with no moving parts 2) "Self-power-up" & auto-configure itself capability 3) Capable of interfacing with multiple standard interface stated in the Engineering Workstation functional requirements.
Engineering HMI/SCPS-Server	Off-the-shelf standard industrial grade computer with latest processing & storage capability to ensure smooth development, operation & maintenance of Engineering Workstation applications

8.5 POWER SUPPLY

All SCPS equipment shall operate within the required performance criteria and accuracy and endure without damage, shortening of service life, or undue increase in power supply drain, or excessive heating, power supply voltage variations within the following ranges in accordance with IEC 60870-2-1 Ed. 2.

DC-Power supply: 125 V + 20% together with a transformer that will reduce the voltage to 48 V + 20% for communications equipment and PCs.

HMI/SCPS-Server will be powered by an AC power supply.

The entire control system shall be directly powered, as a primary operating power source, from the substation control and protection DC power supply. A DC power supply in the substation should have 2 DC sources, one is for main protection and the other is for backup protection. Components that are critical for functionality of a substation such as the Distributed I/O Modules for substation common functions, Central Processing Module, Local User Interface, Time and Date Facilities, Master Station Communication Interface, and Ethernet Switches shall have a secondary power supply from batteries. It shall be possible to switch automatically (in response to a persistent reduced voltage; 80 % of rated) and manually, between power sources, without interruption of any control function.

All equipment shall retain its entire functional program for a minimum period of 30 days during which there is total power loss.

All power supplies installed as part of the control system shall have a sufficient capacity so that the maximum duty placed on them in service, under the most onerous conditions and considering all reasonable extensions of the system, shall not exceed 70 % of their normal power supply rating.

8.6 POWER DISTRIBUTION SYSTEM

The Contractor shall supply power distribution cabinets, power cables, circuit protection, and other accessories needed to supply DC power to the SCPS components.

As a minimum, separate main DC supply circuits for SCPS Distributed I/O Modules shall be designed as follows:

1) One circuit for a group of MV switchgear cabinets connected to one MV bus
2) One circuit for a group of HV switchgear cabinets connected to one main HV bus
3) One circuit for a group of HV/MV transformer cabinets.

The main DC circuits shall be protected by circuit breakers in the DC distribution boards. Each circuit shall be tapped so as to provide an individual DC feed to each of the circuit's Distributed I/O modules. The DC feed to each Distributed I/O Module shall be individually protected by a Miniature Circuit Breaker.

Each separately protected power supplies, both main and tap, shall be individually monitored by the SCPS. The loss or removal from service of any power supply shall raise an alarm on the station alarm list. The required number of points shall be the responsibility of the Contractor.

8.7 INSTALLATION ISSUES

To the extent feasible, distributed BCU and MU&Smart I/O shall be grouped and installed in station cabinets where the required inputs and outputs can be most easily accessed, in order to minimize the length and complexity of control and field wiring, while providing convenient site service and maintenance. A collateral objective is to reduce the exposure of low-level Analog signals to electromagnetic interference (EMI).

Construction requirements for outdoor cabinets are specified in an attachment to this technical specification: 'Equipment Construction Requirements'. Besides cabinets construction, it governs terminal blocks, cabling, and wiring techniques.

8.8 INTEROPERABILITY AMONG DEVICES FROM DIFFERENT MANUFACTURERS, AND WITH LEGACY DEVICES/SYSTEMS

Using this specification, in combination with IEC 61850-7 and IEC 61850-6, the Contractor shall make sure that interoperability between devices from different manufacturers is achievable.

For IED protective relays which are not manufactured by the company providing the SCPS, the interoperability with the SCPS will have to be clearly demonstrated. The Bidders shall provide a certificate showing a list of manufacturers of which their equipment can interoperate with.

8.8.1 Interoperability among Clients and Servers

The Contractor shall develop the necessary IEC 61850-IED interface from detailed IEC 61850 communications requirements provided by PEA so that interoperability at a Bay level is achievable.

Bay level interoperability allows PEA to choose from different bay LAN designs based on functional, performance, reliability, availability, physical and communications acceptance criteria. These bay designs may be functionally equivalent, but still have different quantities of IEDs, LN addresses, and GOOSE messages. At each bay, the BCU shall be able to communicate with other bay IEDs, and provide a centralized and concentrated data store and processing environment.

8.8.2 Interoperability between Control Systems and Bay LAN

Each BCU shall communicate with the BCUs of different manufacturers, protective relays, and other IEDs instead of, or in addition to, the IEDs communicating directly through the bay and station Ethernet Switch, to the SCPS Systems.

The interoperability tests shall be carried out by, or witnessed by, suitably accredited test laboratories, which are independent of the bidder and SCPS manufacturer. The certified copies of test certificates shall be included as part of the bidder's proposal. Failure to conform to this requirement shall be constitute for rejection of the bidder's proposal.

IEC 61850 shall be converted to legacy tele-control protocols for communications to the remote control center.

8.9 DEVICE FUNCTIONALTESTING

The testing of conventional protection and control devices has some differences from the communications-based devices.

8.9.1 Conventional Device Functional Testing

As shown in Fig. 8.1, in the case of conventional testing, the test device has to simulate the substation process through hard-wired interface between the Analog and binary outputs of the test device, and the Analog and binary inputs of the test object.

At the same time the test device has to monitor the closing of relay outputs of the tested device in order to detect the operation of the IED and analyse it to determine if the performance meets the specification.

The operating time usually is measured from the simulated by the test device process change of state that has to trigger the tested function until the moment when it will detect the operation of the IED relay output controlled by the tested function.

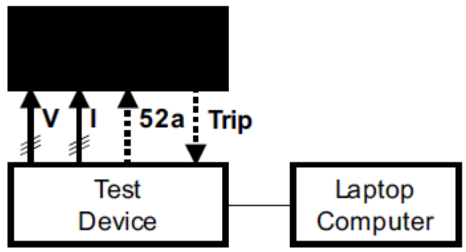


Figure 8.1 – Conventional Device Functional Testing

8.9.2 GOOSE Based Device Functional Testing

Figure 8.2 shows the testing configuration for a partial implementation of IEC 61850 communications in the tested IED. In this case the multifunctional IED interfaces with the process in a similar way to the conventional method described above, i.e., the communications based distributed functions in this case use IEC 61850 GOOSE messages. All devices with communications interface have to be connected to the substation network switch as shown in Figure 8.2.

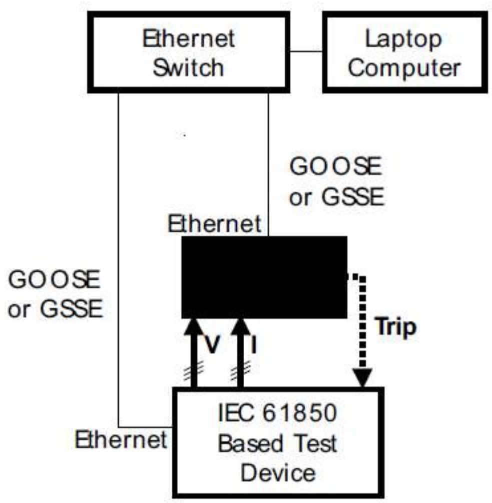


Figure 8.2 – GOOSE-based Device functional Testing

9. TESTING

9.1 GENERAL REQUIREMENTS

Testing shall ensure that the proposed system components and system-at-large are suitable for continuous service in an electric power substation environment.

Test plans and test procedures shall be provided by the Contractor for all tests to ensure that each test is comprehensive and verifies the proper performance of the SCPS under test.

The test plans shall describe the overall test process, including the responsibilities of test personnel and the documentation of the test results.

The test procedures shall describe the individual tests segments and the steps comprising each segment, particularly the methods and processes to be followed.

All of the following tests shall be performed as part of the project:

1) Factory Inspection and Test
2) Routine Tests
3) Type Tests
4) Factory Acceptance Test (FAT)
5) Site Acceptance Test (SAT)
    a. System Integration Test (SIT)
    b. System Commissioning

Complete records of all factory test results shall be maintained by the Contractor. The records shall be keyed to the test procedures.

Upon completion of each factory test, the Contractor shall submit a test report summarizing the tests performed and the results of the tests. The test report shall include the following information:

1) Test Log containing a chronological record of relevant details about the execution of the tests.
2) Test Incident Report documenting any event that occurred during the testing process that required investigation.
3) Test Summary Report summarizing the results of the designated testing activities and providing evaluations based on these results.
4) Variance Report summarizing the resolution of each problem detected during testing.
5) Official Certification that testing has been successfully completed.

For every equipment, the Contractor shall submit performance test report and interoperability test report from independent testing laboratories. For primary equipment essential for the protection of the networks such as Protective relays, the Contractor shall prove that the unit have a proven track record of at least two years operating in a similar environment to the one to be experienced in PEA systems.

9.2 IEC 61850 CONFORMANCE TESTING

1) Factory Acceptance Test:

   Customer agreed functional of the specifically manufactured SCPS or its parts using the parameter set for the planned application as specified in a specific customer specification. The FAT will be carried out in the factory of the manufacturer or other agreed-upon location by the use of process simulating test equipment. See details in Clause 9.7.

2) Hold point:

   Point, defined in the appropriate document beyond which an activity shell not proceed without the approval of the initiator of the conformance test. The test facility shall provide a written notice to the initiator at an agreed time prior to the hold point. The initiator or his representative is obligated to verify the hold point and approve the proceeding of the activity.

3) Interoperability:

   Ability of two or more IEDs from the same vender (or different vendors) to exchange information and use that information for correct co-operation. A set of values having defined correspondence with the quantities or values of another set.

4) Model Implementation Conformance Statement (MICS):

   Details the standard data object model elements supported by the system or device

5) Negative test:

   Test to verify the correct response of a system or a device when subjected to:

   a. IEC 61850 series conformant information and services which are not implementation in the system or device under test.
   b. Non IEC 61850 series conformant information and services sent to the system or device under test.

6) Protocol Implement Conformance Statement (PICS):

   Summary of the communication capabilities of the system or device to be tested.

7) Protocol Implementation eXtra Information for testing (PIXIT):

   The protocol Implementation eXtra Information for test document contains system or device specific information regarding the communication capabilities of the system or device to be tested and which are outside the scope of the IEC 61850 series. The PIXIT is not subject to standardization.

8) Routine Test:

   Performed by the manufacturer in order to ensure device operation and safety. See details in Clause 9.5

9) Site Acceptance Test (SAT):
Verification of each data and control point and the correct functionality within the SCPS, and between the SCPS and its operating environment at the whole installed plant by use of the final parameter set as specified in a specific customer specification. The SAT is the precondition for the SCPS being put into operation. See details in Clause 9.8.

10) System Related Test:
Verification of correct behaviour of the IEDs and of the overall SCPS under specific application conditions. The system related test is part of the final stage of the development of IEDs as belonging to a SCPS-product family.

11) Test Equipment:
All tools and instruments which simulate and verify the I/O of the operation environment of the SCPS such as switchgear, transformer, network control central or connected telecommunication units on the one side, and the serial links between the IEDs of the SCPS on the other.

12) Test Facility:
Organization able to provide appropriate test equipment and trained staff for conformance testing. The management of conformance tests and the resulting information should follow a quality system.

13) Type Test:
Verification of correct behaviour of the IEDs of the SCPS by use of the system tested software under the test conditions corresponding with the technical data. The type test marks the final stage of the hardware development and is the precondition for the start of the production. This test is carried out with IEDs, which have been manufactured through the normal production cycle. See details in Clause 9.6.

14) Witness Point:
Point, defined in the appropriate document at which an inspection will take place on an activity. The activity may proceed without the approval of the initiator of the conformance test.
The test facility provides a written notice to the initiator at an agreed time prior to the witness point. The initiator or his representative has the right, but is NOT obligated, to verify the witness point.

9.3 IEC 61850 CERTIFICATION

Test certification shall be submitted for all proposed IEDs, configuration tools, and test tools used to fulfil IEC 61850 communication requirements. The certificates shall confirm compliance with mandatory aspects of the standard and any non-mandatory aspects claimed by the manufacturer.

The certified copies of IEC 61850 test certification shall be included as part of the bidder's proposal. Failure to conform to this requirement shall be constitute for rejection of the bidder's proposal.

9.4 FACTORY INSPECTIONS AND TESTS

Factory inspections and tests shall be performed for each type of SCPS to ensure compliance with these Technical Specifications. Responsibility for the conduct of the factory tests shall rest with the Contractor. PEA will perform SCPS inspections and will witness the factory testing. Inspection and testing requirements are described in the following sub-clauses. The Contractor shall provide all local ground transportation needed by PEA representatives to perform inspections and witness tests.

9.4.1 Factory Inspections

PEA representatives shall be allowed access to the Contractor's facilities during system testing and to any facility where the SCPS are being produced. Such access will be used to verify by inspection that the SCPS are being fabricated in accordance with the Technical Specifications. Documentation necessary to complete all PEA inspections shall be provided by the Contractor. PEA shall be allowed to inspect the Contractor's quality assurance standards, procedures, and records. Inspections shall include checks on inventory, general appearance, cabling, drawing conformance, and labeling.

9.4.2 Factory Tests

After the switchboard and cabinet structures shave been fabricated and all components assembled, the complete gear including instruments, relays and devices shall be given standard factory tests and all others the latest applicable standards. These tests shall include, but not be limited to, the following:

1) Dielectric Tests
2) Sequence Tests
3) Check of Control Wiring
4) Mechanical Test

9.5 ROUTINE TESTS

The SCPS shall pass the manufacturer's standard routine tests in accordance with the referenced standards.

In addition to the tests described in the IEC standards, the routine tests and test report of the SCPS shall include the following:

1) Visual tests to confirm that construction and sizing requirements have been met.
2) Rigorous testing of each input and output function of the SCPS. This shall include the SOE and the disturbance data storage functions as well as the operation and performance of the SCPS time and date facilities.
3) Verification of ac input without transducers.

4) Verification of the IEDs capability.
5) Verification of the use of the local user interface for maintenance and testing.
6) Verification of the ability to download parameters and configuration data from the DMS master station.
7) Verification that SCPS firmware and software support SCPS sizing and expansion requirements.
8) Verification of successful communications (i.e., protocols) at all the required data rates by using Communication Test Set, i.e., ASE 2000 or equal.
9) Testing for secure operation, including verification that:
   a. Communication errors are detected.
   b. SCBO procedures are properly performed for control outputs.
   c. No erroneous control operation occurs and no incorrect data is generated when power is turned on or off or when operating on low battery voltage.

9.6 TYPE TEST

Where applicable, the SCPS shall have passed type tests to demonstrate that the SCPS comply with the standards cited in these specifications. The results of the Type Tests for each device shall be submitted as part of the bid documents. These independent type tests are required by the PEA to confirm suitability of the equipment to operate in a substation environment in terms of:

1) Dielectric stress
2) Impulse voltage withstand
3) High frequency disturbance
4) Thermal requirement
5) Mechanical requirement
6) Limiting dynamic values
7) Contact performance
8) Electromagnetic radiation susceptibility
9) Electrostatic discharge susceptibility

9.7 FACTORY ACCEPTANCE TEST (FAT)

The purpose of the FAT is to verify that the system is fully developed and meets all contracted configuration, functional, performance, and interface requirements for the system. The tests shall verify the performance and functional integrity of the individual subsystems, including active interfaces among subsystems, and shall demonstrate the operation of the SCPS as an integrated system.

All interfaces with external equipment and systems shall either be connected to this external equipment during the FAT, or appropriate simulators shall be provided by the Contractor and used in the test.

The Contractor shall notify PEA at least 30 (thirty) days in advance of the scheduled starting date for the FAT.

The Contractor shall conduct a Factory Acceptance Test that is interactively witnessed and critiqued by selected PEA personnel. The Contractor shall submit test objectives, a test plan with supporting procedures for PEA approval. These tests shall be conducted at the Contractor's facilities, before delivery of any portions of the system.

The test objectives and test plan shall include integration issues (e.g. interfaces), functional issues, and performance issues.

The Factory Acceptance Test shall use sufficient equipment to reasonably represent actual system behaviour at site. The Contractor shall submit in writing his rationale as to how the proposed, integrated system test plan and set-up fulfils the test objectives.

The FAT shall include but not limited to:

1) Verifying drawings & physical connection
2) Verifying functionality of the System, IED & accessories used
3) Verifying specific system integration & interoperability
4) Verifying communication network operation
5) Verifying system operational and communication performances
6) Verifying cyber security assessment
7) Failed system shall be rejected and shall be subjected to further retesting

The FAT program shall be proposed by the Contractor and approved by PEA. The FAT shall be witnessed and verified by PEA.

9.7.1 Unstructured Testing

The FAT schedule shall allow time throughout the functional testing for unstructured testing by PEA. At least 2 (two) hours shall be reserved for unstructured testing for each six (6) hours of structured testing. PEA shall be allowed to schedule unstructured testing at any time, including during the structured tests.

Unstructured testing is intended solely for use by PEA to perform additional tests, and to investigate potential problems detected during tests. Unstructured testing is not intended for, and shall not be used as, a substitute for formal pre-planned test instructions. Detailed tests procedures shall cover all aspects of system functionality, performance, and management. Variances found during unstructured testing shall be added to the formal Variance List for correction by the Contractor.

9.8 SITE ACCEPTANCE TEST (SAT)

The purpose of the SAT is to confirm that the system has been properly installed and is ready for operational use. The SAT shall be performed by the Contractor after the system has been installed in the designated facilities, and the system startup has successfully been completed. The SAT shall be performed according to written plan and procedures prepared by the Contractor and approved by PEA. The SAT shall include all the tests performed in the FAT, modified as needed for testing the system in the substation environment, and supplemented by new procedures for tests which were not possible with the system configuration and the test environment of the FAT. In particular, functions and performance that could not be fully verified in the environment of the FAT, shall be exhaustively tested in the SAT.

SAT shall be performed to ensure the installed and configured system- at-large and individual components perform as intended. With the problems identified during the FAT already resolved, test objectives at this stage shall focus on verification of complete-system functionality and performance. The Contractor shall submit test objectives, a test plan with supporting procedures for PEA approval. Both functional and performance testing shall be included.

The SAT shall include but not limited to:

1) SAT stages are as follows
   - a Stage 1: Wiring check/system connectivity check
   - b Stage 2: Individual equipment functionality tests
   - c Stage 3: System Integration Tests
   - d Stage 4: System Commissioning
2) All testing stages shall be carried out in sequences
3) The test program shall be proposed by the Contractor and approved by PEA.
4) For System Integration Test (SIT), the Contractor shall perform the SIT which shall include system verification, interoperability & preparation of related documents. As part of on-the-job-training, PEA representatives may perform the tests with close supervision & guidance from the Contractors.

The SAT program shall be proposed by the Contractor and approved by PEA. The SAT shall be witnessed and verified by PEA.

As part of on-the-job-training, PEA representatives may perform the tests with close supervision & guidance from the Contractors.

PEA's failure to detect or recognize a problem during FAT, SAT, or at any other time shall not release the Contractor from the responsibility of (1) correcting problems that are eventually recognized or of (2) producing and delivering reliable systems that perform in the manner intended by the Specification(s). The Contractor shall assist PEA and its agent with 'tightening' these technical specifications where necessary.

9.8.1 Unstructured Testing

Unstructured tests shall be employed, as deemed necessary by PEA, to verify correct overall system operation under actual operating conditions.

9.8.2 System Integration Test (SIT)

The Integration and System Test shall be performed to verify the system conformance, performance, and interoperability. All tests shall be performed at the Contractor's or manufacturer's facility subject to PEA approval.

The SIT shall include the followings:

1) Interoperability between IEDs in small system
2) Test using IEC 61850 communication & verification tools Integration test
3) IED Interface with system
4) Test IED with IED Configuration Tools – generate & exchange SCL files
5) Interoperability among IEDs in a larger system
6) Verification of IEDs as part of IEC 61850 System
7) Test using Configurations Tools and Interactions as part of system test Engineering process
8) Verification of system under normal operation, avalanche, & fault condition (evaluation of IEC 61850 system performance)
9) Cyber Security

For SIT, at least the following test setup shall be provided:

1) IEDs (Device Under Tests)
2) Configuration Tools
3) A simulator (acts as client server) to initiate and generate messages and to record and process resulting information.
4) Background load simulator
5) Time synchronizer
6) Network analyser

SIT shall contain both positive and negative testing. Integration and Interoperability Test shall be performed as a system. The following tests shall be included in test program:

1) IEC 61850 conformance test including communication object, services (functions that utilize the services) and profiles
2) Communications network performance and operations verification
3) Electromechanical interfaces verification
4) Logical connections verification
5) Functional interfaces verification
6) Application behaviour
7) Operational and communication performances including under maximum possible transmission traffic (normal operation, avalanche, & fault condition) on the station local area network (LAN)
8) Contingency plans
9) Cyber security assessment including network, host, database and web (application and server) securities

9.8.3 System Commissioning

Finally, each system shall be commissioned and placed into service.

9.9 TEST AND TEST REPORT

The SCPS shall be tested to ensure compliance with these Technical Specifications.

9.9.1 Test Plans and Test Procedures

Test plans and test procedures shall be provided by the Contractor for all tests to ensure that each test is comprehensive and verifies the proper performance of the SCPS under test.
The test plans shall describe the overall test process, including the responsibilities of test personnel and the documentation of the test results.

The test procedures shall describe the individual tests segments and the steps comprising each segment, particularly the methods and processes to be followed.

9.9.2 Test Report

Complete records of all factory test results shall be maintained by the Contractor. The records shall be keyed to the test procedures.

Upon completion of each factory test, the Contractor shall submit a test report summarizing the tests performed and the results of the tests. The test report shall include the following information:

1) Test Log containing a chronological record of relevant details about the execution of the tests.
2) Test Incident Report documenting any event that occurred during the testing process that required investigation.
3) Test Summary Report summarizing the results of the designated testing activities and providing evaluations based on these results.
4) Variance Report summarizing the resolution of each problem detected during testing.
5) Official Certification that testing has been successfully completed.

10. ENGINEERING AND CONFIGURATION TOOLS

10.1 PROTOCOL ANALYSER SOFTWARE

The Contractor shall provide test set software for DNP 3.0 protocol and the IEC 61850 communications architecture. The test set software is for testing and monitoring system communications capabilities, enabling the user to diagnose problems and maintain the system. All necessary interfaces and facilities (e.g. cables, connectors) shall be provided for use on Industrial Computer platforms.

The DNP 3.0 protocol analyser software shall be capable of emulating both master and slave and supporting DNP Levels 3. The software shall be capable of listening to both the master and slave concurrently. Operation over a serial port or Ethernet / IP shall be supported. The software shall support multiple frame message processing and the full range of objects, variations, function codes, and application service data units (ASDUs).

In support of the IEC 61850 communications architecture, the analyser shall include stack and related communications software that enable the unit to sit on the network and act as an initiating or receiving network node. The user shall be able to set the network address and data link address as MAC address, enabling the unit to operate in lieu of a system node taken off-line. The analyser shall be able to record and analyse traffic at any of the various stack levels of various nodes in the same time, particularly at the applications level. Application data shall be appropriately presented as text and numbers, so that the user can interpret results in a manner consistent with use of the information models. Similarly, the user shall be able to set up a message with a template and issue it to another designated node in client-server mode. Alternatively, the analyser shall be able to broadcast messages in GOOSE mode. All control block capabilities and communication services shall be supported.

The protocol analyser software shall provide dynamic data display during monitoring and 'simulation mode' test sessions (e.g. Master, Slave). It shall be capable of continuously monitoring communications without interfering with normal operation. The message data shall be displayed in a format that can be easily interpreted by the user and also can be displayed in the raw format if the user request. Selection of number base (e.g. decimal, hexadecimal, octal and binary) shall be also available. The protocol analyzer software shall allow the user to store all data resulting from communication tests into memory (e.g. disk, flash) for subsequent analysis.

10.2 DIAGNOSTIC SOFTWARE

The software shall be provided to continuously HMI display of the SCPS and report SCPS hardware errors to the SCADA/DMS. The software shall check for memory, processor, and I/O errors and failures. It is desirable that internal diagnostics be sufficiently detailed to detect malfunctions to the level of the smallest replaceable component.

The SCPS shall facilitate isolation and correction of all failures and shall include features that promote rapid fault isolation and component replacement. All functional module nodes shall be designed with integrated on-line diagnostic functions. The results of these diagnostics shall be reported to the SCPS Systems. The SCPS Systems shall store this information and report it to the SCADA/DMS as permitted by the protocol.

10.3 CONFIGURATION LANGUAGE

Definition of a standard configuration language SCL, (Substation Configuration Language), based on the XML (Extensible Markup Language), allows defining the characteristics of each IED with regards to communication configuration, data model and parameters.

Any IED supporting the IEC 61850 standard will be accompanied by a configuration file with ICD (IED Capability Description) which defines its capacities. This file will start each project with the installation values, such as addresses, initial parameter values, etc. generating a new CID (Configured IED Description) file.

10.4 PROGRAMMABLE LOGIC CAPABILITY

The SCPS shall be provided with programmable logic capabilities supported by easy to use editor facilities. These facilities shall allow PEA non-programming staff to create programmable logic and computational algorithms for the SCPS. The programmable logic capability shall enable the SCPS to perform automatic control functions such as closed-loop analog control, sequencing for equipment startup and shutdown, automatic failover control, and other such functions typically performed by Programmable Logic Controllers (PLCs). The programmable logic facility shall comply with IEC 61131-C and may utilize ladder logic or functional block diagram for configuration of its applications.

10.5 SOFTWARE MAINTENANCE REQUIREMENTS

For local software maintenance/modification purposes the following shall be provided:

1) Hard copy listings of all source programs for: the operating system, standard program packages, utility programs and application programs. Where commercial practices prevent the supply of source listings, guarantees of support for such software shall be obtained with contractual obligations to provide source listings in the event that such support ceases. Additionally hard copy lists of all patches made to the system shall be included.
2) Utility software shall be provided to allow file handling, editing, compilation, linking and debugging of modifications and additions to the system. This work shall be able to be carried out by a trained engineer.
3) Support documentation shall provide: Descriptions of the elements and functions of the operating system; block diagrams of program, data and buffer relationships; memory map and flow diagrams; and descriptions of all standard and application programs.
4) User manuals for the operating system, utility software and maintenance diagnostic programs.

10.6 ENGINEERING TOOLS

The Contractor shall be provided the engineering tools for In IEC 61850-6 part of the standard two different tools are identified in the IEC 61850 engineering process.

The following Engineering Tools shall be supplied for substation:

1) IED configuration tools
2) System (Substation) configuration tools
3) IED interrogation, monitoring and analysis software tools
4) Diagnostics and maintenance tools

To make the engineering task and responsibilities clear, tool roles are introduced for an IED configurator and a system configurator. A “real” tool can play both roles. To fulfil these requirements, the Contractor shall be provided a new complete set of tools that allows carrying out the engineering, configuration, setting and maintenance of a substation under the IEC 61850 standard. It has some tools in order to model the IED and substations, as well as to design the single line diagrams in a quick way and carry out the settings of the substation units.

10.6.1 IED configuration tool

The IED Configurator is a manufacturer-specific, may be even IED specific, tool that shall be able to import or export the files defined by this part of IEC 61850. The tool the provides IED-specific settings and generates IED-specific configuration files, or it loads the IED configuration into the IED.

Tool included within the engineering environment developed by Suppler for the integration of protection devices as well as control in automated projects.

The “Tools Factory” tool enables to define control and protection devices data models according to the IEC 61850 communication standard. These records are made accessible from the control center far from the substation or from local operation stations.

The Tools Factory is strictly adjusted to the communication and hierarchy model architectures established by the IEC 61850 standard in order to develop all the information model of the electrical substation integrating in this model the IED devices from any manufacturer always within the framework of the IEC 61850 standard.

This tool enables to create any IEC 61850 data model starting from scratch thus generating ICD files (IED Capabilities Description). This file will define the data model and IEC 61850 capacities of a device.

Nevertheless, in the engineering of a substation, the ICD files from the different units that will be integrated in the system will have to be provided by the manufacturers of the units themselves. The tool enables us to import these regulating files thus generating automatically the system database from the import of these files.

This automatically generated database is the only system database that is used by all system clients, whether they are local HMIs or like IEDs for control centre communication.

Main characteristics:

- Graphical IED engineering tool.
- Easy creation of complex information models. Modelling based on drag and drop actions.
- Internal repository of all the IEDs modelled. Reusability of created types available.
- Dictionary with the definitions included in the first revision of the standard to improve the comprehension of the models.

- Creation and modification of datasets and control blocks.
- Quick assignments of initial values and descriptions.
- Graphical display of the information model either as a tree or a list of items with filter functionality.
- Import and export of normative configuration files (ICD files).

Specific functions:

- Definition of the data model of the protection or control device ("ICD").
- Definition of the supervision and command graphic consoles.
- Definition of the operation and maintenance historic records.
- Definition of the states and alarms with the state change time.
- Definition of the data/measurement groups through "DataSets".
- Definition of the report groups through "Reports".
- Definition of the historical groups through "Logs".
- Definition of the settings.
- Definition of the local or remote commands.

With this tool there are several options to create a new IED model:

- Using the templates of the standards.
- Using the data types of a previous created device.
- Importing a normative SCL file (ICD, CID or SCD files).

To access to the information the tool provide:

- FILTERS that reduce the information model size. Some available filters are:
- Type: LogicalDevice, LogicalNode, DataObject…
- FunctionalConstraint: Smart I/O, MX, CO…
- Name of the element.
- VIEWS that help users to visualize the information desired.
- Select the columns needed.
- Create your own configurations.
- SEARCHES that help users to find where a data type is used.

10.6.2 System (Substation) Configuration Tools

The system configuration tools shall be supplied together with the substation as one of the mandatory engineering tools.

The system configuration tool is an IED independent system level tool that shall be able to import or export configuration files defined by this part of IEC 61850. It is able to import configuration files from several IEDs, as needed for system level engineering, and used by the configuration engineer to add system information shared by different IEDs. Then the tool shall generate a substation-related configuration file as defined by this part of IEC 61850, which is feed back to the IED Configurator for system-related IED configuration.

The substation configuration tool allows integrating control and protection devices in the data base of the substation according to the IEC-61850 communication standard.

The international IEC 61850 standard establishes communication architecture based on the client-server model where servers (protection and control devices) provides information to the different associated clients (HMIs, SCADA systems, etc.).

This information model defined by the IEC 61850 standard for electrical substations is organized hierarchically in different levels. Voltage tension is defined at highest level; on the next level are substation positions or bays, then can be found the different protection and control intelligent devices or IEDs with communication capacity associated to the substation positions. Finally, on the following levels are specified the structure of each one of the implemented devices.

With IED configuration tool, IED models are created for each type of device. With Substation configuration tool IEDs for a specific substation are instantiated, based on the models created with the IED configuration tool, to configure the specific devices that exist in each installation.

It is important to point out that if in an installation there are various devices of the same type, their configuration will only be done once (in the Tool Factory) and various requests in the substation model will be created. This has the advantage that if it is necessary to update the model from this device, we would only have to do it once in the Tool Factory and the changes will be done automatically in all the devices defined in this model within the installation.

Main characteristics are:

- Graphical IEC 61580 system engineering tool.
- Instantiation of the IEDs of the substation from the library defined in the Tool Factory.
- Assignation of the name and Access Point to the IED.
- Configuration of the system topology and assignation of communications to the IED.
- Edition of settings.
- Edition de DATA_SET and Control Blocks (Report Control Block, Setting Group Control Block and GOOSE Control Block).
- Graphical display of the information model either as a tree or a list of items.
- Powerful filter mechanism to display/modify initial values, descriptions…
- Import and export normative configuration files. (CID, SCD).

This tool enables to define a complete system with the following steps:

- Define the system topology
- Add IEDs to the system
- IEDs created with the IED configuration tool are instantiated to create the substation configuration.

- Configure IED parameters
- Set initial values, descriptions, etc.
- Modify, add and remove datasets and report or GOOSE control blocks (only if they are different from those defined in the IED model)

10.6.3 Diagnostics and maintenance tools

The Contractor shall be provided the simulation and maintenance tools for The IEC 61850 is a complex standard and the tools that help in the test and commissioning of the system become even most important that in the traditional systems.

One of the problems to be solved is the communication network analysis. There are several free and open-source packet analysers in the market which can be used for this purpose. These software are designed for network troubleshooting, analysis, and communications protocol monitoring.

Another problem to be solved in the test and maintenance of the system is the simulation of the different devices in the system. Regarding the IEC 61850 standard we can divide the devices in two types:

Servers: According IEC 61850-2 "on a communication network, a functional node that provides data to, or that allows access to its resources by, other functional nodes. A server may also be a logical subdivision, which has independent control of its operation, within the software algorithm (and/or possibly hardware) structure". In other words any device that provides information for the rest of the system. In this category are the Protective relays and the control and measurement devices. The main example of IEC 61850 servers are the BCUs.

Clients: According IEC 61850-2 "entity that requests a service from a server, or which receives unsolicited data from a server". The main examples of IEC 61850 clients are the Human Machine Interface computers and the TRU.

The Contractor shall provide two different tools:

1) IEC 61850 client simulator
2) IEC 61850 server simulator

IEC 61850 client simulator

This tool emulates an IEC 61850 client and facilitates the test of the communications behaviour of any IEC 61850 server.

The application configuration is based on: CID file, IED data base in the substation tool or IEC 61850 self-description services.

There is the possibility of storage of the displayed information into excel compatible files.

It offers a powerful report monitoring (reports enable, trigger options and optional fields' configuration, etc.). Available services:

- Data polling
- Dataset polling
- Settings and setpoints modification
- Event retrieval and configuration (report or log)
- Goose messages monitoring
- Control services
- File access based on an explorer appearance
- Device data model recover:
- Device data model generation based on the communications self-description services of the standard and automatic generation of an SCL file (CID).

With the CID configuration file of the device (server) we want to communicate, the data model is loaded in the operation tool and we can communicate with the device simulating an IEC 61850 client.

There is also the possibility of recover the device data model based on the communications self-description services.

IEC 61850 server simulator

This tool is an IEC 61850 server application that emulates the communication behaviour of a real device. Several instances of the program can be executed in the same PC emulating several servers. Application configuration based on: CID file or IEC data base in the substation tool. It provides a graphic display of the information sent to the clients. The tool makes easier the navigation through the data model with a tree view. It provides an easy way to generate configurable data change sequences. The response of control services is configurable to emulate different behaviours.

Available services:

- Self-description services.
- Data model.
- Setting model.
- Unbuffered / buffered reporting.
- Goose messages
- Control models: normal and enhanced security, direct and SBO control based on SCL loaded.

With the CID configuration file of the device (server) we want to simulate, the data model is loaded in the tool and we can communicate with the device using any other IEC 61850 client

The basic requirements of the engineering tools are:

Table 10.1 – Engineering Tools

Requirements	Comments
Software Type	1) Open system Software 2) User-friendly and easy to use engineering tools
Security Feature	1) Access control password 2) Authentication of authorized user
Function	1) System versioning and configuration management 2) Configuration wizards 3) Commissioning test facility
Requirement for Tools complying with IEC 61850 standard	1) IEC 61850 compliant 2) Hierarchical navigation tree-view structure based on IED object hierarchy 3) TCP/IP communication access interface 4) Able to create IED configuration template 5) Able to create Bay configuration template based on selected IED configuration 6) Able to communicate and exchange information using XML based Substation Configuration Language (SCL) 7) Able to import and generate Substation Configuration Description (SCD) file 8) As an option - ability to provide System Specification Description (SSD) file based on PEA requirements and substation single line diagram
Accessories	Include as part of substation mandatory accessories

10.7 IED CONFIGURATION TOOLS

The IED configuration tools shall be supplied together with the device as one of the mandatory device engineering tools.

The basic requirements of the device engineering tools are:

Table 10.2 – IED. Configuration Tools

Basic Requirements	Details
Software Type	1) Open system Software 2) User-friendly and easy to use engineering tools
Security Feature	1) Access control password 2) Authentication of authorized user
Function	1) IED versioning and configuration management 2) Configuration wizards 3) Commissioning test facility
Requirement for Tools complying with IEC 61850 standard	1) IEC 61850 compliant 2) Hierarchical navigation tree-view structure based on IED object hierarchy 3) TCP/IP communication access interface 4) Able to communicate and exchange information using XML based Substation Configuration Language (SCL) 5) Able to access and generate IED Capability Description (ICD) file, and Configured IED Description (CID) file
Accessories	Include as part of device mandatory accessories

10.8 IED INTERROGATION, MONITORING AND ANALYSIS SOFTWARE TOOLS

The IED interrogation, monitoring and analysis software tools (multiple or suite of tools are allowed to be supplied) shall be supplied together with the device as one of the mandatory device engineering tools.

The basic requirements of the device engineering tools are:

Table 10.3 – Device Engineering Tools

Basic Requirements	Details
Software Type	1) Manufacturer Native Proprietary Software 2) User-friendly and easy to use engineering tools 3) Include as part of device mandatory accessories
Security Feature	Access control password for setting and configuration change
Function	1) Device setting, function selection and configuration 2) Device configuration programmable logic editor 3) Disturbance, fault and event analysis/evaluation 4) Device communication 5) Commissioning test facility
Requirement for Tools complying with IEC 61850 standard	1) IEC 61850 compliant 2) Hierarchical navigation tree-view structure based on IED 3) Object hierarchy 4) TCP/IP communication access interface

10.9 DIAGNOSTICS AND MAINTENANCE TOOLS

The diagnostics and maintenance supplied together with the substation as one of the mandatory engineering tools.

The basic requirements of the engineering tools are:

Table 10.4 - Diagnostic Tools

Basic Requirements	Details
Software Type	1) Manufacturer Native Proprietary Software 2) User-friendly and easy to use engineering tools
Security Feature	1) Access control password 2) Authentication of authorized user
Function	1) System, network, and device Diagnostics 2) Communication network tools such as Ping, Traceroute, Network Analyser, File Transfer, Remote Terminal, etc. 3) System, network and IED Maintenance 4) Device communication 5) Commissioning test facility
Requirement for Tools complying with IEC 61850 standard	1) IEC 61850 compliant 2) Hierarchical navigation tree-view structure based on IED 3) Object hierarchy 4) TCP/IP communication access interface
Accessories	Include as part of substation mandatory accessories

11. OPERATION AND MAINTENANCE

11.1 GENERAL REQUIREMENTS

The SCPS shall be designed to consider the system operation and maintenance issues as follows:

1) Safety of personnel and equipment
2) Security of operational functions
3) Speed of operation (protection function)
4) Reliability and availability
5) Easy to operate
6) Easy to maintain
7) Easy to repair
8) Easy to get spare parts
9) Easy on-site testing

Among the major features of the SCPS that support the operation and maintenance are:

1) self-monitoring,
2) condition-based monitoring (optional), and
3) management of intelligent devices, communication network and substation equipment.

The Bidder shall provide Maintenance and Service Systems for recording and tracking software versions and configurations of the systems, such as relay software version, relay configuration etc.

11.2 FUTURE EXTENSION AND UPGRADES

The SCPS shall be designed to consider future extension and upgrades over the life time of the system as follows:

Table 11.1 – Future Expansion

Requirements	Description
Expandability	Accommodate increase in the number of devices connected to real-time network
Easy to extend to supporting growth and upgrades	Accommodate the increased of the number of clients accessing control system data. Accommodate the inclusion of new software functionality within acceptable performance levels
Easy to configure	1) Does not affect existing unrelated functions 2) An extension of the station shall be possible with lowest possible effort.

For system future expansion consideration, an additional margin of 15% of the initial capacity requirement shall be used.

11.3 SYSTEM FLEXIBILITY

The SCPS shall be flexible for:

1) system, network and IED configurations
2) system and software upgrades with negligible impact on other SCPS components that are not directly involved.

11.4 SYSTEM SCALABILITY

The SCPS shall be scalable for future expansion, extension, upgrade, and modification over the life time of the system.

The system scalability is defined as the ability to run the same database (e.g. Data Historian), user interfaces (e.g. Station Level Operator Interface (SLOI)/Station-operator HMI and Engineering HMI), communication software, communication standard, etc. of the SCPS in substation of different size and scopes.

11.5 SUBSTATION ACCESS CONTROL AND CYBER SECURITY MEASURES

The user access points (local and remote) and external interface terminal to the SCPS shall consider the Substation Access Control and Cyber Security issues (see below).

Unauthorized user or illegal entry shall be prevented from accessing the SCPS. The SCPS and the substation network shall be adequately secure and protect against physical and cyber-attack.

The substation access control and system cyber security measures shall be consistent with PEA ICT security policy.

The substation access control and system cyber security strategies are:

Table 11.2 – Cyber Security Issues

Strategy	Objective
Confidentiality	Ensure that the contents of a message are not exposed to anyone but the intended recipient
Availability	Ensure that the system can service the needs of users and processes as needed
Integrity	Ensure that the message received is the same as the message sent
Authorization	Ensure that the user or process sending the message has the rights to do so
Authentication	Ensure that the sender of a message is who they claim to be
Nonrepudiation	Ensure that the involvement in an security action cannot be denied

The cyber security shall be provided at the following levels:

1) Security at device level
2) Security at network level
3) Security at remote access level
4) Security management such as substation access control and cyber security management function in engineering workstation

Among the methods to mitigate the threats are, but not limit to:

1) Access management such as user ID authentication and authorization permission levels
2) Backup and disaster recovery
3) Firewalls
4) Information and user log and audit trail
5) Network intrusion detection system (IDS)
6) Password management such as user access password identification, control and verification
7) Virus protection including when a user connects an external storage device, such as a thumb drive, to a PC/computer station in a substation. This virus protection shall be regularly updated, and shall not have a negative effect on any function of the SA.

For overall security assessment, the standard ISO 27001 should be complied so that risks of any sort and the strategy for developing the security system to mitigate those risks could be assessed.

Substation IEDs should be complied to IEEE 1686, the latest version available, regarding cyber security capabilities.

Security on data and communications should be conformed with IEC 62351, parts 1 – 8 and its relevant future extension.

Please refer to Annex 7 for details of cyber security.

12. QUALITY SYSTEM AND ASSURANCE

12.1 QUALITY PLAN

All the system manufacturers, device manufacturers and Contractor shall be required to have quality management systems and quality control practices certified to ISO 9001:2000 standards.

A detailed quality plan shall be submitted for evaluation. The details shall include but not limited to:

1) Organization structure
2) Human resource
3) Personnel involve in the project
4) Qualification
5) Project time line
6) A detailed work program/schedule
7) A detailed work to be performed

8) Work procedure
9) Test procedure
10) Safety measure
11) Person in charge
12) Material handling and storage
13) Control of outsource product & services
14) Handling Non-conformance product, deviation and changes
15) Document Control

12.2 TRAINING

Training is required to qualify PEA personnel to assume full responsibility for the engineering, installation, operation, maintenance, diagnostics and repair of the IEC 61850 based SCPS. The objective is to provide PEA personnel with sufficient training to allow them to operate and maintain the SCPS without significant Contractor's support.

Each operational and technical aspect of the system must be thoroughly covered in the associated training courses. The training venue will be proposed by the Contractor and approved by the PEA, on all devices, equipment and systems delivered by the Contractor. The Contractor shall provide all training materials, and PEA shall be permitted to reproduce any of them and to tape training sessions for internal use. The training syllabus, contents, schedules and training venues shall be proposed by the Contractor and shall be subject to PEA approval. The costs of all training shall be borne by the Contractor.

In addition to the training above, the Contractor is expected to transfer the IEC 61850 based SCPS technologies related to engineering, installation, operation, maintenance, and diagnostics to PEA.

The Contractor shall recommend a list of training courses for the purpose of preparing PEA personnel to configure, operate, program, and maintain the delivered systems. The duration and number of participants of each course will be approved by PEA. It is understood that PEA shall have no programming or configuration responsibilities for the systems under contract, but they may well need these skills after system deliveries.

12.2.1 Operation Training

The two days operation training course shall be provided at each substation. The objective of this course is to train PEA personnel in how to use the SCPS. PEA intends that the personnel receiving this training will become substation operators and or trainers. The training materials shall include the SCPS user's manual and the course shall focus on hand-on training on the delivered SCPS at each site such that participants perform typical system operation. The cost of operation training course and material shall be included in the cost of proposed equipment, not in a separate item.

The operation training course will be attended by 10 people and shall include;

1) A system overview that presents SCPS configuration, application, capability, and performance concept.
2) General operating procedures that cover basic user interface features, display and report capabilities, log-on steps, user access restriction, error message, etc.
3) Equipment handling such as minor SCPS maintenance activities that do not require a technician.
4) Verification that the information in the SCPS user's manual is valid.

12.2.2 Maintenance Training

Training is required to prepare PEA personnel to assume full responsibility for the coordination and supervision of the Contractor's field work and for future PEA maintenance of the system equipment, including their repair by replacing printed circuit boards, modules, and assemblies. All training shall be conducted in English and/or Thai, at PEA headquarters or at manufacturer. All training material and facilities including maintenance tools and other special tools shall be provided by the Contractor. PEA shall be permitted to reproduce any of the training materials and to tape training sessions for internal use.

The Bidders have to quote recommended training course with their lists of quantities and itemized prices. PEA reserves the right to purchase some or all of items, to adjust their quantities, or to cancel them. Evaluation and comparison of bid price for main Item shall not include the prices of training course.

The maintenance training will be attended by 5 people and shall include:

1) Theory of operation of the SCPS
2) Block diagrams and data flows
3) Use of the SCPS local user interfaces (HMIs)
4) Troubleshooting to printed circuit board or replaceable part level
5) Printed circuit board/module/assembly replacement procedures
6) SCPS and HMI installation, startup adjustment, reconfiguration, and expansion
7) Testing of SCPS and HMI communications with the DMS master stations
8) Orientation and coordination of SCPS and HMI documentation such as manuals, configuration and assembly drawings, schematic diagrams, and parts lists
9) Diagnostics and verification of the proper operation of the special tools
10) Theory of operation of the special tools and, to the extent practical, troubleshooting and repair of the special tools.

The training system shall include the following equipment:

1) Substation LAN (2 each) and Ethernet switches: Interconnected with the training system IEDs via fibre optic cable.
2) GPS connection: All necessary parts to deliver the signal.
3) Engineering Interface Unit [HMI] IED (1 each): OPC-Server
4) TRU IED (1 each)

5) BCU and IED Protective relay: Sufficient modules to support all point types and IEC61850 Logical Nodes to be used. These need to be supplemented with simulator panels providing status and counter inputs; these shall support both manually-initiated inputs and automatic toggling and counting. CT and VT inputs shall be provided by PEA via a Double or equivalent test unit.
6) CGW IED (1 each)
7) Fusing, and power distribution: As necessary to safely support the above equipment. To be supplied from a conventional 125 V DC source.
8) Simulator devices for circuit breakers, OLTC controls, reclosers, and any other controlled equipment: Simulator devices shall provide control and status indicators. Other display and control panels shall be provided as needed to interpret system behaviour. The training system shall not be connected to any real primary system equipment.
9) Combitest or test switch blocks or equivalent for isolation and testing of Protective relays within the system allow rack space for mounting these.
10) Open relay racks to support 19” rack mounting at convenient heights and trays to support cable and wiring interconnections.

13. DOCUMENTATION REQUIREMENTS

13.1 GENERAL REQUIREMENTS

The Contractor shall provide full documentation for the SCPS substation. The documentation shall include conceptual and detailed design, drawings, data, operation and maintenance instruction manuals, and testing documentation, as well as training materials.

The Contractor shall provide complete documentation and electronic (soft copies)-file for all system equipment. All documentation shall be in English.

The following Documentations shall be supplied for substation:

1) Documentation for Substation
2) Documentation for the SCPS
3) Documentation for IEDs
4) Documentation for (Data Exchange Diagram) DEDs
5) Network Design List; see Annex 9.

The Contractor shall provide the following documentations to PEA as part of the works:

Table 13.1 – Drawings and other Documentation

Documentation	Requirements
Technical Drawings	Conceptual Drawings including, but not limit to Function diagram of protection Interlocking and control logic diagram All applications for substation automation logic diagram Detailed Schematic or Circuit Drawings
Detail System Physical and Logical Architecture	1) Detailed Substation Automation System architecture (both physical and logical) 2) SCPS components and interrelationship 3) SCPS integration and interface 4) Power system substation single line diagram IED configuration and communication network configuration including Substation Configuration Language (SCL) electronic description in the form of; 5) System Specification Description (SSD) file (if available) 6) System Configuration Description (SCD) file 7) IED Capability Description (ICD) file, and 8) Configured IED Description (CID) file (if available) 9) IED MICS, PICS and PIXIT description 10) IED function allocations and object modelling description 11) Object naming convention (The object naming convention rule is to be determined by PEA) 12) Communication services description 13) Time synchronisation description 14) Detailed information management system 15) Performance, availability, reliability, maintainability, etc. of the 16) SCPS
Compliance Declaration	1) Compliance statement to PEA functional specification 2) IED conformance test certificate based on IEC 61850-10 3) SCPS components and IED type test results and certificates 4) System test and operating conditions
System Test Plan and Procedure	1) System test plan including test schedule in relation to SCPS project and engineering phases 2) System test procedure including scenario & methodology, specific test sequence, performance measurement, test evaluation methodology, acceptance criteria, etc. 3) Quality control of SCPS components and IEDs

Documentation	Requirements
Graphical User Interface	Common and customised graphical user interface description of all HMIs including Substation Level Operator interface (SLOI) and Engineering HMI
Configuration Management	1) Configuration management methodology 2) Configuration management system using Engineering Workstation 3) Configuration management procedure including configuration maintenance, tracking, updating, revision change, backup, etc.
Operational Control	1) Access control of SCADA and Engineering Workstation 2) Access control and cyber security definition 3) Access control verification procedure 4) Access control administration and management procedure 5) Setting Management 6) Control and verification of IED individual, group and configuration settings 7) Access and interrogation through Engineering Workstation 8) Report Management of all communication services (Client- Server, and GOOSE) 9) Control of IED reporting Report/Event/Log Control 10) Block definition 11) IED Data Set definition 12) Time Synchronisation 13) Time Synchronisation description 14) Time stamp accuracy definition for Substation 15) Automation System functions

13.2 DOCUMENTATION FOR SUBSTATION

The following minimum documentation shall be provided or prepared as part of the substation requirements:

1) Substation contract documents including substation technical specifications and information, etc.
2) Substation conceptual drawings
3) Substation detailed drawings
4) Substation training presentation hand-out
5) Substation test reports (FAT, SAT, Commissioning)

13.3 DOCUMENTATION FOR THE SCPS

The following minimum documentation shall be provided or prepared as part of the system requirements:

1) SCPS Product Catalogue
2) SCPS Product Operation and Maintenance (O&M) Manual

3) SCPS Product Technical Specifications and Information
4) SCPS Training Presentation Hand-out
5) SCPS Test Reports
6) SCPS Functional Decomposition Diagram (Refer to ANNEX 11)
7) Substation GOOSE source/sink table
8) Sequence diagram for each function
9) Logical connection diagram
10) State diagram for each device behaviour
11) Cyber security application and implementation

13.4 DOCUMENTATION FOR IED

The following minimum documentation shall be provided or prepared as part of the device requirements:

1) Device Terminal Function Diagram
2) Device Catalogue
3) Device Product Operation and Maintenance (O&M) Manual
4) Device Product Technical Specifications and Information
5) Device Training Presentation Hand-out
6) Device Test Reports
7) Device Guidebook – PEA standard relay setting, configuration and terminal function assignment

13.5 INSTRUCTION MANUALS

Instruction manuals shall include all information and instructions needed by PEA technicians to maintain the SCPS, and to troubleshoot and repair the equipment to the level of replacing printed circuit boards and other easily replaceable modules and assemblies.

The instruction manuals shall address the following topics:

1) <u>Preventive Maintenance</u>**:** Instructions including all visual checks, software and hardware tests, diagnostic routines, and resultant adjustments and calibrations necessary for periodic maintenance. Required schedules for preventive maintenance shall be included where applicable.

2) <u>Troubleshooting</u>: Instructions for quickly locating malfunctions to the level of printed circuit boards and replaceable modules, using the Contractor-supplied field test system. The instructions shall contain concise information on equipment operation, with block diagrams and simplified schematic diagrams of electrical, mechanical, and electronic circuits. Troubleshooting guidelines shall be provided for the location of faults, identifying symptoms and probable causes, and instructions for remedying the problems.

3) Test Parameters: A tabulation of voltage, current, or power measurements as needed for servicing the equipment. This tabulation shall list all test points and their nominal readings. This tabulation shall show both normal values and their acceptable limits.

4) Configuration Drawings: Drawings that identify the location of circuit boards, equipment assemblies, cables, and external connections.

5) Repair Instructions: Instructions for the removal, repair, adjustment, and replacement of all items. Layout drawings, parts-location information, photographs, interconnection cabling diagrams, intra-rack wiring data diagrams or tabular listings, and enlarged sectional views of mechanical assemblies shall be provided. Cautions and warnings to protect personnel and equipment shall be included as needed.

6) Theory of Operation: Tutorials detailing equipment. an operators manual shall be provided describing the operators use of the equipment in clear colloquial, non-technical English. The manual shall have to be suitable for use by and the training of the PEA personnel with little knowledge of computer based equipment, computer systems or computer jargon.

7) Diagnostics: Use of the field test system and other means to verify the proper operation of the SCPS.

8) Test Tools Manuals: A comprehensive manual that covers all the functions included in the test tools. Functions that pertain to features which are not included in the delivered equipment shall be identified in the manuals.

9) Schematic Diagrams: Complete schematic diagrams, assembly drawings, and parts lists shall be provided for all subassemblies. The parts lists shall identify each part and component in sufficient detail for procurement from an approved source.

13.6 DRAWINGS AND DATA FOR APPROVAL

The Contractor shall submit the drawings and data listed below. Contractor must submit technical equipment for the installation of the system to PEA for approval (Approved) and stamped "For Construction" prior to deployment as power substations. The details and documents for the installation as follows.

The documents technical details of the system devices, each consisting of 6 sets:

1) Configuration/assembly drawings Diagram detailing the connection between the devices HMI, BCU, IED Protective relay, MU & Smart I/O, GPS, connection port.
2) Bill of Materials table detailing the equipment used by the resolution. It must be labelled as what equipment. Products / What version (no need to specify "OR EQUAL" or other words meaning the same) and how many countries (sets, lot).
3) SCPS internal wiring/cabling drawings

4) SCPS external connection drawings
5) SCPS configuration data for each installation.
6) All other drawings considered necessary for the installation, operation and maintenance of the control equipment.
7) Details of database prepared which documents all data points within the substation.
8) Catalogue of all equipment.
9) Other (if the Contractor need for PEA approval.)

The Installation and Wiring Drawing diagram for installing the SCPS:
1) Form Configuration/assembly drawings for each device.
2) Bill of Materials.
3) Form Installation location and type of installation of equipment.
4) DC Schematic Diagram showing a detailed wiring devices.
5) Form Interlocking Logic Diagram showing the Interlocking Logic Diagram for a command from SCPS.
6) SCPS AC and DC Power Supply Wiring Diagram.
7) Type Optical Fibre Tray Layout and Installation Diagram.
8) Terminal Diagram.

The document detailed I/O Points List of SCPS and provide the SCADA/DMS Mapping points connected to the system for SCADA/DMS for 6 sets.
1) Sample Screen Display of 4 sets of SCPS.
2) AC and DC Schematic diagram of the power station, all for reference check of a set / type of the stop.
3) SCPS internal wiring/cabling drawings.
4) SCPS external connection drawings.
5) SCPS configuration data for each installation.
6) All other drawings considered necessary for the installation, operation and maintenance of the control equipment.
7) Details of database prepared which documents all data points within the substation.

Generally, if no more details are required, one approved copy of each drawing/document will be returned to the Contractor within forty five calendar days after receipt by PEA. If PEA requires additional information, the Contractor cannot regard the lost time as a reason for extending the delivery time without penalty. When the drawings have been returned for correction, the Contractor shall make the necessary revisions on them and shall submit the corrected drawings and data for approval within thirty calendar days. Any manufacturing done before approval of the drawings and data, will be at the Contractor's risk.

PEA shall have the right to require the Contractor to make any changes in the design which may be necessary in the opinion of PEA, to make the equipment conform to the requirements and intent of this Contract Document without additional cost to PEA. Approval of the Contractor's drawings shall not be held to relieve the Contractor of any part of the Contractor's obligation to meet all of the requirements of this Contract Document or of the responsibility for the correctness of the drawings.

13.7 TEST PLAN AND TEST PROCEDURE FOR APPROVAL

13.7.1 Factory Acceptance Test (FAT) Plan

This document shall lay out a plan for the factory acceptance testing of the System. The plan shall include:

1) Test philosophy, rules, and guidelines
2) Functions to be tested
3) Test bed description: block diagram showing all major components of the test configuration, simulation hardware, test equipment, etc.
4) Description of the methods that will be used and tools that will be provided to create the conditions required for the performance testing. Analyses to prove the validity of the proposed simulations tools and extrapolation methods shall be included, and the methods and tools shall be subject to approval by PEA.
5) Methods that will be employed to screen and record test results
6) Procedures to report variances and to track their correction
7) A day-by-day and hour-by-hour test schedule that contains enough detail to estimate the duration of the FAT and the testing activities.
8) Scheduling and instructions for activities that are needed in preparation for certain test. In order to ensure that necessary preparations will indeed be performed in a timely and orderly fashion, the instruction for activities that are needed ahead of time in preparation for certain tests must be included in the test plan or in a special section of the test procedures.

In order to assure that a realistic and accurate schedule is available for the FAT, the test schedule shall be verified and updated during the PreFAT. The actual duration of each test shall be recorded during the PreFAT, and this information shall be used to refine the final plan for the FAT.

13.7.2 Factory Acceptance Test (FAT) Procedures

Detailed procedures designed to satisfy the FAT requirements described later shall be presented in a Factory Acceptance Test Procedures document. The procedures shall comprise detailed guides for tests to verify that:

1) The development of the system and each of its functions is complete.
2) The hardware and software is fully integrated.
3) All the functional, performance, and sizing requirements of the Contract are met.
4) The development of the interfaces and functions for operation with the SCADA/DMS, and the external systems is complete.

The test procedures shall be documented in the order in which they are to be performed.

The test procedures shall be in the form of detailed step-by-step test guides. Detailed test/initial conditions, inputs, and expected results shall be explicitly included in each procedure. The procedures shall be designed to test the behavior of each function under both normal and abnormal conditions, and to verify the capability of the system to cope with user errors. The goal is to rigorously test the system by strictly following detailed, pre-planned procedures, without having to resort to informal, unstructured testing.

13.7.3 Site Acceptance Test (SAT) Procedures

The SAT procedures shall verify that the System has been correctly installed, and that it performs satisfactorily under real operating conditions. The SAT procedures shall be comprised of the FAT procedures, modified as needed for operation in the substation environment and supplemented by new procedures for tests which were not possible with the system configuration and the test environment of the FAT.

13.8 AS-BUILT DOCUMENTATION AND SCD FILE

The system will be accepted by PEA only after the Contactor completes the delivery of all the as-built documentation and software for the system, and their approval by PEA.

13.8.1 Final System Documentation

The Contractor shall submit final, "as-built", System documentation for review and approval by PEA. This documentation shall include all deliverable documentation which has been revised to reflect the as-built System. Any modification to the System resulting from the FAT or SAT shall be reflected in the "as-built" documentation.

All other previously submitted documents which have been changed because of engineering changes, contract changes, or error or omissions shall be resubmitted for approval.

When "as-built" documents and other revised documents are approved by PEA, hard copies of the final documents shall be provided to PEA in the quantities specified earlier. In addition electronic copies of all the documents and drawings shall be provided on CDs or DVDs.

13.8.2 SCD File

The Contractor shall provide the following "SCD File", in machine-readable format on DVDs, CDs, or other medium as appropriate.

14. DATA TO BE GIVEN BY BIDDER

For the SCPS offered, the following details shall be submitted by Bidders:

14.1 Table of Conformance

The form of the information shall include the following fields for all clauses and sub-clauses corresponding to each part of the Technical Specifications:

1) Clause or sub-clause number
2) Clause or sub-clause name
3) Proposal reference
4) Conformance status - enter one of the following codes :
   a) E Bidder's product offers an enhancement to the Specifications.
   b) C Bidder conforms with the Specifications
   c) A Bidder proposes an alternative method to conform
   d) X Bidder takes exception to the Specifications.
5) Standard equipment status - enter one of the following codes if an "E", "C", or "A" was entered in the Conformance status field:
   a) S Bidder's standard equipment will be used to meet the requirements
   b) M Bidder's standard equipment needs to be modified in order to meet the requirements.
6) Description - explain how the Bidder's product enhances, provides an alternative, or fails to meet each relevant requirement. Explanations shall not reference "boiler plate" material. It is required that all explanations be self-contained.

14.2 ANNEX: Bidders shall complete the Annex with the proposed SCPS data.

14.3 Block diagram(s) showing his proposed control scheme.

14.4 Technical specifications, descriptions and catalogues of the equipment and devices he propose to use.

14.5 List of materials contained in each panel he propose to supply.

14.6 Control system logic diagram(s).

14.7 List of software to be used including literature/details of their functions.

14.8 Equipment layouts

14.9 Type test certificates and test results on the equipment being offered.

14.10 Maintenance training program proposal described in this specification, with itemized prices.

14.11 List of spare parts for two-year operation, with itemized prices.

14.12 List of special tools, with itemized prices.

14.13 List of operation and maintenance manual(s).

14.14 Experience/reference list of the manufacturer in supplying control system.

ANNEX 1 – CONTROL AND PROTECTION SYSTEM CONFIGURATIONS

A1.1 SCL-Compliance

Not only shall all IEDs supplied for this bid be compliant with the IEC 61850 communications standard, but they shall be configured using SCL-compliant tools, files, and procedures as described in IEC 61850, Part 6.

A1.2 Remote Configuration and File-Based Maintenance

All system software, applications, and devices (e.g. IEDs) shall be designed to facilitate easy reconfiguration and program updates via remote file downloads. Some proprietary files may be required.

for an entity to operate as intended, but this is not a problem as long as the content of those files does not adversely affect IED or system communications interoperability, as defined by IEC 61850.

A1.3 Structure and Content of the Local Repository

The structure, information models, interfaces, and services of the Local Repository shall comply with the IEC 61850 communications standard.

The Repository shall contain two sets of IEC 61850-compatible schemas: Proxy 'Server Views' and Proxy 'Client Views'. Design implementation shall not limit the growth of the Repository over time, as some sites may appreciably increase in scope. No programming or system regeneration shall be necessary for adding or modifying components; reconfiguration through the SCL configuration process shall be used

These replicate the actual Server Views held in IEDs, to the extent their use is contemplated by PEA.

As a minimum, all Logical Devices (i.e. domains) belonging to those IEDs need to be shown. This is important, because files related to server IEDs are referenced through their associated Logical Devices. Because of the way file transfer functionality is specified, files need to be referenced in both IED 'Server Views' and Proxy 'Server Views'.

Proxy 'Server Views' shall only be used to support browsing, so that operators and system designers can determine what data is available from each IED Server and how that data is structurally organized. This means that all defined Logical Nodes, and the data they contain, shall be replicated from the IED Servers to the Proxy 'Server Views.' The only exceptions are data that PEA agrees will never be used. IEDs shall not be directly browsed during normal system operation.

Any time a related configuration file is updated and downloaded to a HMI or IED, the affected schemas shall be automatically updated. Given the way file management is specified, any reconfiguration of IED 'Server Views' shall automatically result in an identical reconfiguration of the corresponding Proxy

'Server Views' in both the primary and standby (if present) HMI. Reconfiguration of Proxy 'Client Views' does not affect any IED besides HMI, unless changes to structure and data affect existing client subscriptions. Such issues are generally handled by the SCL configuration process.

While IED Server Views tend to be product-oriented, Client Views tend to be application-oriented. Client Views rearrange the way information is grouped and organized. This is done to suit the convenience and viewpoint of the client. In this specification, PEA is primarily focused on an operations viewpoint. See it represented in a way that best meets their needs. It frequently depends on the work culture of the group.
The desired content may be provided by several IEDs, each having a portion of the required data, so those various pieces need to be mapped to the content of XB_691 in the Client Views.

Each Logical Node in a Client View may draw its data from one to several IEDs. Logical Nodes in the IED Servers may send different pieces of their data to different Logical Nodes in the Client Views. This requires a mapping process that links IED Server components with Client View components. SCL tools provide this capability. Note that this is a 'pick-and-choose' process that begins at the Logical Device level, and proceeds down through IEC 61850's data modelling hierarchy:

- Some components at the lower end are mandatory, some are optional, and some involve interdependencies. The mapped linkages determine how data from the IED Servers is used to keep the Client Views up to date.

All data that the HMI selectively acquires (e.g. subscribes, polls) from IED Servers shall be stored in the Local Repository under both Proxy Server Views and Proxy Client Views. Related support data (e.g. operational parameters, configuration parameters, text descriptions) specified by the IEC 61850 data models shall also be included, except for those items that both optional and of no interest to PEA. Other categories of data to be represented within Client Views include the following, as long as they serve a defined purpose for PEA:

Calculated data

- Data generated by application programs
- Diagnostic data (e.g. operational status) and system performance statistics

These are to be represented in a manner consistent with standard IEC 61850 information models and application usage.

The contractor shall consult with PEA and recommend schema for IEDs and client applications installed at the individual stations. The Repository structure and content shall be designed according to these specifications, documented by the contractor, and presented for PEA approval.

Per the IEC 61850 standard, real-time data values stored in the Local Repository are represented in engineering units. Where there is latitude in how those units are expressed (e.g. V or kV), the contractor shall propose choices for PEA approval.

A1.4 Things to Avoid

Delivered equipment shall not use DIP switches, connection jumpers, wire-wrap techniques, or any similar technique for user-defined parameters.

A1.5 Contractor Responsibilities

The contractor shall be responsible for integrating and configuring all required system software, applications, and equipment. These shall all be reconfigurable by PEA, using tools and procedures provided by the contractor, so that evolving operational requirements can be met.

The structure and content of Proxy Server Views must be identical to the corresponding IED Server Views, to the extent that the Proxy Server Views show Server View information. As a minimum, all Logical Devices (i.e. domains) must be shown.

Any file associated with a Server View is referenced through its associated Logical Device directory.

Any file associated with a Proxy Client View is referenced through its associated Logical Device directory.

Server View s and Proxy Client View s are created through the system configuration process.

ANNEX 2 – ELECTRICAL TECHNOLOGICAL AND MECHANICAL CONSIDERATIONS

A2.1 Electrical and Mechanical Requirements

Table A2.1 – Conformance Requirements

Test Item	Test Goal	Test Programme	Remarks
IEC 60255-21-1	Vibration Test	Mechanical resistance to sinusoidal vibrations	Mandatory
IEC 60255-21-2	Shock and bump tests	Mechanical resistance to shock and bump	Non Mandatory
IEC 60255-21-3	Seismic Test	Mechanical resistance to single axis sine sweep	Non
IEC 60255-1	Insulation	50Hz dielectric strength test Insulation resistance Impulse voltage test Spacing	Mandatory
IEC 60255-26 IEC 60694	EMC immunity	Damped oscillatory wave Test at 10MHz and test at 100kHz, 1 MHz, 50MHz	Mandatory (Tests at 10MHz, and 50MHz Non-mandatory)
IEC 60255-26 IEC 61000-4-4 Class 4	EMC immunity	Fast transient test	Mandatory
IEC 60255-22-5 IEC 61000-4-5 Class 3	EMC immunity	Surge test	Mandatory
IEC 60255-22-6 IEC 61000-4-6 Class 3	EMC immunity	Conducted radio interference test	Mandatory
IEC 60255-26 IEC 61000-4-2 Class 3	EMC immunity	Electrostatic discharge test	Mandatory
IEC 61000-4-11 for AC IEC 60255-3 and IEC 60255-26 for DC	EMC immunity	Variations and interruptions in AC and DC auxiliary voltage	Mandatory
IEC 61000-4-3 Class 3 ENV 50204 Class 3	EMC immunity	Electromagnetic fields	Mandatory
IEC 61000-4-8 Class 5	EMC immunity	50Hz power frequency magnetic fields	Mandatory
CISPR 11, Class A, Group I. EMC emission IEC 60555-2	EMC emission	Conducted RF interference on power supply terminals and radiated interference. Harmonics for AC supply.	Mandatory
CISPR 14	EMC emission	Flicker	Non Mandatory

A2.2 Protective relay Reference Standards

All Protective relays shall be designed and tested according to International Electro-technical Commission (IEC) as applicable. As basic requirement, it will comply with the following standards:

No.	Standard Requirements	IEC Standard
1	Measuring relays and protection equipment - Part 1: Common requirements	IEC 60255-1
2	Electrical relays - Part 12: Directional relays and power relays with two input energizing quantities	IEC 60255-12
3	Electrical relays - Part 13: Biased (percentage) differential relays	IEC 60255-13
4	Measuring relays and protection equipment - Part 24: Common format for transient data exchange (COMTRADE) for power systems	IEC 60255-24
5	Measuring relays and protection equipment - Part 26: Electromagnetic compatibility requirements	IEC 60255-26
6	Measuring relays and protection equipment - Part 27: Product safety requirements	IEC 60255-27
7	Measuring relays and protection equipment - Part 121: Functional requirements for distance protection	IEC 60255-121
8	Measuring relays and protection equipment - Part 127: Functional requirements for over/under voltage protection	IEC 60255-127
9	Measuring relays and protection equipment - Part 149: Functional requirements for thermal electrical relays	IEC 60255-149
10	Measuring relays and protection equipment - Part 151: Functional requirements for over/under current protection	IEC 60255-151
11	Surge Withstand Capability Test	IEC 60255-26
12	Radiated Electromagnetic Interference tests	IEC 60255-26
13	Electrostatic discharge tests	IEC 60255-26
14	Service Condition & Electrical Rating	IEC 60255-1
15	Make and carry and interrupting ratings for tripping output circuits	IEC 61810-2 IEC 61810-2

No.	Standard Requirements	IEC Standard
16	Heating limits of temperature rise for coils	IEC 60255-1 IEC 60085
17	Mechanical requirements	IEC 60255-1
18	Insulation tests	IEC 60255-27

ANNEX 3 – MINIMUM REQUIREMENTS FOR PC AND LAPTOP COMPUTER

For a PC used for HMI, as referred to in Chapters 5 and 8, the equipment should have at least the following specifications:

1) Industrial Grade PC* with the latest and competent specifications for all the functionalities needed
2) Processor:* Core 2 Quad 2.6 GHz Intel i7 processor, Minimum L2 cache: 6MB
3) Mainboard:* X38 express chipset or better, minimum FSB 1,333 MHz, Trusted Platform Module (TPM)
4) 4 GB DDRII 800 MHz*, with required 2 spare memories
5) 500 GB, or more, Serial ATA 150, 7200 rpm
6) At least 8 @ USB Ports*, 2 @ Ethernet Port (RJ45), 1 @ e-SATA
7) Video Card PCI express with 1GB dedicated memory
8) Redundant Power supply
9) 23-inch colour monitor TFT-LED type, Resolutions: 1920 x 1080 for desktop. Dot pitch is not more than 0.26 mm
10) Network Interface & Communications: Dual Fast Ethernet NIC (10/100/1000Mbps) communications adapter with all necessary facilities for Ethernet TCP/IP networking per the IEC 61850 network profile specifications, including compatible TCP/IP stack. (Note: Two independent ports required with same IP address)
11) Accessories
    a. USB standard Microsoft keyboard (or better) with a minimum of 104 keys with Thai/English key labels. Function keys required for dedicated HMI functions.
    b. Microsoft Windows, either Professional™ or Business™, with Thai language support and latest service packed version or later version
    c. USB standard Microsoft Mouse (or better) optical mouse, Recovery CDs operating system and Driver CDs, A loudspeaker/sound card for audible alarming and for use with future functions
    d. 2 @ spare expansion PCI slots for future expansion
    e. Real-time clock, calendar with battery backup, and support for HMI time-synchronization.
    f. Auto-restart capability.
    g. Diagnostics, on-site installation, and validation.

*All the specifications above should be at least as specified above, or the latest and better version, if technologically available.

For a laptop for an Engineering Workstation, as referred to in Chapter 8, the equipment should have at least the following specifications:

1) Industrial Grade Laptop with the latest and competent specifications for all the functionalities needed

2) Processor: 1.2GHz dual-core Intel Core M processor (Turbo Boost up to 2.6GHz) with 4MB shared L3 cache. Configurable to 1.3GHz dual-core Intel Core M processor (Turbo Boost up to 2.9GHz) with 4MB shared L3 cache.
3) Display: 12-inch (diagonal) LED-backlit display with IPS technology
   a. 2304-by-1440 resolution at 226 pixels per inch with support for millions of colors
   b. 16:10 aspect ratio
   c. Supported scaled resolutions:
      - 1440 by 900
      - 1280 by 800
      - 1024 by 640
4) Memory: 8GB of 1600MHz LPDDR3 onboard memory
5) Storage: 512GB PCIe-based onboard flash storage
6) Graphics and Video Support: Intel HD Graphics 5300 (or better)
7) Wireless:
   a. Wi-Fi: 802.11ac Wi-Fi wireless networking;IEEE 802.11a/b/g/n compatible
   b. Bluetooth: Bluetooth 4.0 wireless technology
8) Battery and Power: Up to 9 hours wireless web, with at least 39.7-watt-hour lithium-polymer battery
9) Electrical and Operating Requirements
   a. Line voltage: 100V–240V AC
   b. Frequency: 50Hz to 60Hz
   c. Operating temperature: 50° to 95° F (10° to 35° C)
   d. Storage temperature: -13° to 113° F (-25° to 45° C)
   e. Relative humidity: 0% to 90% noncondensing

ANNEX 4 – REQUIRED DATA POINTS

Generic I/O Requirements for ANNEX 4

Table A4-1.1 through A4-1.11 list the quantities of I/O points required for each type of substation power device that will be monitored and/or controlled by the SCPS and the DMS. For some devices, the quantify of I/O points varies depending on the substation configuration. In cases where the I/O point count varies with substation configuration, separate I/O point lists are provided for each configuration. These are only examples, and the Bidder can propose a better one upon PEA approval. Each of these tables contains the following information:

1) Description of each required I/O point
2) Engineering units for Analog points
3) English-language descriptor for status and control points
4) Total quantity of each type of point

For ac analog points, the total quantity of points is categorized into normal current inputs (0-1 amp or 0-5 amp), voltage inputs (0-125 V AC) and fault current inputs (if any).

For status inputs, the total quantity of points is categorized as follows:

4) Digital input (DI) or Regular (i.e. not Momentary Change Detect) Status Inputs
    a. Two-state, single-contact inputs (SC-2S)
    b. Two-state, double-contact inputs (DC-2S)
    c. Two-state but slowly change (slow DC-2S)
    d. Three-state Status (DC-3S)
2) Sequence-of-Events (SOE) or Momentary Change Detect (MCD) points
    a. Two-state, single-contact inputs (SC-2S)
    b. Two-state, double-contact inputs (DC-2S)
    c. Three-state Status (DC-3S)

For control points, the total quantity of points is categorized into regular (on/off) control outputs and raise/lower control outputs.

1) Table A4-1.1: I/O Point Counts for 22 kV Vacuum CB Indoor Type Metal-Clad Switchgears, Single Bus Configuration

2) Table A4-1.2: I/O Point Counts for 22 or 33 kV GIS

3) Table A4-1.3: I/O Point Counts for 115 kV GIS Switchgears Double Main Bus Configuration

4) Table A4-1.4: I/O Point Counts for 115 kV Outdoor Type Switchyard, Single Main and Transfer Bus Configuration

5) Table A4-1.5: I/O Point Counts for 115 kV Outdoor Type Switchyard, Breaker and A-Half Configuration

6) Table A4-1.6: I/O Point Counts for 115 kV AIS Double Bus-Single Breaker

7) Table A4-1.7: I/O Point Counts for 115 kV GIS H-Configuration

8) Table A4-1.8: I/O Point Counts for 115 kV AIS Compact H-Configuration

9) Table A4-1.9: I/O Point Counts for 115 kV Substation Connected by Tie Line

10) Table A4-1.10: I/O Point Counts for 115 kV Power Transformer Configuration

11) Table A4-1.11: I/O Point Counts for 115 kV/Substation Monitoring Single Bus Configuration

12) Table A4-1.12: I/O Point Counts for SCPS Connected with Protection Relay (for Double Main Protection Concept) 115 kV Incoming & Outgoing Line

[illegible]

I/O POINT COUNTS FOR

22kV VACUUM CB INDOOR TYPE METAL-CLAD SWITCHGEARS, SINGLE BUS CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	22kV	Bay Name :	22kV Incoming Feeder No.xx		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	INC_01	1BVB-01	CLOSE/OPEN COMMAND	Close	Open	DCP	INC01	xx.xx							SBO	12	1	echo of request			
2	INC_01	1BVB-01	50BF ON/OFF COMMAND	On	Off	DCP	INC01	cc							SBO	12	1	echo of request			
3	INC_01	1BVB-01	E/T ON/OFF COMMAND	On	Off	DCP	INC01	cc		Control	XSWI2	Pos	ctlVal		SBO	12	1	echo of request			
4	INC_01	1BVB-01	50BF ON/OFF COMMAND	On	Off	DCP	INC01	cc		Control	XSWI3	Pos	ctlVal		SBO	12	1	echo of request			
5	INC_01	1BVB-01	U/F RELAY OFF COMMAND	OFF	-	SCP	INC01	cc		System	PloGGIO1/SPCSO1	Pos	ctlVal		DOP	12	1	echo of request			
5	INC_01	1BVB-01	U/F RELAY STEP1 ON COMMAND	On	-	SCP	INC01	cc		System	PloGGIO1/SPCSO2	Pos	ctlVal		DOP	12	1	echo of request			
6	INC_01	1BVB-01	U/F RELAY STEP2 ON COMMAND	On	-	SCP	INC01	cc		System	PloGGIO1/SPCSO3	Pos	ctlVal		DOP	12	1	echo of request			
7	INC_01	1BVB-01	U/F RELAY STEP3 ON COMMAND	On	-	SCP	INC01	cc		System	PloGGIO1/SPCSO4	Pos	ctlVal		DOP	12	1	echo of request			
8	INC_01	1BVB-01	U/F RELAY STEP4 ON COMMAND	On	-	SCP	INC01	cc		System	PloGGIO1/SPCSO5	Pos	ctlVal		DOP	12	1	echo of request			
9	INC_01	1BVB-01	U/F RELAY STEP5 ON COMMAND	On	-	SCP	INC01	cc		System	PloGGIO1/SPCSO6	Pos	ctlVal		DOP	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	INC_01	1BVB-01	CURRENT PHASE A	0-1800	0-32767	A	INC01	xx.xx							AI	32	2	00, 01	2		1800/1A
2	INC_01	1BVB-01	CURRENT PHASE B	0-1800	0-32767	A	INC01	xx.xx							AI	32	2	00, 01	2		1800/1A
3	INC_01	1BVB-01	CURRENT PHASE C	0-1800	0-32767	A	INC01	xx.xx							AI	32	2	00, 01	2		1800/1A
4	INC_01	1BVB-01	VOLTAGE A-B	0-30	0-32768	kV	INC01	xx.xx							AI	32	2	00, 01	2		22000/110V
5	INC_01	1BVB-01	VOLTAGE B-C	0-30	0-32768	kV	INC01	xx.xx							AI	32	2	00, 01	2		22000/110V
6	INC_01	1BVB-01	VOLTAGE C-A	0-30	0-32768	kV	INC01	xx.xx							AI	32	2	00, 01	2		22000/110V
7	INC_01	1BVB-01	ACTIVE POWER	-93.53 - +93.53	-32767 - +32767	MW	INC01	cc							AI	32	2	00, 01	2		Calculation
8	INC_01	1BVB-01	RECATIVE POWER	-93.53 - +93.53	-32767 - +32767	Mvar	INC01	cc							AI	32	2	00, 01	2		Calculation
9	INC_01	1BVB-01	POWER FACTOR	+/- 100	-32767 - +32767	%	INC01	cc							AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
1	INC_01	1BVB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	INC01	xx.xx							SOE	2	2	17, 28	1		
								INC01	xx.xx							SOE	2	2	17, 28	1		
2	INC_01	1BVG-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	INC01	xx.xx							DI	2	1	17, 28	1		
								INC01	xx.xx							DI	2	1	17, 28	1		
3	INC_01	1BVB-01	WITHDRAW UNIT STATION	Undefine	In Service	Out Service	Fault	INC01	xx.xx							DI	2	1	17, 28	1		
								INC01	xx.xx							DI	2	1	17, 28	1		
4	INC_01	1BVB-01	CONTROL SET MODE	Undefine	Local	Remote	Fault	INC01	xx.xx							DI	2	1	17, 28	1		
								INC01	xx.xx							DI	2	1	17, 28	1		
5	INC_01	1BVB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	INC01	cc							DI	2	1	17, 28	1		
								INC01	cc							DI	2	1	17, 28	1		
6	INC_01	1BVB-01	E/F RELAY ON/OFF STATUS	-	On	Off	-	INC01	cc							DI	2	1	17, 28	1		
								INC01	cc							DI	2	1	17, 28	1		
7	INC_01	1BVB-01	O/C RELAY TIME PHASE A	Normal	Trip	-	-	INC01	cc		Protection	OcpPTOC1	ST	Op.phsA	No	SOE	2	2	17, 28	1		
8	INC_01	1BVB-01	O/C RELAY TIME PHASE B	Normal	Trip	-	-	INC01	cc		Protection	OcpPTOC1	ST	Op.phsB	No	SOE	2	2	17, 28	1		
9	INC_01	1BVB-01	O/C RELAY TIME PHASE C	Normal	Trip	-	-	INC01	cc		Protection	OcpPTOC1	ST	Op.phsC	No	SOE	2	2	17, 28	1		
10	INC_01	1BVB-01	E/F TIME RELAY	Normal	Trip	-	-	INC01	cc		Protection	EfmPTOC1	ST	Op.gerneral	No	SOE	2	2	17, 28	1		
11	INC_01	1BVB-01	O/C INSTANTANEOUS PHASE A	Normal	Trip	-	-	INC01	cc		Protection	OcpPTOC3	ST	Op.phsA	No	SOE	2	2	17, 28	1		
12	INC_01	1BVB-01	O/C INSTANTANEOUS PHASE B	Normal	Trip	-	-	INC01	cc		Protection	OcpPTOC3	ST	Op.phsB	No	SOE	2	2	17, 28	1		
13	INC_01	1BVB-01	O/C INSTANTANEOUS PHASE C	Normal	Trip	-	-	INC01	cc		Protection	OcpPTOC3	ST	Op.phsC	No	SOE	2	2	17, 28	1		
14	INC_01	1BVB-01	E/F INSTANTANEOUS RELAY	Normal	Trip	-	-	INC01	cc		Protection	EfmPTOC3	ST	Op.gerneral	No	SOE	2	2	17, 28	1		
15	INC_01	1BVB-01	TIME DELAY FAIL (CB Fail)	Normal	Trip	-	-	INC01	cc		Protection	CbfRBRF1	ST	OpEx.general	No	SOE	2	2	17, 28	1		
16	INC_01	1BVB-01	U/F RELAY STEP 1	Normal	Trip	-	-	INC01	cc		System	GosGGIO2	ST	Ind4.stVal	Yes	SOE	2	2	17, 28	1		
17	INC_01	1BVB-01	U/F RELAY STEP 2	Normal	Trip	-	-	INC01	cc		System	GosGGIO2	ST	Ind5.stVal	Yes	SOE	2	2	17, 28	1		
18	INC_01	1BVB-01	U/F RELAY STEP 3	Normal	Trip	-	-	INC01	cc		System	GosGGIO2	ST	Ind6.stVal	Yes	SOE	2	2	17, 28	1		
19	INC_01	1BVB-01	U/F RELAY STEP 4	Normal	Trip	-	-	INC01	cc		System	GosGGIO2	ST	Ind7.stVal	Yes	SOE	2	2	17, 28	1		
20	INC_01	1BVB-01	U/F RELAY STEP 5	Normal	Trip	-	-	INC01	cc		System	GosGGIO2	ST	Ind8.stVal	Yes	SOE	2	2	17, 28	1		

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address
21	INC_01	1BVB-01	U/F TRIP SELECTION	Normal	Off	-	-	INC01	cc		System	GosGGIO2	ST	Ind9.stVal	Yes	DI	2	1	17, 28	1	
22	INC_01	1BVB-01	U/F TRIP SELECTION STEP 1	Normal	Step 1	-	-	INC01	cc		System	GosGGIO2	ST	Ind10.stVal	Yes	DI	2	1	17, 28	1	
23	INC_01	1BVB-01	U/F TRIP SELECTION STEP 2	Normal	Step 2	-	-	INC01	cc		System	GosGGIO2	ST	Ind11.stVal	Yes	DI	2	1	17, 28	1	
24	INC_01	1BVB-01	U/F TRIP SELECTION STEP 3	Normal	Step 3	-	-	INC01	cc		System	GosGGIO2	ST	Ind12.stVal	Yes	DI	2	1	17, 28	1	
25	INC_01	1BVB-01	U/F TRIP SELECTION STEP 4	Normal	Step 4	-	-	INC01	cc		System	GosGGIO2	ST	Ind13.stVal	Yes	DI	2	1	17, 28	1	
26	INC_01	1BVB-01	U/F TRIP SELECTION STEP 5	Normal	Step 5	-	-	INC01	cc		System	GosGGIO2	ST	Ind14.stVal	Yes	DI	2	1	17, 28	1	
27	INC_01	1BVB-01	ARC DETECTION SYSTEM	Normal	Operated	-	-	INC01	cc							DI	2	1	17, 28	1	
28	INC_01	1BVB-01	UNDER VOLTAGE	Normal	Alarm	-	-	INC01	cc							DI	2	1	17, 28	1	
29	INC_01	1BVB-01	OVER VOLTAGE	Normal	Alarm	-	-	INC01	cc							DI	2	1	17, 28	1	
30	INC_01	1BVB-01	VT SUPERVISION	Normal	Alarm	-	-	INC01	xx.xx							DI	2	1	17, 28	1	
31	INC_01	1BVB-01	DC SUPPLY	Normal	Alarm	-	-	INC01	xx.xx							DI	2	1	17, 28	1	
32	INC_01	1BVB-01	AC SUPPLY	Normal	Alarm	-	-	INC01	xx.xx							DI	2	1	17, 28	1	
33	INC_01	1BVB-01	LV. CONNECTOR PULLED	Normal	Alarm	-	-	INC01	xx.xx							DI	2	1	17, 28	1	
34	INC_01	1BVB-01	SPRING CHARGE	Normal	Fail	-	-	INC01	xx.xx							DI	2	1	17, 28	1	
35	INC_01	1BVB-01	TRIP CCT. SUPERVISION	Normal	Fail	-	-	INC01	xx.xx							DI	2	1	17, 28	1	
36	INC_01	1BVB-01	PROTECTION RELAY	Normal	Fail	-	-	INC01	cc							DI	2	1	17, 28	1	
37	INC_01	1BVB-01	PROTECTION RELAY LAN A	Normal	Alarm	-	-	INC01	cc							DI	2	1	17, 28	1	
38	INC_01	1BVB-01	PROTECTION RELAY LAN B	Normal	Alarm	-	-	INC01	cc							DI	2	1	17, 28	1	
39	INC_01	1BVB-01	PROTECTION RELAY GOOSE ALARM	Normal	Alarm	-	-	INC01	cc							DI	2	1	17, 28	1	
40	INC_01	1BVB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	INC01	cc							DI	2	1	17, 28	1	

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.1
I/O POINT COUNTS FOR
22kV VACUUM CB INDOOR TYPE METAL-CLAD SWITCHGEARS, SINGLE BUS CONFIGURATION

Substation Name :		Substation Code Name :	
Voltage Level :	22kV	Bay Name :	22kV Outgoing Feeder No.xx
IED Product :		IED Model/Type :	
IED IP Address :			

Substation DNP Adress :

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
1	OUT_0x	xxVB-01	CLOSE/OPEN COMMAND	Close	Open	DPC	OUTxx	xx.xx		Control	XCBR1	Pos	ctlVal		SBO	12	1	echo of request			
2	OUT_0x	xxVB-01	A/R ON/OFF COMMAND	On	Off	DCP	OUTxx	cc		Control	XSWI1	Pos	ctlVal		SBO	12	1	echo of request			
3	OUT_0x	xxVB-01	E/F ON/OFF COMMAND	On	Off	DCP	OUTxx	cc		Control	XSWI2	Pos	ctlVal		SBO	12	1	echo of request			
4	OUT_0x	xxVB-01	SOEF ON/OFF COMMAND	On	Off	DCP	OUTxx	cc		Control	XSWI3	Pos	ctlVal		SBO	12	1	echo of request			
5	OUT_0x	xxVB-01	U/F RELAY OFF COMMAND	OFF	-	SCP	OUTxx	cc		System	PloGGIO1/SPCSO1	Pos	ctlVal		DOP	12	1	echo of request			
5	OUT_0x	xxVB-01	U/F RELAY STEP1 ON COMMAND	On	-	SCP	OUTxx	cc		System	PloGGIO1/SPCSO2	Pos	ctlVal		DOP	12	1	echo of request			
6	OUT_0x	xxVB-01	U/F RELAY STEP2 ON COMMAND	On	-	SCP	OUTxx	cc		System	PloGGIO1/SPCSO3	Pos	ctlVal		DOP	12	1	echo of request			
7	OUT_0x	xxVB-01	U/F RELAY STEP3 ON COMMAND	On	-	SCP	OUTxx	cc		System	PloGGIO1/SPCSO4	Pos	ctlVal		DOP	12	1	echo of request			
8	OUT_0x	xxVB-01	U/F RELAY STEP4 ON COMMAND	On	-	SCP	OUTxx	cc		System	PloGGIO1/SPCSO5	Pos	ctlVal		DOP	12	1	echo of request			
9	OUT_0x	xxVB-01	U/F RELAY STEP5 ON COMMAND	On	-	SCP	OUTxx	cc		System	PloGGIO1/SPCSO6	Pos	ctlVal		DOP	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
1	OUT_0x	xxVB-01	CURRENT PHASE A	0-600	0-32767	A	OUTxx	xx.xx		Measurements	MMXU1/A1/phaA	MX	cVal		AI	32	2	00, 01	2		600/1A
2	OUT_0x	xxVB-01	CURRENT PHASE B	0-600	0-32767	A	OUTxx	xx.xx		Measurements	MMXU1/A1/phaB	MX	cVal		AI	32	2	00, 01	2		600/1A
3	OUT_0x	xxVB-01	CURRENT PHASE C	0-600	0-32767	A	OUTxx	xx.xx		Measurements	MMXU1/A1/phaC	MX	cVal		AI	32	2	00, 01	2		600/1A
4	OUT_0x	xxVB-01	ACTIVE POWER	-31.18 - +31.18	-32767 - +32767	MW	OUTxx	cc		Measurements	MMXU1/AI/TotW	MX	cVal		AI	32	2	00, 01	2		Calculation
5	OUT_0x	xxVB-01	RECATIVE POWER	-31.18 - +31.18	-32767 - +32767	Mvar	OUTxx	cc		Measurements	MMXU1/AI/TotVAr	MX	cVal		AI	32	2	00, 01	2		Calculation
6	OUT_0x	xxVB-01	POWER FACTOR	+/- 100	-32767 - +32767	%	OUTxx	cc		Measurements	MMXU1/AI/TotPF	MX	cVal		AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	OUT_0x	xxVB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	OUTxx	xx.xx		Control	XCBR1	Pos	stVal	No	SOE	2	2	17, 28	1		
								OUTxx	xx.xx							SOE	2	2	17, 28	1		
2	OUT_0x	01VG-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	OUTxx	xx.xx		Control	XSWI5	Pos	stVal	No	DI	2	1	17, 28	1		
								OUTxx	xx.xx							DI	2	1	17, 28	1		
3	OUT_0x	xxVB-01	WITHDRAW UNIT STATION	Undefine	In Service	Out Service	Fault	OUTxx	xx.xx		Control	XSWI5	Pos	stVal	No	DI	2	1	17, 28	1		
								OUTxx	xx.xx							DI	2	1	17, 28	1		
4	OUT_0x	xxVB-01	CONTROL SET MODE	Undefine	Local	Remote	Fault	OUTxx	xx.xx		Control	XSWI6	Pos	stVal	No	DI	2	1	17, 28	1		
								OUTxx	xx.xx							DI	2	1	17, 28	1		
5	OUT_0x	xxVB-01	AUTO RECL ON/OFF STATUS	-	On	Off	-	OUTxx	cc		Control	XSWI1	Pos	stVal	No	DI	2	1	17, 28	1		
								OUTxx	cc							DI	2	1	17, 28	1		
6	OUT_0x	xxVB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	OUTxx	cc		Control	XSWI2	Pos	stVal	No	DI	2	1	17, 28	1		
								OUTxx	cc							DI	2	1	17, 28	1		
7	OUT_0x	xxVB-01	E/F RELAY ON/OFF STATUS	-	On	Off	-	OUTxx	xx.xx		Control	XSWI3	Pos	stVal	No	DI	2	1	17, 28	1		
								OUTxx	xx.xx							DI	2	1	17, 28	1		
8	OUT_0x	xxVB-01	O/C RELAY TIME PHASE A	Normal	Trip	-	-	OUTxx	cc		Protection	OcpPTOC1	ST	Op.phsA	No	SOE	2	2	17, 28	1		
9	OUT_0x	xxVB-01	O/C RELAY TIME PHASE B	Normal	Trip	-	-	OUTxx	cc		Protection	OcpPTOC1	ST	Op.phsB	No	SOE	2	2	17, 28	1		
10	OUT_0x	xxVB-01	O/C RELAY TIME PHASE C	Normal	Trip	-	-	OUTxx	cc		Protection	OcpPTOC1	ST	Op.phsC	No	SOE	2	2	17, 28	1		
11	OUT_0x	xxVB-01	E/F TIME RELAY	Normal	Trip	-	-	OUTxx	cc		Protection	EfmPTOC1	ST	Op.gerneral	No	SOE	2	2	17, 28	1		
12	OUT_0x	xxVB-01	O/C INSTANTANEOUS PHASE A	Normal	Trip	-	-	OUTxx	cc		Protection	OcpPTOC3	ST	Op.phsA	No	SOE	2	2	17, 28	1		
13	OUT_0x	xxVB-01	O/C INSTANTANEOUS PHASE B	Normal	Trip	-	-	OUTxx	cc		Protection	OcpPTOC3	ST	Op.phsB	No	SOE	2	2	17, 28	1		
14	OUT_0x	xxVB-01	O/C INSTANTANEOUS PHASE C	Normal	Trip	-	-	OUTxx	cc		Protection	OcpPTOC3	ST	Op.phsC	No	SOE	2	2	17, 28	1		
15	OUT_0x	xxVB-01	E/F INSTANTANEOUS RELAY	Normal	Trip	-	-	OUTxx	cc		Protection	EfmPTOC3	ST	Op.gerneral	No	SOE	2	2	17, 28	1		
16	OUT_0x	xxVB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	OUTxx	cc		Protection	CbfRBRF1	ST	OpEx.general	No	SOE	2	2	17, 28	1		
17	OUT_0x	xxVB-01	AUTO RECL OPERATE STATUS	Normal	Operate	-	-	OUTxx	cc		Control	ArcRREC1	ST	Op.gerneral	No	SOE	2	2	17, 28	1		
18	OUT_0x	xxVB-01	AUTO RECL LOCKOUT STATUS	Normal	Lockout	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind3.stVal	Yes	SOE	2	2	17, 28	1		
19	OUT_0x	xxVB-01	U/F RELAY STEP 1	Normal	Trip	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind4.stVal	Yes	SOE	2	2	17, 28	1		
20	OUT_0x	xxVB-01	U/F RELAY STEP 2	Normal	Trip	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind5.stVal	Yes	SOE	2	2	17, 28	1		
21	OUT_0x	xxVB-01	U/F RELAY STEP 3	Normal	Trip	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind6.stVal	Yes	SOE	2	2	17, 28	1		
22	OUT_0x	xxVB-01	U/F RELAY STEP 4	Normal	Trip	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind7.stVal	Yes	SOE	2	2	17, 28	1		
23	OUT_0x	xxVB-01	U/F RELAY STEP 5	Normal	Trip	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind8.stVal	Yes	SOE	2	2	17, 28	1		

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
24	OUT_0x	xxVB-01	U/F TRIP SELECTION	Normal	Off	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind9.stVal	Yes	DI	2	1	17, 28	1		
25	OUT_0x	xxVB-01	U/F TRIP SELECTION STEP 1	Normal	Step 1	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind10.stVal	Yes	DI	2	1	17, 28	1		
26	OUT_0x	xxVB-01	U/F TRIP SELECTION STEP 2	Normal	Step 2	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind11.stVal	Yes	DI	2	1	17, 28	1		
27	OUT_0x	xxVB-01	U/F TRIP SELECTION STEP 3	Normal	Step 3	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind12.stVal	Yes	DI	2	1	17, 28	1		
28	OUT_0x	xxVB-01	U/F TRIP SELECTION STEP 4	Normal	Step 4	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind13.stVal	Yes	DI	2	1	17, 28	1		
29	OUT_0x	xxVB-01	U/F TRIP SELECTION STEP 5	Normal	Step 5	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind14.stVal	Yes	DI	2	1	17, 28	1		
30	OUT_0x	xxVB-01	UNDER VOLTAGE	Normal	Alarm	-	-	OUTxx	cc		Protection	VtpPhsPTUV1	ST	Op.gerneral	No	DI	2	1	17, 28	1		
31	OUT_0x	xxVB-01	UNDER VOLTAGE	Normal	Trip	-	-	OUTxx	cc		Protection	VtpPhsPTUV2	ST	Op.gerneral	No	SOE	2	2	17, 28	1		
32	OUT_0x	xxVB-01	OVER VOLTAGE	Normal	Alarm	-	-	OUTxx	cc		Protection	VtpPhsPTOV1	ST	Op.gerneral	No	DI	2	1	17, 28	1		
33	OUT_0x	xxVB-01	OVER VOLTAGE	Normal	Trip	-	-	OUTxx	cc		Protection	VtpPhsPTOV2	ST	Op.gerneral	No	SOE	2	2	17, 28	1		
34	OUT_0x	xxVB-01	VT SUPERVISION	Normal	Alarm	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind15.stVal	Yes	DI	2	1	17, 28	1		
35	OUT_0x	xxVB-01	DC SUPPLY	Normal	Alarm	-	-	OUTxx	xx.xx		System	GosGGIO2	ST	Ind16.stVal	Yes	DI	2	1	17, 28	1		
36	OUT_0x	xxVB-01	AC SUPPLY	Normal	Alarm	-	-	OUTxx	xx.xx		System	GosGGIO2	ST	Ind17.stVal	Yes	DI	2	1	17, 28	1		
37	OUT_0x	xxVB-01	LV. CONNECTOR PULLED	Normal	Alarm	-	-	OUTxx	xx.xx		System	GosGGIO2	ST	Ind18.stVal	Yes	DI	2	1	17, 28	1		
38	OUT_0x	xxVB-01	SPRING CHARGE	Normal	Fail	-	-	OUTxx	xx.xx		System	GosGGIO2	ST	Ind19.stVal	Yes	DI	2	1	17, 28	1		
39	OUT_0x	xxVB-01	TRIP CCT. SUPERVISION	Normal	Fail	-	-	OUTxx	xx.xx		System	GosGGIO2	ST	Ind20.stVal	Yes	DI	2	1	17, 28	1		
40	OUT_0x	xxVB-01	PROTECTION RELAY DC FAIL	Normal	Alarm	-	-	OUTxx	xx.xx		System	GosGGIO2	ST	Ind21.stVal	Yes	DI	2	1	17, 28	1		
41	OUT_0x	xxVB-01	PROTECTION RELAY	Normal	Fail	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind22.stVal	Yes	DI	2	1	17, 28	1		
42	OUT_0x	xxVB-01	PROTECTION RELAY LAN A	Normal	Alarm	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind23.stVal	Yes	DI	2	1	17, 28	1		
43	OUT_0x	xxVB-01	PROTECTION RELAY LAN B	Normal	Alarm	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind24.stVal	Yes	DI	2	1	17, 28	1		
44	OUT_0x	xxVB-01	PROTECTION RELAY GOOSE ALARM	Normal	Alarm	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind25.stVal	Yes	DI	2	1	17, 28	1		
45	OUT_0x	xxVB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	OUTxx	cc		System	GosGGIO2	ST	Ind26.stVal	Yes	DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.1

I/O POINT COUNTS FOR

22 kV VACUUM CB INDOOR TYPE METAL-CLAD SWITCHGEARS, SINGLE BUS CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	22kV	Bay Name :	22kV Bus Section		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	BS_01	0BVB-01	CLOSE/OPEN COMMAND	Close	Open	DCP	BS01	xx.xx							SBO	12	1	echo of request			
2	BS_01	0BVB-01	E/F ON/OFF COMMAND	On	Off	DCP	BS01	cc							SBO	12	1	echo of request			
3	BS_01	0BVB-01	50BF ON/OFF COMMAND	On	Off	DCP	BS01	xx.xx							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	BS_01	0BVB-01	CURRENT PHASE A	0-1800	0-32767	A	BS01	xx.xx							AI	32	2	00,01	2		1800/1A
2	BS_01	0BVB-01	CURRENT PHASE B	0-1800	0-32767	A	BS01	xx.xx							AI	32	2	00,01	2		1800/1A
3	BS_01	0BVB-01	CURRENT PHASE C	0-1800	0-32767	A	BS01	xx.xx							AI	32	2	00,01	2		1800/1A
4	BS_01	0BVB-01	ACTIVE POWER	-93.53 - +93.53	-32767 - +32767	MW	BS01	cc							AI	32	2	00,01	2		Calculation
5	BS_01	0BVB-01	RECATIVE POWER	-93.53 - +93.53	-32767 - +32767	Mvar	BS01	cc							AI	32	2	00,01	2		Calculation
6	BS_01	0BVB-01	POWER FACTOR	+/-100	-32767 - +32767	%	BS01	cc							AI	32	2	00,01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
1	BS_01	0BVB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BS01	xx.xx							SOE	2	2	17, 28	1		
								BS01	xx.xx							SOE	2	2	17, 28	1		
2	BS_01	0BVB-01	WITHDRAW UNIT STATION	Undefine	In Service	Out Service	Fault	BS01	xx.xx							DI	2	1	17, 28	1		
								BS01	xx.xx							DI	2	1	17, 28	1		
3	BS_01	0BVB-01	CONTROL SET MODE	Undefine	Local	Remote	Fault	BS01	xx.xx							DI	2	1	17, 28	1		
								BS01	xx.xx							DI	2	1	17, 28	1		
4	BS_01	0BVB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	BS01	cc							DI	2	1	17, 28	1		
								BS01	cc							DI	2	1	17, 28	1		
5	BS_01	0BVB-01	E/F RELAY ON/OFF STATUS	-	On	Off	-	BS01	cc							DI	2	1	17, 28	1		
								BS01	cc							DI	2	1	17, 28	1		
6	BS_01	0BVB-01	O/C RELAY TIME PHASE A	Normal	Trip	-	-	BS01	cc		Protection	OcpPTOC1	ST	Op.phsA	No	SOE	2	2	17, 28	1		
7	BS_01	0BVB-01	O/C RELAY TIME PHASE B	Normal	Trip	-	-	BS01	cc		Protection	OcpPTOC1	ST	Op.phsB	No	SOE	2	2	17, 28	1		
8	BS_01	0BVB-01	O/C RELAY TIME PHASE C	Normal	Trip	-	-	BS01	cc		Protection	OcpPTOC1	ST	Op.phsC	No	SOE	2	2	17, 28	1		
9	BS_01	0BVB-01	E/F TIME RELAY	Normal	Trip	-	-	BS01	cc		Protection	EfmPTOC1	ST	Op.gerneral	No	SOE	2	2	17, 28	1		
10	BS_01	0BVB-01	O/C INSTANTANEOUS PHASE A	Normal	Trip	-	-	BS01	cc		Protection	OcpPTOC3	ST	Op.phsA	No	SOE	2	2	17, 28	1		
11	BS_01	0BVB-01	O/C INSTANTANEOUS PHASE B	Normal	Trip	-	-	BS01	cc		Protection	OcpPTOC3	ST	Op.phsB	No	SOE	2	2	17, 28	1		
12	BS_01	0BVB-01	O/C INSTANTANEOUS PHASE C	Normal	Trip	-	-	BS01	cc		Protection	OcpPTOC3	ST	Op.phsC	No	SOE	2	2	17, 28	1		
13	BS_01	0BVB-01	E/F INSTANTANEOUS RELAY	Normal	Trip	-	-	BS01	cc		Protection	EfmPTOC3	ST	Op.gerneral	No	SOE	2	2	17, 28	1		
14	BS_01	0BVB-01	TIME DELAY FAIL (CB Fail)	Normal	Trip	-	-	BS01	cc							SOE	2	2	17, 28	1		
15	BS_01	0BVB-01	VT SUPERVISION	Normal	Alarm	-	-	BS01	cc							DI	2	1	17, 28	1		
16	BS_01	0BVB-01	DC MCB TRIP	Normal	Alarm	-	-	BS01	xx.xx							DI	2	1	17, 28	1		
17	BS_01	0BVB-01	AC MCB TRIP	Normal	Alarm	-	-	BS01	xx.xx							DI	2	1	17, 28	1		
18	BS_01	0BVB-01	LV. CONNECTOR PULLED	Normal	Alarm	-	-	BS01	xx.xx							DI	2	1	17, 28	1		
19	BS_01	0BVB-01	SPRING CHARGE	Normal	Fail	-	-	BS01	xx.xx							DI	2	1	17, 28	1		
20	BS_01	0BVB-01	TRIP CCT. SUPERVISION	Normal	Fail	-	-	BS01	xx.xx							DI	2	1	17, 28	1		
21	BS_01	0BVB-01	PROTECTION RELAY	Normal	Fail	-	-	BS01	cc							DI	2	1	17, 28	1		
22	BS_01	0BVB-01	PROTECTION RELAY LAN A	Normal	Alarm	-	-	BS01	cc							DI	2	1	17, 28	1		
23	BS_01	0BVB-01	PROTECTION RELAY LAN B	Normal	Alarm	-	-	BS01	cc							DI	2	1	17, 28	1		
24	BS_01	0BVB-01	PROTECTION RELAY GOOSE ALARM	Normal	Alarm	-	-	BS01	cc							DI	2	1	17, 28	1		
25	BS_01	0BVB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	BS01	cc							DI	2	1	17, 28	1		

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AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.1

I/O POINT COUNTS FOR

22kV VACUUM CB INDOOR TYPE METAL-CLAD SWITCHGEARS, SINGLE BUS CONFIGURATION

Substation Name :		Substation Code Name:		Substation DNP Adress :	
Voltage Level :	22kV	Bay Name :	22kV Bus VT		
IED Product :		IED Model/Type:			
IED IP Address :					

Analog Points:

Item	Feeder Name	Bay Name	Details			Unit	Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State				Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				1	2																
1	BUS_01	0BVP-01	VOLTAGE A-B	0-30	0-32768	kV	BUSVT01	xxxx							AI	32	2	00, 01	2		22000/110V
2	BUS_01	0BVP-01	VOLTAGE B-C	0-30	0-32768	kV	BUSVT01	xxxx							AI	32	2	00, 01	2		22000/110V
3	BUS_01	0BVP-01	VOLTAGE C-A	0-30	0-32768	kV	BUSVT01	xxxx							AI	32	2	00, 01	2		22000/110V

NOTE:-

xxxx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before "/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.1

I/O POINT COUNTS FOR

22kV VACUUM CB INDOOR TYPE METAL-CLAD SWITCHGEARS, SINGLE BUS CONFIGURATION

Substation Name :		Substation Code Name :	Substation DNP Adress :
Voltage Level :	22kV	Bay Name :	22kV Station Service Transformer No.xx
IED Product :		IED Model/Type :	
IED IP Address :			

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qti	Class	Address	Remark
1	TS_01	T1VS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	TS01	xx.xx							DI	2	1	17, 28	1		
								TS01	xx.xx							DI	2	1	17, 28	1		
2	TS_01	T1VG-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	TS01	xx.xx							DI	2	1	17, 28	1		
								TS01	xx.xx							DI	2	1	17, 28	1		
3	TS_01	T1VS-01	AC SUPPLY	Normal	Fail	-	-	TS01	xx.xx							DI	2	1	17, 28	1		
4	TS_01	T1VS-01	DC SUPPLY CB CONTROL CIRCUIT	Normal	Fail	-	-	TS01	xx.xx							DI	2	1	17, 28	1		
5	TS_01	T1VS-01	HRC FUSE	Normal	Alarm	-	-	TS01	xx.xx							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before "/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.1

I/O POINT COUNTS FOR

22kV VACUUM CB INDOOR TYPE METAL-CLAD SWITCHGEARS, SINGLE BUS CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	**22kV**	Bay Name :	**22kV Capacitor Bank Feeder No.xx**		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Detail: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	QI	Class	Address	Remark
1	CAP_01	1CVB-01	CLOSE/OPEN COMMAND	Close	Open	DCP	CAP01	xx.xx							SBO	12	1	echo of request		0	
2	CAP_01	1CVB-01	E/F ON/OFF COMMAND	On	Off	DCP	CAP01	cc							SBO	12	1	echo of request		1	
3	CAP_01	1CVB-01	50BF ON/OFF COMMAND	On	Off	DCP	OUT01	cc							SBO	12	1	echo of request		2	
4	CAP_01	1CVB-01	CAP SET ON COMMAND	Auto	Manual	DCP	CAP01	xx.xx							SBO	12	1	echo of request		3	
5	CAP_01	1CVB-01	CAP STEP 1 COMMAND	On	Off	DCP	CAP01	xx.xx							SBO	12	1	echo of request		4	
6	CAP_01	1CVB-01	CAP STEP 2 COMMAND	On	Off	DCP	CAP01	xx.xx							SBO	12	1	echo of request		5	
7	CAP_01	1CVB-01	CAP STEP 3 COMMAND	On	Off	DCP	CAP01	xx.xx							SBO	12	1	echo of request		6	

Analog Points:

Item	Feeder Name	Bay Name	Detail: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	QI	Class	Address	Remark
1	CAP_01	1CVB-01	CURRENT PHASE A	0-600	0-32767	A	CAP01	xx.xx							AI	32	2	00, 01	2		600/1A
2	CAP_01	1CVB-01	CURRENT PHASE B	0-600	0-32767	A	CAP01	xx.xx							AI	32	2	00, 01	2		600/1A
3	CAP_01	1CVB-01	CURRENT PHASE C	0-600	0-32767	A	CAP01	xx.xx							AI	32	2	00, 01	2		600/1A
7	CAP_01	1CVB-01	ACTIVE POWER	-31.18 - +31.18	-32767 - +32767	MW	CAP01	cc							AI	32	2	00, 01	2		Calculation
8	CAP_01	1CVB-01	RECATIVE POWER	-31.18 - +31.18	-32767 - +32767	Mvar	CAP01	cc							AI	32	2	00, 01	2		Calculation
9	CAP_01	1CVB-01	POWER FACTOR	+/- 100	-32767 - +32767	%	CAP01	cc							AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
1	CAP_01	1CVB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	CAP01	xx.xx							SOE	2	2	17, 28	1		
								CAP01	xx.xx							SOE	2	2	17, 28	1		
2	CAP_01	1CVG-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	CAP01	xx.xx							DI	2	1	17, 28	1		
								CAP01	xx.xx							DI	2	1	17, 28	1		
3	CAP_01	1CVB-01	WITHDRAW UNIT STATION	Undefine	In Service	Out Service	Fault	CAP01	xx.xx							DI	2	1	17, 28	1		
								CAP01	xx.xx							DI	2	1	17, 28	1		
4	CAP_01	1CVB-01	CONTROL SET MODE	Undefine	Local	Remote	Fault	CAP01	xx.xx							DI	2	1	17, 28	1		
								CAP01	xx.xx							DI	2	1	17, 28	1		
5	CAP_01	1CVB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	CAP01	cc							DI	2	1	17, 28	1		
								CAP01	cc							DI	2	1	17, 28	1		
6	CAP_01	1CVB-01	E/F RELAY ON/OFF STATUS	-	On	Off	-	CAP01	cc							DI	2	1	17, 28	1		
								CAP01	cc							DI	2	1	17, 28	1		
7	CAP_01	1CVB-01	CAP CONTROL SET MODE	Undefine	Local	Remote	Fault	CAP01	xx.xx							DI	2	1	17, 28	1		
								CAP01	xx.xx							DI	2	1	17, 28	1		
8	CAP_01	1CVB-01	CAP SET ON STATUS	Undefine	Auto	Manual	Fault	CAP01	xx.xx							DI	2	1	17, 28	1		
								CAP01	xx.xx							DI	2	1	17, 28	1		
9	CAP_01	1CVB-01	CAP STEP 1 ON/OFF STATUS	Undefine	On	Off	Fault	CAP01	xx.xx							DI	2	1	17, 28	1		
								CAP01	xx.xx							DI	2	1	17, 28	1		
10	CAP_01	1CVB-01	CAP STEP 2 ON/OFF STATUS	Undefine	On	Off	Fault	CAP01	xx.xx							DI	2	1	17, 28	1		
								CAP01	xx.xx							DI	2	1	17, 28	1		
11	CAP_01	1CVB-01	CAP STEP 3 ON/OFF STATUS	Undefine	On	Off	Fault	CAP01	xx.xx							DI	2	1	17, 28	1		
								CAP01	xx.xx							DI	2	1	17, 28	1		
12	CAP_01	1CVB-01	O/C RELAY TIME PHASE A	Normal	Trip	-	-	CAP01	cc		Protection	OcpPTOC1	ST	Op.phsA	No	SOE	2	2	17, 28	1		
13	CAP_01	1CVB-01	O/C RELAY TIME PHASE B	Normal	Trip	-	-	CAP01	cc		Protection	OcpPTOC1	ST	Op.phsB	No	SOE	2	2	17, 28	1		
14	CAP_01	1CVB-01	O/C RELAY TIME PHASE C	Normal	Trip	-	-	CAP01	cc		Protection	OcpPTOC1	ST	Op.phsC	No	SOE	2	2	17, 28	1		
15	CAP_01	1CVB-01	E/F TIME RELAY	Normal	Trip	-	-	CAP01	cc		Protection	EfmPTOC1	ST	Op.gerneral	No	SOE	2	2	17, 28	1		
16	CAP_01	1CVB-01	O/C INSTANTANEOUS PHASE A	Normal	Trip	-	-	CAP01	cc		Protection	OcpPTOC3	ST	Op.phsA	No	SOE	2	2	17, 28	1		
17	CAP_01	1CVB-01	O/C INSTANTANEOUS PHASE B	Normal	Trip	-	-	CAP01	cc		Protection	OcpPTOC3	ST	Op.phsB	No	SOE	2	2	17, 28	1		
18	CAP_01	1CVB-01	O/C INSTANTANEOUS PHASE C	Normal	Trip	-	-	CAP01	cc		Protection	OcpPTOC3	ST	Op.phsC	No	SOE	2	2	17, 28	1		
19	CAP_01	1CVB-01	E/F INSTANTANEOUS RELAY	Normal	Trip	-	-	CAP01	cc		Protection	EfmPTOC3	ST	Op.gerneral	No	SOE	2	2	17, 28	1		
20	CAP_01	1CVB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	CAP01	cc							SOE	2	2	17, 28	1		

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
21	CAP_01	1CVB-01	UNDER VOLTAGE	Normal	Alarm	-	-	CAP01	cc							DI	2	1	17, 28	1		
22	CAP_01	1CVB-01	OVER VOLTAGE	Normal	Alarm	-	-	CAP01	cc							DI	2	1	17, 28	1		
23	CAP_01	1CVB-01	VT SUPERVISION	Normal	Alarm	-	-	CAP01	cc							DI	2	1	17, 28	1		
24	CAP_01	1CVB-01	DC MCB TRIP	Normal	Alarm	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
25	CAP_01	1CVB-01	AC MCB TRIP	Normal	Alarm	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
26	CAP_01	1CVB-01	LV. CONNECTOR PULLED	Normal	Alarm	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
27	CAP_01	1CVB-01	SPRING CHARGE	Normal	Fail	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
28	CAP_01	1CVB-01	TRIP CCT. SUPERVISION	Normal	Fail	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
29	CAP_01	1CVB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	CAP01	xx.xx		System	GosGGIO2	ST	Ind22.stVal	Yes	DI	2	1	17, 28	1		
30	CAP_01	1CVB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	CAP01	xx.xx		System	GosGGIO2	ST	Ind23.stVal	Yes	SOE	2	2	17, 28	1		
31	CAP_01	1CVB-01	PROTECTION RELAY	Normal	Fail	-	-	CAP01	cc							DI	2	1	17, 28	1		
32	CAP_01	1CVB-01	PROTECTION RELAY LAN A	Normal	Alarm	-	-	CAP01	cc							DI	2	1	17, 28	1		
33	CAP_01	1CVB-01	PROTECTION RELAY LAN B	Normal	Alarm	-	-	CAP01	cc							DI	2	1	17, 28	1		
34	CAP_01	1CVB-01	PROTECTION RELAY GOOSE ALARM	Normal	Alarm	-	-	CAP01	cc							DI	2	1	17, 28	1		
35	CAP_01	1CVB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	CAP01	cc							DI	2	1	17, 28	1		
36	CAP_01	1CVB-01	CAP STEP 1 DC SUPPLY	Normal	Fail	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
37	CAP_01	1CVB-01	CAP STEP 2 DC SUPPLY	Normal	Fail	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
38	CAP_01	1CVB-01	CAP STEP 3 DC SUPPLY	Normal	Fail	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
39	CAP_01	1CVB-01	CAP STEP 1 UNBALANCE	Normal	Operated	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
40	CAP_01	1CVB-01	CAP STEP 2 UNBALANCE	Normal	Operated	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
41	CAP_01	1CVB-01	CAP STEP 3 UNBALANCE	Normal	Operated	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
42	CAP_01	1CVB-01	CAP STEP 1 OVERVOLTAGE RELAY	Normal	Trip	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
43	CAP_01	1CVB-01	CAP STEP 2 OVERVOLTAGE RELAY	Normal	Trip	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
44	CAP_01	1CVB-01	CAP STEP 3 OVERVOLTAGE RELAY	Normal	Trip	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
45	CAP_01	1CVB-01	INTERNAL FAULT OF VCB 1	Normal	Operated	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
46	CAP_01	1CVB-01	INTERNAL FAULT OF VCB 2	Normal	Operated	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		
47	CAP_01	1CVB-01	INTERNAL FAULT OF VCB 3	Normal	Operated	-	-	CAP01	xx.xx							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

TABLE A4-1.2

I/O POINT COUNTS FOR

22 OR 33 kV GIS

Substation Name :		Substation Code Name :	Substation DNP Adress :
Voltage Level :	22kV	Bay Name :	22kV Incoming Feeder No.xx
IED Product :		IED Model/Type :	
IED IP Address :			

Control Outputs:-

Item	Feeder Name	Bay Name	Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	IEC 61850 Logical Node	IEC 61850 Data Object	IEC 61850 Data Attribute	IEC 61850 Logic	DMS (DNP Mapping) Type	DMS (DNP Mapping) Obj	DMS (DNP Mapping) Var	DMS (DNP Mapping) Qii	DMS (DNP Mapping) Class	DMS (DNP Mapping) Address	Remark
1	INC_01	1BVB-01	CLOSE/OPEN COMMAND	Close	Open	DCP	INC01	xx.xx							SBO	12	1	echo of request			
2	INC_01	1BVB-01	50BF ON/OFF COMMAND	On	Off	DCP	INC01	cc							SBO	12	1	echo of request			
3	INC_01	1BVB-01	E/F ON/OFF COMMAND	On	Off	DCP	INC01	cc		Control	XSWI2	Pos	ctlVal		SBO	12	1	echo of request			
4	INC_01	1BVB-01	50BF ON/OFF COMMAND	On	Off	DCP	INC01	cc		Control	XSWI3	Pos	ctlVal		SBO	12	1	echo of request			
5	INC_01	1BVB-01	U/F RELAY OFF COMMAND	Off	-	SCP	INC01	cc		System	PloGGIO1/SPCSO	Pos	ctlVal		DOP	12	1	echo of request			
6	INC_01	1BVB-01	U/F RELAY STEP 1 ON COMMAND	On	-	SCP	INC01	cc		System	PloGGIO1/SPCSO	Pos	ctlVal		DOP	12	1	echo of request			
6	INC_01	1BVB-01	U/F RELAY STEP 2 ON COMMAND	On	-	SCP	INC01	cc		System	PloGGIO1/SPCSO	Pos	ctlVal		DOP	12	1	echo of request			
7	INC_01	1BVB-01	U/F RELAY STEP 3 ON COMMAND	On	-	SCP	INC01	cc		System	PloGGIO1/SPCSO	Pos	ctlVal		DOP	12	1	echo of request			
8	INC_01	1BVB-01	U/F RELAY STEP 4 ON COMMAND	On	-	SCP	INC01	cc		System	PloGGIO1/SPCSO	Pos	ctlVal		DOP	12	1	echo of request			
9	INC_01	1BVB-01	U/F RELAY STEP 5 ON COMMAND	On	-	SCP	INC01	cc		System	PloGGIO1/SPCSO	Pos	ctlVal		DOP	12	1	echo of request			

Analog Points:-

Item	Feeder Name	Bay Name	Details: Point Name	Details: State 1	Details: State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	IEC 61850 Logical Node	IEC 61850 Data Object	IEC 61850 Data Attribute	IEC 61850 Logic	DMS (DNP Mapping) Type	DMS (DNP Mapping) Obj	DMS (DNP Mapping) Var	DMS (DNP Mapping) Qii	DMS (DNP Mapping) Class	DMS (DNP Mapping) Address	Remark
1	INC_01	1BVB-01	CURRENT PHASE A	0-1800	0-32767	A	INC01	xx.xx							AI	32	2	00,01	2		1800/1A
2	INC_01	1BVB-01	CURRENT PHASE B	0-1800	0-32767	A	INC01	xx.xx							AI	32	2	00,01	2		1800/1A
3	INC_01	1BVB-01	CURRENT PHASE C	0-1800	0-32767	A	INC01	xx.xx							AI	32	2	00,01	2		1800/1A
4	INC_01	1BVB-01	VOLTAGE A-B	0-30	0-32768	kV	INC01	xx.xx							AI	32	2	00,01	2		22000/110V
5	INC_01	1BVB-01	VOLTAGE B-C	0-30	0-32768	kV	INC01	xx.xx							AI	32	2	00,01	2		22000/110V
6	INC_01	1BVB-01	VOLTAGE C-A	0-30	0-32768	kV	INC01	xx.xx							AI	32	2	00,01	2		22000/110V
7	INC_01	1BVB-01	ACTIVE POWER	-93.53 - +93.53	-32767 - +32767	MW	INC01	cc							AI	32	2	00,01	2		Calculation
8	INC_01	1BVB-01	RECATIVE POWER	-93.53 - +93.53	-32767 - +32767	Mvar	INC01	cc							AI	32	2	00,01	2		Calculation
9	INC_01	1BVB-01	POWER FACTOR	+/- 100	-32767 - +32767	%	INC01	cc							AI	32	2	00,01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)					
			Point Name	State					Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address
				0	1	2	3														
1	INC_01	1BVB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	INC01	xx.xx							SOE	2	2	17, 28	1	0
								INC01	xx.xx							SOE	2	2	17, 28	1	
2	INC_01	1BVG-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	INC01	xx.xx							DI	2	1	17, 28	1	
								INC01	xx.xx							DI	2	1	17, 28	1	
3	INC_01	1BVS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	INC01	xx.xx							DI	2	1	17, 28	1	
								INC01	xx.xx							DI	2	1	17, 28	1	
4	INC_01	1BVB-01	CONTROL SET MODE	Undefine	Local	Remote	Fault	INC01	xx.xx							DI	2	1	17, 28	1	
								INC01	xx.xx							DI	2	1	17, 28	1	
5	INC_01	1BVB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	INC01	cc							DI	2	1	17, 28	1	
								INC01	cc							DI	2	1	17, 28	1	
6	INC_01	1BVB-01	E/F RELAY ON/OFF STATUS	-	On	Off	-	INC01	cc							DI	2	1	17, 28	1	
								INC01	cc							DI	2	1	17, 28	1	
7	INC_01	1BVB-01	O/C RELAY TIME PHASE A	Normal	Trip	-	-	INC01	cc		Protection	OcpPTOC1	ST	Op.phsA	No	SOE	2	2	17, 28	1	
8	INC_01	1BVB-01	O/C RELAY TIME PHASE B	Normal	Trip	-	-	INC01	cc		Protection	OcpPTOC1	ST	Op.phsB	No	SOE	2	2	17, 28	1	
9	INC_01	1BVB-01	O/C RELAY TIME PHASE C	Normal	Trip	-	-	INC01	cc		Protection	OcpPTOC1	ST	Op.phsC	No	SOE	2	2	17, 28	1	
10	INC_01	1BVB-01	E/F TIME RELAY	Normal	Trip	-	-	INC01	cc		Protection	EfmPTOC1	ST	Op.gerneral	No	SOE	2	2	17, 28	1	
11	INC_01	1BVB-01	O/C INSTANTANEOUS PHASE A	Normal	Trip	-	-	INC01	cc		Protection	OcpPTOC3	ST	Op.phsA	No	SOE	2	2	17, 28	1	
12	INC_01	1BVB-01	O/C INSTANTANEOUS PHASE B	Normal	Trip	-	-	INC01	cc		Protection	OcpPTOC3	ST	Op.phsB	No	SOE	2	2	17, 28	1	
13	INC_01	1BVB-01	O/C INSTANTANEOUS PHASE C	Normal	Trip	-	-	INC01	cc		Protection	OcpPTOC3	ST	Op.phsC	No	SOE	2	2	17, 28	1	
14	INC_01	1BVB-01	E/F INSTANTANEOUS RELAY	Normal	Trip	-	-	INC01	cc		Protection	EfmPTOC3	ST	Op.gerneral	No	SOE	2	2	17, 28	1	
15	INC_01	1BVB-01	TIME DELAY FAIL (CB FAILI)	Normal	Trip	-	-	INC01	cc		Protection	CbfRBRF1	ST	OpEx.general	No	SOE	2	2	17, 28	1	
16	INC_01	1BVB-01	U/F RELAY STEP 1	Normal	Trip	-	-	INC01	cc		System	GosGGIO2	ST	Ind4.stVal	Yes	SOE	2	2	17, 28	1	
17	INC_01	1BVB-01	U/F RELAY STEP 2	Normal	Trip	-	-	INC01	cc		System	GosGGIO2	ST	Ind5.stVal	Yes	SOE	2	2	17, 28	1	
18	INC_01	1BVB-01	U/F RELAY STEP 3	Normal	Trip	-	-	INC01	cc		System	GosGGIO2	ST	Ind6.stVal	Yes	SOE	2	2	17, 28	1	
19	INC_01	1BVB-01	U/F RELAY STEP 4	Normal	Trip	-	-	INC01	cc		System	GosGGIO2	ST	Ind7.stVal	Yes	SOE	2	2	17, 28	1	
20	INC_01	1BVB-01	U/F RELAY STEP 5	Normal	Trip	-	-	INC01	cc		System	GosGGIO2	ST	Ind8.stVal	Yes	SOE	2	2	17, 28	1	

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)					
			Point Name	State					Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address
				0	1	2	3														
21	INC_01	1BVB-01	U/F TRIP SELECTION	Normal	Off	-	-	INC01	cc		System	GosGGIO2	ST	Ind9.stVal	Yes	DI	2	1	17, 28	1	
22	INC_01	1BVB-01	U/F TRIP SELECTION STEP 1	Normal	Step 1	-	-	INC01	cc		System	GosGGIO2	ST	Ind10.stVal	Yes	DI	2	1	17, 28	1	
23	INC_01	1BVB-01	U/F TRIP SELECTION STEP 2	Normal	Step 2	-	-	INC01	cc		System	GosGGIO2	ST	Ind11.stVal	Yes	DI	2	1	17, 28	1	
24	INC_01	1BVB-01	U/F TRIP SELECTION STEP 3	Normal	Step 3	-	-	INC01	cc		System	GosGGIO2	ST	Ind12.stVal	Yes	DI	2	1	17, 28	1	
25	INC_01	1BVB-01	U/F TRIP SELECTION STEP 4	Normal	Step 4	-	-	INC01	cc		System	GosGGIO2	ST	Ind13.stVal	Yes	DI	2	1	17, 28	1	
26	INC_01	1BVB-01	U/F TRIP SELECTION STEP 5	Normal	Step 5	-	-	INC01	cc		System	GosGGIO2	ST	Ind14.stVal	Yes	DI	2	1	17, 28	1	
27	INC_01	1BVB-01	ARC DETECTION SYSTEM	Normal	Operated	-	-	INC01	cc		System	GosGGIO2	ST	Ind15.stVal	Yes	DI	2	1	17, 28	1	
28	INC_01	1BVB-01	UNDER VOLTAGE	Normal	Alarm	-	-	INC01	cc		System	GosGGIO2	ST	Ind14.stVal	Yes	DI	2	1	17, 28	1	
29	INC_01	1BVB-01	OVER VOLTAGE	Normal	Alarm	-	-	INC01	cc		System	GosGGIO2	ST	Ind16.stVal	Yes	DI	2	1	17, 28	1	
30	INC_01	1BVB-01	VT SUPERVISION	Normal	Alarm	-	-	INC01	xx.xx		System	GosGGIO2	ST	Ind16.stVal	Yes	DI	2	1	17, 28	1	
31	INC_01	1BVB-01	DC SUPPLY	Normal	Alarm	-	-	INC01	xx.xx		System	GosGGIO2	ST	Ind17.stVal	Yes	DI	2	1	17, 28	1	
32	INC_01	1BVB-01	AC SUPPLY	Normal	Alarm	-	-	INC01	xx.xx		System	GosGGIO2	ST	Ind18stVal	Yes	DI	2	1	17, 28	1	
33	INC_01	1BVB-01	LV. CONNECTOR PULLED	Normal	Alarm	-	-	INC01	xx.xx		System	GosGGIO2	ST	Ind19.stVal	Yes	DI	2	1	17, 28	1	
34	INC_01	1BVB-01	SPRING CHARGE	Normal	Fail	-	-	INC01	xx.xx		System	GosGGIO2	ST	Ind20.stVal	Yes	DI	2	1	17, 28	1	
35	INC_01	1BVB-01	TRIP CCT. SUPERVISION	Normal	Fail	-	-	INC01	xx.xx		System	GosGGIO2	ST	Ind21.stVal	Yes	DI	2	1	17, 28	1	
36	INC_01	1BVB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	INC01	xx.xx		System	GosGGIO2	ST	Ind22.stVal	Yes	DI	2	1	17, 28	1	
37	INC_01	1BVB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	INC01	xx.xx		System	GosGGIO2	ST	Ind23.stVal	Yes	SOE	2	2	17, 28	1	
38	INC_01	1BVB-01	PROTECTION RELAY	Normal	Fail	-	-	INC01	cc							DI	2	1	17, 28	1	
39	INC_01	1BVB-01	PROTECTION RELAY LAN A	Normal	Alarm	-	-	INC01	cc							DI	2	1	17, 28	1	
40	INC_01	1BVB-01	PROTECTION RELAY LAN B	Normal	Alarm	-	-	INC01	cc							DI	2	1	17, 28	1	
41	INC_01	1BVB-01	PROTECTION RELAY GOOSE ALARM	Normal	Alarm	-	-	INC01	cc							DI	2	1	17, 28	1	
42	INC_01	1BVB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	INC01	cc							DI	2	1	17, 28	1	

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-12
I/O POINT COUNTS FOR
22 OR 33 kV GIS

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	22kV	Bay Name :	22kV Outgoing Feeder No.xx		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
1	OUT_01	01VB-01	CLOSE/OPEN COMMAND	Close	Open	DPC	OUT01	xx.xx		Control	XCBR1	Pos	ctlVal		SBO	12	1	echo of request			
2	OUT_01	01VB-01	A/R ON/OFF COMMAND	On	Off	DCP	OUT01	cc		Control	XSWI1	Pos	ctlVal		SBO	12	1	echo of request			
3	OUT_01	01VB-01	E/F ON/OFF COMMAND	On	Off	DCP	OUT01	cc		Control	XSWI2	Pos	ctlVal		SBO	12	1	echo of request			
4	OUT_01	01VB-01	SEF ON/OFF COMMAND	On	Off	DCP	OUT01	cc		Control	XSWI3	Pos	ctlVal		SBO	12	1	echo of request			
5	OUT_01	01VB-01	U/F RELAY OFF COMMAND	OFF	-	SCP	OUT01	cc		System	PloGGIO1/SPCSO1	Pos	ctlVal		DOP	12	1	echo of request			
5	OUT_01	01VB-01	U/F RELAY STEP 1 ON COMMAND	On	-	SCP	OUT01	cc		System	PloGGIO1/SPCSO2	Pos	ctlVal		DOP	12	1	echo of request			
6	OUT_01	01VB-01	U/F RELAY STEP 2 ON COMMAND	On	-	SCP	OUT01	cc		System	PloGGIO1/SPCSO3	Pos	ctlVal		DOP	12	1	echo of request			
7	OUT_01	01VB-01	U/F RELAY STEP 3 ON COMMAND	On	-	SCP	OUT01	cc		System	PloGGIO1/SPCSO4	Pos	ctlVal		DOP	12	1	echo of request			
8	OUT_01	01VB-01	U/F RELAY STEP 4 ON COMMAND	On	-	SCP	OUT01	cc		System	PloGGIO1/SPCSO5	Pos	ctlVal		DOP	12	1	echo of request			
9	OUT_01	01VB-01	U/F RELAY STEP 5 ON COMMAND	On	-	SCP	OUT01	cc		System	PloGGIO1/SPCSO6	Pos	ctlVal		DOP	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
1	OUT_01	01VB-01	CURRENT PHASE A	0-600	0-32767	A	OUT01	xx.xx		Measurements	MMXU1/A1/phaA	MX	cVal		AI	32	2	00, 01	2		600/1A
2	OUT_01	01VB-01	CURRENT PHASE B	0-600	0-32767	A	OUT01	xx.xx		Measurements	MMXU1/A1/phaB	MX	cVal		AI	32	2	00, 01	2		600/1A
3	OUT_01	01VB-01	CURRENT PHASE C	0-600	0-32767	A	OUT01	xx.xx		Measurements	MMXU1/A1/phaC	MX	cVal		AI	32	2	00, 01	2		600/1A
4	OUT_01	01VB-01	ACTIVE POWER	-31.18 - +31.18	-32767 - +32767	MW	OUT01	cc		Measurements	MMXU1/AI/TotW	MX	cVal		AI	32	2	00, 01	2		Calculation
5	OUT_01	01VB-01	RECATIVE POWER	-31.18 - +31.18	-32767 - +32767	Mvar	OUT01	cc		Measurements	MMXU1/AI/TotVAr	MX	cVal		AI	32	2	00, 01	2		Calculation
6	OUT_01	01VB-01	POWER FACTOR	+/- 100	-32767 - +32767	%	OUT01	cc		Measurements	MMXU1/AI/TotPF	MX	cVal		AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)					
			Point Name	State					Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address
				0	1	2	3														
1	OUT_01	01VB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	OUT01	xx.xx		Control	XCBR1	Pos	stVal	No	SOE	2	2	17, 28	1	
								OUT01	xx.xx							SOE	2	2	17, 28	1	
2	OUT_01	01VG-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	OUT01	xx.xx		Control	XSWI5	Pos	stVal	No	DI	2	1	17, 28	1	
								OUT01	xx.xx							DI	2	1	17, 28	1	
3	OUT_01	01VS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	OUT01	xx.xx		Control	XSWI5	Pos	stVal	No	DI	2	1	17, 28	1	
								OUT01	xx.xx							DI	2	1	17, 28	1	
4	OUT_01	01VB-01	CONTROL SET MODE	Undefine	Local	Remote	Fault	OUT01	xx.xx		Control	XSWI6	Pos	stVal	No	DI	2	1	17, 28	1	
								OUT01	xx.xx							DI	2	1	17, 28	1	
5	OUT_01	01VB-01	AUTO RECL ON/OFF STATUS	-	On	Off	-	OUT01	cc		Control	XSWI1	Pos	stVal	No	DI	2	1	17, 28	1	
								OUT01	cc							DI	2	1	17, 28	1	
6	OUT_01	01VB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	OUT01	cc		Control	XSWI2	Pos	stVal	No	DI	2	1	17, 28	1	
								OUT01	cc							DI	2	1	17, 28	1	
7	OUT_01	01VB-01	E/F RELAY ON/OFF STATUS	-	On	Off	-	OUT01	xx.xx		Control	XSWI3	Pos	stVal	No	DI	2	1	17, 28	1	
								OUT01	xx.xx							DI	2	1	17, 28	1	
8	OUT_01	01VB-01	O/C RELAY TIME PHASE A	Normal	Trip	-	-	OUT01	cc		Protection	OcpPTOC1	ST	Op.phsA	No	SOE	2	2	17, 28	1	
9	OUT_01	01VB-01	O/C RELAY TIME PHASE B	Normal	Trip	-	-	OUT01	cc		Protection	OcpPTOC1	ST	Op.phsB	No	SOE	2	2	17, 28	1	
10	OUT_01	01VB-01	O/C RELAY TIME PHASE C	Normal	Trip	-	-	OUT01	cc		Protection	OcpPTOC1	ST	Op.phsC	No	SOE	2	2	17, 28	1	
11	OUT_01	01VB-01	E/F TIME RELAY	Normal	Trip	-	-	OUT01	cc		Protection	EfmPTOC1	ST	Op.gerneral	No	SOE	2	2	17, 28	1	
12	OUT_01	01VB-01	O/C INSTANTANEOUS PHASE A	Normal	Trip	-	-	OUT01	cc		Protection	OcpPTOC3	ST	Op.phsA	No	SOE	2	2	17, 28	1	
13	OUT_01	01VB-01	O/C INSTANTANEOUS PHASE B	Normal	Trip	-	-	OUT01	cc		Protection	OcpPTOC3	ST	Op.phsB	No	SOE	2	2	17, 28	1	
14	OUT_01	01VB-01	O/C INSTANTANEOUS PHASE C	Normal	Trip	-	-	OUT01	cc		Protection	OcpPTOC3	ST	Op.phsC	No	SOE	2	2	17, 28	1	
15	OUT_01	01VB-01	E/F INSTANTANEOUS RELAY	Normal	Trip	-	-	OUT01	cc		Protection	EfmPTOC3	ST	Op.gerneral	No	SOE	2	2	17, 28	1	
16	OUT_01	01VB-01	TIME DELAY FAIL (CB FAILI)	Normal	Trip	-	-	OUT01	cc		Protection	CbfRBRF1	ST	OpEx.general	No	SOE	2	2	17, 28	1	
17	OUT_01	01VB-01	AUTO RECL OPERATE STATUS	Normal	Operate	-	-	OUT01	cc		Control	ArcRREC1	ST	Op.gerneral	No	SOE	2	2	17, 28	1	
18	OUT_01	01VB-01	AUTO RECL LOCKOUT STATUS	Normal	Lockout	-	-	OUT01	cc		System	GosGGIO2	ST	Ind3.stVal	Yes	SOE	2	2	17, 28	1	
19	OUT_01	01VB-01	U/F RELAY STEP 1	Normal	Trip	-	-	OUT01	cc		System	GosGGIO2	ST	Ind4.stVal	Yes	SOE	2	2	17, 28	1	
20	OUT_01	01VB-01	U/F RELAY STEP 2	Normal	Trip	-	-	OUT01	cc		System	GosGGIO2	ST	Ind5.stVal	Yes	SOE	2	2	17, 28	1	
21	OUT_01	01VB-01	U/F RELAY STEP 3	Normal	Trip	-	-	OUT01	cc		System	GosGGIO2	ST	Ind6.stVal	Yes	SOE	2	2	17, 28	1	
22	OUT_01	01VB-01	U/F RELAY STEP 4	Normal	Trip	-	-	OUT01	cc		System	GosGGIO2	ST	Ind7.stVal	Yes	SOE	2	2	17, 28	1	
23	OUT_01	01VB-01	U/F RELAY STEP 5	Normal	Trip	-	-	OUT01	cc		System	GosGGIO2	ST	Ind8.stVal	Yes	SOE	2	2	17, 28	1	

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State					Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
24	OUT_01	01VB-01	U/F TRIP SELECTION	Normal	Off	-	-	OUT01	cc		System	GosGGIO2	ST	Ind9.stVal	Yes	DI	2	1	17, 28	1		
25	OUT_01	01VB-01	U/F TRIP SELECTION STEP 1	Normal	Step 1	-	-	OUT01	cc		System	GosGGIO2	ST	Ind10.stVal	Yes	DI	2	1	17, 28	1		
26	OUT_01	01VB-01	U/F TRIP SELECTION STEP 2	Normal	Step 2	-	-	OUT01	cc		System	GosGGIO2	ST	Ind11.stVal	Yes	DI	2	1	17, 28	1		
27	OUT_01	01VB-01	U/F TRIP SELECTION STEP 3	Normal	Step 3	-	-	OUT01	cc		System	GosGGIO2	ST	Ind12.stVal	Yes	DI	2	1	17, 28	1		
28	OUT_01	01VB-01	U/F TRIP SELECTION STEP 4	Normal	Step 4	-	-	OUT01	cc		System	GosGGIO2	ST	Ind13.stVal	Yes	DI	2	1	17, 28	1		
29	OUT_01	01VB-01	U/F TRIP SELECTION STEP 5	Normal	Step 5	-	-	OUT01	cc		System	GosGGIO2	ST	Ind14.stVal	Yes	DI	2	1	17, 28	1		
30	OUT_01	01VB-01	UNDER VOLTAGE	Normal	Alarm	-	-	OUT01	cc		Protection	VtpPhsPTUV1	ST	Op.gerneral	No	DI	2	1	17, 28	1		
31	OUT_01	01VB-01	UNDER VOLTAGE	Normal	Trip	-	-	OUT01	cc		Protection	VtpPhsPTUV2	ST	Op.gerneral	No	SOE	2	2	17, 28	1		
32	OUT_01	01VB-01	OVER VOLTAGE	Normal	Alarm	-	-	OUT01	cc		Protection	VtpPhsPTOV1	ST	Op.gerneral	No	DI	2	1	17, 28	1		
33	OUT_01	01VB-01	OVER VOLTAGE	Normal	Trip	-	-	OUT01	cc		Protection	VtpPhsPTOV2	ST	Op.gerneral	No	SOE	2	2	17, 28	1		
34	OUT_01	01VB-01	VT SUPERVISION	Normal	Alarm	-	-	OUT01	cc		System	GosGGIO2	ST	Ind15.stVal	Yes	DI	2	1	17, 28	1		
35	OUT_01	01VB-01	DC SUPPLY	Normal	Alarm	-	-	OUT01	xx.xx		System	GosGGIO2	ST	Ind16.stVal	Yes	DI	2	1	17, 28	1		
36	OUT_01	01VB-01	AC SUPPLY	Normal	Alarm	-	-	OUT01	xx.xx		System	GosGGIO2	ST	Ind17.stVal	Yes	DI	2	1	17, 28	1		
37	OUT_01	01VB-01	LV. CONNECTOR PULLED	Normal	Alarm	-	-	OUT01	xx.xx		System	GosGGIO2	ST	Ind18.stVal	Yes	DI	2	1	17, 28	1		
38	OUT_01	01VB-01	SPRING CHARGE	Normal	Fail	-	-	OUT01	xx.xx		System	GosGGIO2	ST	Ind19.stVal	Yes	DI	2	1	17, 28	1		
39	OUT_01	01VB-01	TRIP CCT. SUPERVISION	Normal	Fail	-	-	OUT01	xx.xx		System	GosGGIO2	ST	Ind20.stVal	Yes	DI	2	1	17, 28	1		
40	OUT_01	01VB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	OUT01	xx.xx		System	GosGGIO2	ST	Ind22.stVal	Yes	DI	2	1	17, 28	1		
41	OUT_01	01VB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	OUT01	xx.xx		System	GosGGIO2	ST	Ind23.stVal	Yes	SOE	2	2	17, 28	1		
42	OUT_01	01VB-01	PROTECTION RELAY	Normal	Fail	-	-	OUT01	cc		System	GosGGIO2	ST	Ind21.stVal	Yes	DI	2	1	17, 28	1		
43	OUT_01	01VB-01	PROTECTION RELAY LAN A	Normal	Alarm	-	-	OUT01	cc		System	GosGGIO2	ST	Ind22.stVal	Yes	DI	2	1	17, 28	1		
44	OUT_01	01VB-01	PROTECTION RELAY LAN B	Normal	Alarm	-	-	OUT01	cc		System	GosGGIO2	ST	Ind23.stVal	Yes	DI	2	1	17, 28	1		
45	OUT_01	01VB-01	PROTECTION RELAY GOOSE ALARM	Normal	Alarm	-	-	OUT01	cc		System	GosGGIO2	ST	Ind24.stVal	Yes	DI	2	1	17, 28	1		
46	OUT_01	01VB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	OUT01	cc		System	GosGGIO2	ST	Ind25.stVal	Yes	DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.2

I/O POINT COUNTS FOR

22 OR 33 kV GIS

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	22kV	Bay Name :	22kV Bus Section		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	Details: State 1	Details: State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	IEC 61850: Logical Node	IEC 61850: Data Object	IEC 61850: Data Attribute	IEC 61850: Logic	DMS (DNP Mapping): Type	DMS (DNP Mapping): Obj	DMS (DNP Mapping): Var	DMS (DNP Mapping): Qii	DMS (DNP Mapping): Class	DMS (DNP Mapping): Address	Remark
1	BS_01	0BVB-01	CLOSE/OPEN COMMAND	Close	Open	DCP	BS01	xx.xx							SBO	12	1	echo of request			
2	BS_01	0BVB-01	E/F ON/OFF COMMAND	On	Off	DCP	BS01	cc							SBO	12	1	echo of request			
3	BS_01	0BVB-01	50BF ON/OFF COMMAND	On	Off	DCP	BS01	xx.xx							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	Details: State 1	Details: State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	IEC 61850: Logical Node	IEC 61850: Data Object	IEC 61850: Data Attribute	IEC 61850: Logic	DMS (DNP Mapping): Type	DMS (DNP Mapping): Obj	DMS (DNP Mapping): Var	DMS (DNP Mapping): Qii	DMS (DNP Mapping): Class	DMS (DNP Mapping): Address	Remark
1	BS_01	0BVB-01	CURRENT PHASE A	0-1800	0-32767	A	BS01	xx.xx							AI	32	2	00, 01	2		1800/1A
2	BS_01	0BVB-01	CURRENT PHASE B	0-1800	0-32767	A	BS01	xx.xx							AI	32	2	00, 01	2		1800/1A
3	BS_01	0BVB-01	CURRENT PHASE C	0-1800	0-32767	A	BS01	xx.xx							AI	32	2	00, 01	2		1800/1A
4	BS_01	0BVB-01	ACTIVE POWER	-93.53 - +93.53	-32767 - +32767	MW	BS01	cc							AI	32	2	00, 01	2		Calculation
5	BS_01	0BVB-01	RECATIVE POWER	-93.53 - +93.53	-32767 - +32767	Mvar	BS01	cc							AI	32	2	00, 01	2		Calculation
6	BS_01	0BVB-01	POWER FACTOR	+/- 100	-32767 - +32767	%	BS01	cc							AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	BS_01	0BVB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BS01	xx.xx							SOE	2	2	17, 28	1		
								BS01	xx.xx							SOE	2	2	17, 28	1		
2	BS_01	0BVS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BS01	xx.xx							DI	2	1	17, 28	1		
								BS01	xx.xx							DI	2	1	17, 28	1		
3	BS_01	0BVS-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BS01	xx.xx							DI	2	1	17, 28	1		
								BS01	xx.xx							DI	2	1	17, 28	1		
4	BS_01	0BVS-03	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BS01	xx.xx							DI	2	1	17, 28	1		
								BS01	xx.xx							DI	2	1	17, 28	1		
5	BS_01	0BVS-04	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BS01	xx.xx							DI	2	1	17, 28	1		
								BS01	xx.xx							DI	2	1	17, 28	1		
6	BS_01	0BVG-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BS01	xx.xx							DI	2	1	17, 28	1		
								BS01	xx.xx							DI	2	1	17, 28	1		
7	BS_01	0BVG-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BS01	xx.xx							DI	2	1	17, 28	1		
								BS01	xx.xx							DI	2	1	17, 28	1		
8	BS_01	0BVG-03	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BS01	xx.xx							DI	2	1	17, 28	1		
								BS01	xx.xx							DI	2	1	17, 28	1		
9	BS_01	0BVG-04	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BS01	xx.xx							DI	2	1	17, 28	1		
								BS01	xx.xx							DI	2	1	17, 28	1		
10	BS_01	0BVB-01	CONTROL SET MODE	Undefine	Local	Remote	Fault	BS01	xx.xx							DI	2	1	17, 28	1		
								BS01	xx.xx							DI	2	1	17, 28	1		
11	BS_01	0BVB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	BS01	cc							DI	2	1	17, 28	1		
								BS01	cc							DI	2	1	17, 28	1		
12	BS_01	0BVB-01	E/F RELAY ON/OFF STATUS	-	On	Off	-	BS01	cc							DI	2	1	17, 28	1		
								BS01	cc							DI	2	1	17, 28	1		
13	BS_01	0BVB-01	O/C RELAY TIME PHASE A	Normal	Trip	-	-	BS01	cc		Protection	OcpPTOC1	ST	Op.phsA	No	SOE	2	2	17, 28	1		
14	BS_01	0BVB-01	O/C RELAY TIME PHASE B	Normal	Trip	-	-	BS01	cc		Protection	OcpPTOC1	ST	Op.phsB	No	SOE	2	2	17, 28	1		
15	BS_01	0BVB-01	O/C RELAY TIME PHASE C	Normal	Trip	-	-	BS01	cc		Protection	OcpPTOC1	ST	Op.phsC	No	SOE	2	2	17, 28	1		
16	BS_01	0BVB-01	E/F TIME RELAY	Normal	Trip	-	-	BS01	cc		Protection	EfmPTOC1	ST	Op.gemeral	No	SOE	2	2	17, 28	1		
17	BS_01	0BVB-01	O/C INSTANTANEOUS PHASE A	Normal	Trip	-	-	BS01	cc		Protection	OcpPTOC3	ST	Op.phsA	No	SOE	2	2	17, 28	1		
18	BS_01	0BVB-01	O/C INSTANTANEOUS PHASE B	Normal	Trip	-	-	BS01	cc		Protection	OcpPTOC3	ST	Op.phsB	No	SOE	2	2	17, 28	1		
19	BS_01	0BVB-01	O/C INSTANTANEOUS PHASE C	Normal	Trip	-	-	BS01	cc		Protection	OcpPTOC3	ST	Op.phsC	No	SOE	2	2	17, 28	1		
20	BS_01	0BVB-01	E/F INSTANTANEOUS RELAY	Normal	Trip	-	-	BS01	cc		Protection	EfmPTOC3	ST	Op.gemeral	No	SOE	2	2	17, 28	1		

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
21	BS_01	0BVB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	BS01	cc							SOE	2	2	17, 28	1		
22	BS_01	0BVB-01	VT SUPERVISION	Normal	Alarm	-	-	BS01	cc							DI	2	1	17, 28	1		
23	BS_01	0BVB-01	DC MCB TRIP	Normal	Alarm	-	-	BS01	xx.xx							DI	2	1	17, 28	1		
24	BS_01	0BVB-01	AC MCB TRIP	Normal	Alarm	-	-	BS01	xx.xx							DI	2	1	17, 28	1		
25	BS_01	0BVB-01	LV. CONNECTOR PULLED	Normal	Alarm	-	-	BS01	xx.xx							DI	2	1	17, 28	1		
26	BS_01	0BVB-01	SPRING CHARGE	Normal	Fail	-	-	BS01	xx.xx							DI	2	1	17, 28	1		
27	BS_01	0BVB-01	TRIP CCT. SUPERVISION	Normal	Fail	-	-	BS01	xx.xx							DI	2	1	17, 28	1		
28	BS_01	0BVB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	BS01	xx.xx							DI	2	1	17, 28	1		
29	BS_01	0BVB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	BS01	xx.xx							SOE	2	2	17, 28	1		
30	BS_01	0BVB-01	PROTECTION RELAY	Normal	Fail	-	-	BS01	cc							DI	2	1	17, 28	1		
31	BS_01	0BVB-01	PROTECTION RELAY LAN A	Normal	Alarm	-	-	BS01	cc							DI	2	1	17, 28	1		
32	BS_01	0BVB-01	PROTECTION RELAY LAN B	Normal	Alarm	-	-	BS01	cc							DI	2	1	17, 28	1		
33	BS_01	0BVB-01	PROTECTION RELAY GOOSE ALARM	Normal	Alarm	-	-	BS01	cc							DI	2	1	17, 28	1		
34	BS_01	0BVB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	BS01	cc							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.2

I/O POINT COUNTS FOR

22 OR 33 kV GIS

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	22kV	Bay Name :	22kV Bus VT		
IED Product :		IED Model/Type :			
IED IP Address :					

Analog Points:

Item	Feeder Name	Bay Name	Details			Unit	Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State						Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qli	Class	Address	
				1	2																
1	BUS_01	0BVP-01	VOLTAGE A-B	0-30	0-32768	kV	BUSVT01	xx.xx							AI	32	2	00, 01	2		22000/110V
2	BUS_01	0BVP-01	VOLTAGE B-C	0-30	0-32768	kV	BUSVT01	xx.xx							AI	32	2	00, 01	2		22000/110V
3	BUS_01	0BVP-01	VOLTAGE C-A	0-30	0-32768	kV	BUSVT01	xx.xx							AI	32	2	00, 01	2		22000/110V

NOTE:

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Table A4-1.2
I/O POINT COUNTS FOR
22 OR 33 kV GIS

Substation Name :		Substation Code Name :	
Voltage Level :	22kV	Bay Name :	22kV Station Service Transformer No.xx
IED Product :		IED Model/Type :	
IED IP Address :			

Substation DNP Adress :

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
1	BS_01	CBVB-01	CLOSE/OPEN COMMAND	Close	Open	DCF	BSD1	xx.xx							SBO	12	1	echo of request			

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
1	TS_01	1TVB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault		xx.xx							SOE	2	2	17, 28	1		
									xx.xx							SOE	2	2	17, 28	1		
2	TS_01	1TVS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault		xx.xx							DI	2	1	17, 28	1		
									xx.xx							DI	2	1	17, 28	1		
3	TS_01	1TVG-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault		xx.xx							DI	2	1	17, 28	1		
									xx.xx							DI	2	1	17, 28	1		
4	TS_01	1TVB-01	CONTROL SET MODE	Undefine	Local	Remote	Fault		xx.xx							DI	2	1	17, 28	1		
									xx.xx							DI	2	1	17, 28	1		
5	TS_01	1TVB-01	OVERCURRENT RELAY	Normal	Trip	-	-		cc							SOE	2	2	17, 28	1		
6	TS_01	1TVB-01	AC SUPPLY	Normal	Fail	-	-		xx.xx							DI	2	1	17, 28	1		
7	TS_01	1TVB-01	DC SUPPLY CB CONTROL CIRCUIT	Normal	Fail	-	-		xx.xx							DI	2	1	17, 28	1		
8	TS_01	1TVB-01	TRIP CCT. SUPERVISION	Normal	Fail	-	-		xx.xx							DI	2	1	17, 28	1		
9	TS_01	1TVB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-		xx.xx							DI	2	1	17, 28	1		
10	TS_01	1TVB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-		xx.xx							SOE	2	2	17, 28	1		
11	TS_01	1TVB-01	PROTECTION RELAY LAN A	Normal	Alarm	-	-		cc							DI	2	1	17, 28	1		
12	TS_01	1TVB-01	PROTECTION RELAY LAN B	Normal	Alarm	-	-		cc							DI	2	1	17, 28	1		
13	TS_01	1TVB-01	PROTECTION RELAY GOOSE ALARM	Normal	Alarm	-	-		cc							DI	2	1	17, 28	1		
14	TS_01	1TVB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-		cc							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programmable

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The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.2

I/O POINT COUNTS FOR

22 OR 33 kV GIS

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	22kV	Bay Name :	22kV Capacitor Bank Feeder No.xx		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Detail: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qi	Class	Address	Remark
1	CAP_01	1CVB-01	CLOSE/OPEN COMMAND	Close	Open	DCP	CAP01	xx.xx							SBO	12	1	echo of request			
2	CAP_01	1CVB-01	EF ON/OFF COMMAND	On	Off	DCP	CAP01	cc							SBO	12	1	echo of request			
3	CAP_01	1CVB-01	50BF ON/OFF COMMAND	On	Off	DCP	OUT01	cc							SBO	12	1	echo of request			
4	CAP_01	1CVB-01	CAP SET ON COMMAND	Auto	Manual	DCP	CAP01	xx.xx							SBO	12	1	echo of request			
5	CAP_01	1CVB-01	CAP STEP 1 COMMAND	On	Off	DCP	CAP01	xx.xx							SBO	12	1	echo of request			
6	CAP_01	1CVB-01	CAP STEP 2 COMMAND	On	Off	DCP	CAP01	xx.xx							SBO	12	1	echo of request			
7	CAP_01	1CVB-01	CAP STEP 3 COMMAND	On	Off	DCP	CAP01	xx.xx							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Detail: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qi	Class	Address	Remark
1	CAP_01	1CVB-01	CURRENT PHASE A	0-600	0-32767	A	CAP01	xx.xx							AI	32	2	00, 01	2		600/1A
2	CAP_01	1CVB-01	CURRENT PHASE B	0-600	0-32767	A	CAP01	xx.xx							AI	32	2	00, 01	2		600/1A
3	CAP_01	1CVB-01	CURRENT PHASE C	0-600	0-32767	A	CAP01	xx.xx							AI	32	2	00, 01	2		600/1A
7	CAP_01	1CVB-01	ACTIVE POWER	-31.18 - +31.18	-32767 - +32767	MW	CAP01	cc							AI	32	2	00, 01	2		Calculation
8	CAP_01	1CVB-01	RECATIVE POWER	-31.18 - +31.18	-32767 - +32767	Mvar	CAP01	cc							AI	32	2	00, 01	2		Calculation
9	CAP_01	1CVB-01	POWER FACTOR	+/- 100	-32767 - +32767	%	CAP01	cc							AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)					
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address
				0	1	2	3														
1	CAP_01	1CVB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	CAP01	xx.xx							SOE	2	2	17, 28	1	
								CAP01	xx.xx							SOE	2	2	17, 28	1	
2	CAP_01	1CVG-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	CAP01	xx.xx							DI	2	1	17, 28	1	
								CAP01	xx.xx							DI	2	1	17, 28	1	
3	CAP_01	1CVS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	CAP01	xx.xx							DI	2	1	17, 28	1	
								CAP01	xx.xx							DI	2	1	17, 28	1	
4	CAP_01	1CVB-01	CONTROL SET MODE	Undefine	Local	Remote	Fault	CAP01	xx.xx							DI	2	1	17, 28	1	
								CAP01	xx.xx							DI	2	1	17, 28	1	
5	CAP_01	1CVB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	CAP01	cc							DI	2	1	17, 28	1	
								CAP01	cc							DI	2	1	17, 28	1	
6	CAP_01	1CVB-01	E/F RELAY ON/OFF STATUS	-	On	Off	-	CAP01	cc							DI	2	1	17, 28	1	
								CAP01	cc							DI	2	1	17, 28	1	
7	CAP_01	1CVB-01	CAP CONTROL SET MODE	Undefine	Local	Remote	Fault	CAP01	xx.xx							DI	2	1	17, 28	1	
								CAP01	xx.xx							DI	2	1	17, 28	1	
8	CAP_01	1CVB-01	CAP SET ON STATUS	Undefine	Auto	Manual	Fault	CAP01	xx.xx							DI	2	1	17, 28	1	
								CAP01	xx.xx							DI	2	1	17, 28	1	
9	CAP_01	1CVB-01	CAP STEP 1 ON/OFF STATUS	Undefine	On	Off	Fault	CAP01	xx.xx							DI	2	1	17, 28	1	
								CAP01	xx.xx							DI	2	1	17, 28	1	
10	CAP_01	1CVB-01	CAP STEP 2 ON/OFF STATUS	Undefine	On	Off	Fault	CAP01	xx.xx							DI	2	1	17, 28	1	
								CAP01	xx.xx							DI	2	1	17, 28	1	
11	CAP_01	1CVB-01	CAP STEP 3 ON/OFF STATUS	Undefine	On	Off	Fault	CAP01	xx.xx							DI	2	1	17, 28	1	
								CAP01	xx.xx							DI	2	1	17, 28	1	
12	CAP_01	1CVB-01	O/C RELAY TIME PHASE A	Normal	Trip	-	-	CAP01	cc		Protection	OcpPTOC1	ST	Op.phsA	No	SOE	2	2	17, 28	1	
13	CAP_01	1CVB-01	O/C RELAY TIME PHASE B	Normal	Trip	-	-	CAP01	cc		Protection	OcpPTOC1	ST	Op.phsB	No	SOE	2	2	17, 28	1	
14	CAP_01	1CVB-01	O/C RELAY TIME PHASE C	Normal	Trip	-	-	CAP01	cc		Protection	OcpPTOC1	ST	Op.phsC	No	SOE	2	2	17, 28	1	
15	CAP_01	1CVB-01	E/F TIME RELAY	Normal	Trip	-	-	CAP01	cc		Protection	EfmPTOC1	ST	Op.gerneral	No	SOE	2	2	17, 28	1	
16	CAP_01	1CVB-01	O/C INSTANTANEOUS PHASE A	Normal	Trip	-	-	CAP01	cc		Protection	OcpPTOC3	ST	Op.phsA	No	SOE	2	2	17, 28	1	
17	CAP_01	1CVB-01	O/C INSTANTANEOUS PHASE B	Normal	Trip	-	-	CAP01	cc		Protection	OcpPTOC3	ST	Op.phsB	No	SOE	2	2	17, 28	1	
18	CAP_01	1CVB-01	O/C INSTANTANEOUS PHASE C	Normal	Trip	-	-	CAP01	cc		Protection	OcpPTOC3	ST	Op.phsC	No	SOE	2	2	17, 28	1	
19	CAP_01	1CVB-01	E/F INSTANTANEOUS RELAY	Normal	Trip	-	-	CAP01	cc		Protection	EfmPTOC3	ST	Op.gerneral	No	SOE	2	2	17, 28	1	
20	CAP_01	1CVB-01	TIME DELAY FAIL (CB FAILl)	Normal	Trip	-	-	CAP01	cc							SOE	2	2	17, 28	1	

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)					
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address
				0	1	2	3														
21	CAP_01	1CVB-01	UNDER VOLTAGE	Normal	Alarm	-	-	CAP01	cc							DI	2	1	17, 28	1	
22	CAP_01	1CVB-01	OVER VOLTAGE	Normal	Alarm	-	-	CAP01	cc							DI	2	1	17, 28	1	
23	CAP_01	1CVB-01	VT SUPERVISION	Normal	Alarm	-	-	CAP01	cc							DI	2	1	17, 28	1	
24	CAP_01	1CVB-01	DC MCB TRIP	Normal	Alarm	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
25	CAP_01	1CVB-01	AC MCB TRIP	Normal	Alarm	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
26	CAP_01	1CVB-01	LV. CONNECTOR PULLED	Normal	Alarm	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
27	CAP_01	1CVB-01	SPRING CHARGE	Normal	Fail	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
28	CAP_01	1CVB-01	TRIP CCT. SUPERVISION	Normal	Fail	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
29	CAP_01	1CVB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	CAP01	xx.xx		System	GosGGIO2	ST	Ind22.stVal	Yes	DI	2	1	17, 28	1	
30	CAP_01	1CVB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	CAP01	xx.xx		System	GosGGIO2	ST	Ind23.stVal	Yes	SOE	2	2	17, 28	1	
31	CAP_01	1CVB-01	PROTECTION RELAY	Normal	Fail	-	-	CAP01	cc							DI	2	1	17, 28	1	
32	CAP_01	1CVB-01	PROTECTION RELAY LAN A	Normal	Alarm	-	-	CAP01	cc							DI	2	1	17, 28	1	
33	CAP_01	1CVB-01	PROTECTION RELAY LAN B	Normal	Alarm	-	-	CAP01	cc							DI	2	1	17, 28	1	
34	CAP_01	1CVB-01	PROTECTION RELAY GOOSE ALARM	Normal	Alarm	-	-	CAP01	cc							DI	2	1	17, 28	1	
35	CAP_01	1CVB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	CAP01	cc							DI	2	1	17, 28	1	
36	CAP_01	1CVB-01	CAP STEP 1 DC SUPPLY	Normal	Fail	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
37	CAP_01	1CVB-01	CAP STEP 2 DC SUPPLY	Normal	Fail	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
38	CAP_01	1CVB-01	CAP STEP 3 DC SUPPLY	Normal	Fail	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
39	CAP_01	1CVB-01	CAP STEP 1 UNBALANCE	Normal	Operated	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
40	CAP_01	1CVB-01	CAP STEP 2 UNBALANCE	Normal	Operated	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
41	CAP_01	1CVB-01	CAP STEP 3 UNBALANCE	Normal	Operated	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
42	CAP_01	1CVB-01	CAP STEP 1 OVERVOLTAGE RELAY	Normal	Trip	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
43	CAP_01	1CVB-01	CAP STEP 2 OVERVOLTAGE RELAY	Normal	Trip	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
44	CAP_01	1CVB-01	CAP STEP 3 OVERVOLTAGE RELAY	Normal	Trip	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
45	CAP_01	1CVB-01	INTERNAL FAULT OF VCB 1	Normal	Operated	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
46	CAP_01	1CVB-01	INTERNAL FAULT OF VCB 2	Normal	Operated	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	
47	CAP_01	1CVB-01	INTERNAL FAULT OF VCB 3	Normal	Operated	-	-	CAP01	xx.xx							DI	2	1	17, 28	1	

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.3

I/O POINT COUNTS FOR

115kV GIS SWITCHGEARS DOUBLE MAIN BUS CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	115kV	Bay Name :	115 kV Incoming or Outgoing Line No.xx		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINE_xx	xxYB-01	CLOSE/OPEN COMMAND	Close	Open	DPC	LINExx	xx.xx							SBO	12	1	echo of request			
2	LINE_xx	xxYB-01	CLOSE/OPEN BY PASS COMMAND	Close	-	SCP	LINExx	xx.xx							SBO	12	1	echo of request			
3	LINE_xx	xxYS-01	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xx.xx							SBO	12	1	echo of request			
4	LINE_xx	xxYS-02	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xx.xx							SBO	12	1	echo of request			
5	LINE_xx	xxYS-03	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xx.xx							SBO	12	1	echo of request			
6	LINE_xx	xxYB-01	A/R ON/OFF COMMAND	On	Off	DCP	LINExx	cc							SBO	12	1	echo of request			
7	LINE_xx	xxYB-01	SOBF ON/OFF COMMAND	On	Off	DCP	LINExx	cc							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINE_xx	xxYB-01	CURRENT PHASE A	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2		1800/1A
2	LINE_xx	xxYB-01	CURRENT PHASE B	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2		1800/1A
3	LINE_xx	xxYB-01	CURRENT PHASE C	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2		1800/1A
4	LINE_xx	xxYB-01	VOLTAGE A-B	0-150	0-32767	kV	LINExx	xx.xx							AI	32	2	00, 01	2		115000/115
5	LINE_xx	xxYB-01	VOLTAGE B-C	0-150	0-32767	kV	LINExx	xx.xx							AI	32	2	00, 01	2		115000/115
6	LINE_xx	xxYB-01	VOLTAGE C-A	0-150	0-32767	kV	LINExx	xx.xx							AI	32	2	00, 01	2		115000/115
7	LINE_xx	xxYB-01	ACTIVE POWER	-467.64 - +467.64	-32767 - +32767	MW	LINExx	cc							AI	32	2	00, 01	2		Calculation
8	LINE_xx	xxYB-01	REACTIVE POWER	-467.64 - +467.64	-32767 - +32767	Mvar	LINExx	cc							AI	32	2	00, 01	2		Calculation
9	LINE_xx	xxYB-01	POWER FACTOR	+/- 100	-32767 - +32767	%	LINExx	cc							AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Point Name	Details – State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address
1	LINE_xx	xxYB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							SOE	2	2	17, 28	1	
								LINExx	xx.xx							SOE	2	2	17, 28	1	
2	LINE_xx	xxYS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1	
								LINExx	xx.xx							DI	2	1	17, 28	1	
3	LINE_xx	xxYS-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1	
								LINExx	xx.xx							DI	2	1	17, 28	1	
4	LINE_xx	xxYS-03	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1	
								LINExx	xx.xx							DI	2	1	17, 28	1	
5	LINE_xx	xxYG-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1	
								LINExx	xx.xx							DI	2	1	17, 28	1	
6	LINE_xx	xxYB-01	CONTROL SET MODE	Undefine	Remote	Local	Fault	LINExx	xx.xx							DI	2	1	17, 28	1	
								LINExx	xx.xx							DI	2	1	17, 28	1	
8	LINE_xx	xxYB-01	AUTO RECL ON/OFF STATUS	-	On	Off	-	LINExx	cc							DI	2	1	17, 28	1	
								LINExx	cc							DI	2	1	17, 28	1	
9	LINE_xx	xxYB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	LINExx	cc							DI	2	1	17, 28	1	
								LINExx	cc							DI	2	1	17, 28	1	
10	LINE_xx	xxYB-01	BUS ZONE 1 TRIP STATUS	Undefine	Inservice	Isolate	Fault	LINExx	cc							DI	2	1	17, 28	1	
								LINExx	cc							DI	2	1	17, 28	1	
11	LINE_xx	xxYB-01	BUS ZONE 2 TRIP STATUS	Undefine	Inservice	Isolate	Fault	LINExx	cc							DI	2	1	17, 28	1	
								LINExx	cc							DI	2	1	17, 28	1	
12	LINE_xx	xxYB-01	DISTANCE RELAY VT CIRCUIT FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	
13	LINE_xx	xxYB-01	DISTANCE RELAY	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	
14	LINE_xx	xxYB-01	DISTANCE RELAY ZONE 1	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	
15	LINE_xx	xxYB-01	DISTANCE RELAY ZONE 2	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	
16	LINE_xx	xxYB-01	DISTANCE RELAY ZONE 3	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	
17	LINE_xx	xxYB-01	DISTANCE RELAY PHASE A	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	
18	LINE_xx	xxYB-01	DISTANCE RELAY PHASE B	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	
19	LINE_xx	xxYB-01	DISTANCE RELAY PHASE C	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	
20	LINE_xx	xxYB-01	DISTANCE RELAY PHASE N	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	
21	LINE_xx	xxYB-01	DISTANCE SWITCH ON TO FAULT	Normal	Alarm	-	-	LINExx	cc							SOE	2	2	17, 28	1	
22	LINE_xx	xxYB-01	DISTANCE LINE AIDED TRIP	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)					
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address
				0	1	2	3														
23	LINE_xx	xxYB-01	AUTO RECL. PROGRESS STATUS	Normal	Operated	-	-	LINExx	cc							SOE	2	2	17, 28	1	
24	LINE_xx	xxYB-01	AUTO RECL. LOCK OUT STATUS	Normal	Lockout	-	-	LINExx	cc							SOE	2	2	17, 28	1	
25	LINE_xx	xxYB-01	DIRECTIONAL OVERCURRENT PHASE A	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	
26	LINE_xx	xxYB-01	DIRECTIONAL OVERCURRENT PHASE B	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	
27	LINE_xx	xxYB-01	DIRECTIONAL OVERCURRENT PHASE C	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	
28	LINE_xx	xxYB-01	DIRECTIONAL EARTH FAULT	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	
29	LINE_xx	xxYB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	
30	LINE_xx	xxYB-01	BUS ZONE 1 TRIP	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	
31	LINE_xx	xxYB-01	BUS ZONE 2 TRIP	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	
32	LINE_xx	xxYB-01	SYNCH. SWITCH SELECTION	Normal	Auto	-	-	LINExx	cc							DI	2	1	17, 28	1	
33	LINE_xx	xxYB-01	SYNCH. SWITCH SELECTION	Normal	Off	-	-	LINExx	cc							DI	2	1	17, 28	1	
34	LINE_xx	xxYB-01	SYNCH. SWITCH SELECTION	Normal	Manual	-	-	LINExx	cc							DI	2	1	17, 28	1	
35	LINE_xx	xxYB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	
36	LINE_xx	xxYB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	LINExx	xx.xx							SOE	2	2	17, 28	1	
37	LINE_xx	xxYB-01	SPRING CHARGE	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	
38	LINE_xx	xxYB-01	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	
39	LINE_xx	xxYB-01	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	
40	LINE_xx	xxYB-01	TRIP TRANSFER STATUS	Normal	Tie	-	-	LINExx	cc							DI	2	1	17, 28	1	
41	LINE_xx	xxYB-01	AC SUPPLY FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	
42	LINE_xx	xxYB-01	DC SUPPLY FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	
43	LINE_xx	xxYB-01	PROTECTION RELAY DC FAIL	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	
44	LINE_xx	xxYB-01	AIR-CONDITION ALARM	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	
45	LINE_xx	xxYB-01	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	
46	LINE_xx	xxYB-01	PROTECTION RELAY	Normal	Fail	-	-	LINExx	cc							DI	2	1	17, 28	1	
47	LINE_xx	xxYB-01	PROTECTION RELAY LAN A	Offline	Online	-	-	LINExx	cc							DI	2	1	17, 28	1	
48	LINE_xx	xxYB-01	PROTECTION RELAY LAN B	Offline	Online	-	-	LINExx	cc							DI	2	1	17, 28	1	
49	LINE_xx	xxYB-01	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	LINExx	cc							DI	2	1	17, 28	1	
50	LINE_xx	xxYB-01	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	LINExx	cc							DI	2	1	17, 28	1	
51	LINE_xx	xxYB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	LINExx	cc							DI	2	1	17, 28	1	

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.3

I/O POINT COUNTS FOR

115kV GIS SWITCHGEARS DOUBLE MAIN BUS CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	115kV	Bay Name :	115 kV Bus Coupling Breaker		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs :

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	BUS	0BYB-01	CLOSE/OPEN COMMAND	Close	Open	DCP	BUS	xx.xx							SBO	12	1	echo of request			
2	BUS	0BYS-01	CLOSE/OPEN COMMAND	Close	Open	Class	BUS	xx.xx							SBO	12	1	echo of request			
3	BUS	0BYS-02	CLOSE/OPEN COMMAND	Close	Open	DCP	BUS	xx.xx							SBO	12	1	echo of request			
4	BUS	0BYB-01	50BF ON/OFF COMMAND	On	Off	DCP	BUS	cc							SBO	12	1	echo of request			
5	BUS	0BYB-01	87B ON/OFF COMMAND	On	Off	DCP	BUS	cc							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	BUS	0BYB-01	BUS 1 VOLTAGE	0-150	0-32767	kV	BUS	xx.xx							AI	32	2	00, 01	2		115000/115V
2	BUS	0BYB-01	BUS 1 FREQUENCY	0-60	0-32767	Hz	BUS	cc							AI	32	2	00, 01	2		-
3	BUS	0BYB-01	BUS 2 VOLTAGE	0-150	0-32767	kV	BUS	xx.xx							AI	32	2	00, 01	2		115000/115V
4	BUS	0BYB-01	BUS 2 FREQUENCY	0-60	0-32767	Hz	BUS	cc							AI	32	2	00, 01	2		-

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)					
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address
				0	1	2	3														
1	BUS	0BYB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BUS	xx.xx							SOE	2	2	17, 28	1	
								BUS	xx.xx							SOE	2	2	17, 28	1	
2	BUS	0BYS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BUS	xx.xx							DI	2	1	17, 28	1	
								BUS	xx.xx							DI	2	1	17, 28	1	
3	BUS	0BYS-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BUS	xx.xx							DI	2	1	17, 28	1	
								BUS	xx.xx							DI	2	1	17, 28	1	
4	BUS	0BYB-01	CONTROL SET MODE	Undefine	Remote	Local	Fault	BUS	xx.xx							DI	2	1	17, 28	1	
								BUS	xx.xx							DI	2	1	17, 28	1	
5	BUS	0BYB-01	87B RELAY ON/OFF STATUS	-	On	Off	-	BUS	cc							DI	2	1	17, 28	1	
								BUS	cc							DI	2	1	17, 28	1	
6	BUS	0BYB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	BUS	cc							DI	2	1	17, 28	1	
								BUS	cc							DI	2	1	17, 28	1	
7	BUS	0BYB-01	BUS ZONE 1 TRIP STATUS		Inservice	Isolate		BUS	cc							DI	2	1	17, 28	1	
								BUS	cc							DI	2	1	17, 28	1	
8	BUS	0BYB-01	BUS ZONE 2 TRIP STATUS		Inservice	Isolate		BUS	cc							DI	2	1	17, 28	1	
								BUS	cc							DI	2	1	17, 28	1	
9	BUS	0BYB-01	BUS 1 DIFFERENTIAL PHASE A	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1	
10	BUS	0BYB-01	BUS 1 DIFFERENTIAL PHASE B	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1	
11	BUS	0BYB-01	BUS 1 DIFFERENTIAL PHASE B	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1	
12	BUS	0BYB-01	BUS 2 DIFFERENTIAL PHASE A	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1	
13	BUS	0BYB-01	BUS 2 DIFFERENTIAL PHASE B	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1	
14	BUS	0BYB-01	BUS 2 DIFFERENTIAL PHASE B	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1	
15	BUS	0BYB-01	BUS 1 AC SUPERVISION PHASE A	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1	
16	BUS	0BYB-01	BUS 1 AC SUPERVISION PHASE B	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1	
17	BUS	0BYB-01	BUS 1 AC SUPERVISION PHASE C	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1	
18	BUS	0BYB-01	BUS 2 AC SUPERVISION PHASE A	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1	
19	BUS	0BYB-01	BUS 2 AC SUPERVISION PHASE B	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1	
20	BUS	0BYB-01	BUS 2 AC SUPERVISION PHASE C	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1	
21	BUS	0BYB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1	
22	BUS	0BYB-01	BUS ZONE 1 TRIP STATUS	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1	
23	BUS	0BYB-01	BUS ZONE 2 TRIP STATUS	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1	

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address
24	BUS	0BYB-01	BUS 1 DC SUPPLY	Normal	Fail	-	-	BUS	cc							SOE	2	2	17, 28	1	
25	BUS	0BYB-01	BUS 2 DC SUPPLY	Normal	Fail	-	-	BUS	cc							DI	2	1	17, 28	1	
26	BUS	0BYB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	BUS	xx.xx							DI	2	1	17, 28	1	
27	BUS	0BYB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	BUS	xx.xx							SOE	2	2	17, 28	1	
28	BUS	0BYB-01	SPRING CHARGE	Normal	Fail	-	-	BUS	xx.xx							DI	2	1	17, 28	1	
29	BUS	0BYB-01	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	BUS	xx.xx							DI	2	1	17, 28	1	
30	BUS	0BYB-01	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail	-	-	BUS	xx.xx							DI	2	1	17, 28	1	
31	BUS	0BYB-01	AC SUPPLY FAILURE	Normal	Alarm	-	-	BUS	xx.xx							DI	2	1	17, 28	1	
32	BUS	0BYB-01	DC SUPPLY FAILURE	Normal	Alarm	-	-	BUS	xx.xx							DI	2	1	17, 28	1	
33	BUS	0BYB-01	PROTECTION RELAY DC FAIL	Normal	Alarm	-	-	BUS	xx.xx							DI	2	1	17, 28	1	
34	BUS	0BYB-01	AIR-CONDITION ALARM	Normal	Alarm	-	-	BUS	xx.xx							DI	2	1	17, 28	1	
35	BUS	0BYB-01	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	BUS	xx.xx							DI	2	1	17, 28	1	
36	BUS	0BYB-01	PROTECTION RELAY	Normal	Fail	-	-	BUS	cc							DI	2	1	17, 28	1	
37	BUS	0BYB-01	PROTECTION RELAY LAN A	Offline	Online	-	-	BUS	cc							DI	2	1	17, 28	1	
38	BUS	0BYB-01	PROTECTION RELAY LAN B	Offline	Online	-	-	BUS	cc							DI	2	1	17, 28	1	
39	BUS	0BYB-01	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1	
40	BUS	0BYB-01	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1	
41	BUS	0BYB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	BUS	cc							DI	2	1	17, 28	1	

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.3

I/O POINT COUNTS FOR

115kV GIS SWITCHGEARS DOUBLE MAIN BUS CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	**115kV**	Bay Name :	**115 kV Power Transformer Bay No.xx**		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Detail			Data	Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State		Class		Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				1	2																
1	LINETP_01	xxYB-01	CLOSE/OPEN COMMAND	Close	Open	DCP	LINETP01	xx.xx							SBO	12	1	echo of request			
2	LINETP_01	xxYS-01	CLOSE/OPEN COMMAND	Close	Open	DCP	LINETP01	xx.xx							SBO	12	1	echo of request			
3	LINETP_01	xxYS-02	CLOSE/OPEN COMMAND	Close	Open	DCP	LINETP01	xx.xx							SBO	12	1	echo of request			
4	LINETP_01	xxYB-01	50BF ON/OFF COMMAND	On	Off	DCP	LINETP01	cc							SBO	12	1	echo of request			
5	LINETP_01	xxYB-01	87T ON/OFF COMMAND	On	Off	DCP	LINETP01	cc							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Detail			Unit	Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State				Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				1	2																
1	LINETP_01	xxYB-01	CURRENT PHASE A	0-400	0-32767	A	LINETP01	xx.xx							AI	32	2	00, 01	2		400/1A
2	LINETP_01	xxYB-01	CURRENT PHASE B	0-400	0-32767	A	LINETP01	xx.xx							AI	32	2	00, 01	2		400/1A
3	LINETP_01	xxYB-01	CURRENT PHASE C	0-400	0-32767	A	LINETP01	xx.xx							AI	32	2	00, 01	2		400/1A
4	LINETP_01	xxYB-01	VOLTAGE A-B	0-150	0-32767	kV	LINETP01	xx.xx							AI	32	2	00, 01	2		11500/115
5	LINETP_01	xxYB-01	VOLTAGE B-C	0-150	0-32767	kV	LINETP01	xx.xx							AI	32	2	00, 01	2		11500/115
6	LINETP_01	xxYB-01	VOLTAGE C-A	0-150	0-32767	kV	LINETP01	xx.xx							AI	32	2	00, 01	2		11500/115
7	LINETP_01	xxYB-01	ACTIVE POWER	-467.64 - +467.64	-32767 - +32767	MW	LINETP01	cc							AI	32	2	00, 01	2		Calculation
8	LINETP_01	xxYB-01	RECATIVE POWER	-467.64 - +467.64	-32767 - +32767	Mvar	LINETP01	cc							AI	32	2	00, 01	2		Calculation
9	LINETP_01	xxYB-01	POWER FACTOR	+/- 100	-32767 - +32767	%	LINETP01	cc							AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Point Name	Details: State 0	1	2	3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address
1	LINETP_01	xxYB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							SOE	2	2	17, 28	1	
								LINETP01	xx.xx							SOE	2	2	17, 28	1	
2	LINETP_01	xxYS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1	
								LINETP01	xx.xx							DI	2	1	17, 28	1	
3	LINETP_01	xxYS-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1	
								LINETP01	xx.xx							DI	2	1	17, 28	1	
4	LINETP_01	xxYS-03	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1	
								LINETP01	xx.xx							DI	2	1	17, 28	1	
5	LINETP_01	xxYB-01	CONTROL SET MODE	Undefine	Remote	Local	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1	
								LINETP01	xx.xx							DI	2	1	17, 28	1	
6	LINETP_01	xxYB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	LINETP01	cc							DI	2	1	17, 28	1	
								LINETP01	cc							DI	2	1	17, 28	1	
7	LINETP_01	xxYB-01	87T RELAY ON/OFF STATUS	-	On	Off	-	LINETP01	cc							DI	2	1	17, 28	1	
								LINETP01	cc							DI	2	1	17, 28	1	
8	LINETP_01	xxYB-01	BUS ZONE 1 TRIP STATUS	-	Inservice	Isolate	-	LINETP01	cc							DI	2	1	17, 28	1	
								LINETP01	cc							DI	2	1	17, 28	1	
9	LINETP_01	xxYB-01	BUS ZONE 2 TRIP STATUS	-	Inservice	Isolate	-	LINETP01	cc							DI	2	1	17, 28	1	
								LINETP01	cc							DI	2	1	17, 28	1	
10	LINETP_01	xxYB-01	TRANSFORMER DIFFERENTIAL PHASE A	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
11	LINETP_01	xxYB-01	TRANSFORMER DIFFERENTIAL PHASE B	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
12	LINETP_01	xxYB-01	TRANSFORMER DIFFERENTIAL PHASE C	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
13	LINETP_01	xxYB-01	TRANSFORMER DIFFERENTIAL RELAY	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
14	LINETP_01	xxYB-01	O/C RELAY TIME PHASE A (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
15	LINETP_01	xxYB-01	O/C RELAY TIME PHASE B (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
16	LINETP_01	xxYB-01	O/C RELAY TIME PHASE C (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
17	LINETP_01	xxYB-01	O/C INST RELAY PHASE A (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
18	LINETP_01	xxYB-01	O/C INST RELAY PHASE B (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
19	LINETP_01	xxYB-01	O/C INST RELAY PHASE C (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
20	LINETP_01	xxYB-01	E/F TIME RELAY (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)					
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address
				0	1	2	3														
21	LINETP_01	xxYB-01	E/F INSTANTANEOUS RELAY (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
22	LINETP_01	xxYB-01	RESTRICTED EARTH FAULT (LV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
23	LINETP_01	xxYB-01	O/C GROUND BACKUP (LV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
24	LINETP_01	xxYB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
25	LINETP_01	xxYB-01	BUS ZONE 1 TRIP STATUS	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
26	LINETP_01	xxYB-01	BUS ZONE 2 TRIP STATUS	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1	
27	LINETP_01	xxYB-01	TRANSFORMER INTERNAL PROTECTION	Normal	Trip	-	-	LINETP01	xx.xx							SOE	2	2	17, 28	1	
28	LINETP_01	xxYB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1	
29	LINETP_01	xxYB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	LINETP01	xx.xx							SOE	2	2	17, 28	1	
30	LINETP_01	xxYB-01	SPRING CHARGE	Normal	Fail	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1	
31	LINETP_01	xxYB-01	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1	
32	LINETP_01	xxYB-01	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail			LINETP01	xx.xx							DI	2	1	17, 28	1	
33	LINETP_01	xxYB-01	AC SUPPLY FAILURE	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1	
34	LINETP_01	xxYB-01	DC SUPPLY FAILURE	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1	
35	LINETP_01	xxYB-01	PROTECTION RELAY DC FAIL	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1	
36	LINETP_01	xxYB-01	AIR-CONDITION ALARM	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1	
37	LINETP_01	xxYB-01	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1	
38	LINETP_01	xxYB-01	PROTECTION RELAY	Normal	Fail	-	-	LINETP01	cc							DI	2	1	17, 28	1	
39	LINETP_01	xxYB-01	PROTECTION RELAY LAN A	Offline	Online	-	-	LINETP01	cc							DI	2	1	17, 28	1	
40	LINETP_01	xxYB-01	PROTECTION RELAY LAN B	Offline	Online	-	-	LINETP01	cc							DI	2	1	17, 28	1	
41	LINETP_01	xxYB-01	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	LINETP01	cc							DI	2	1	17, 28	1	
42	LINETP_01	xxYB-01	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	LINETP01	cc							DI	2	1	17, 28	1	
43	LINETP_01	xxYB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	LINETP01	cc							DI	2	1	17, 28	1	

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.4

I/O POINT COUNTS FOR

115kV OUTDOOR TYPE SWITCHYARD, SINGLE MAIN & TRANSFER BUS CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	115kV	Bay Name :	115kV Incoming or Outgoing No.01		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
1	LINE_01	01YB-01	CLOSE/OPEN COMMAND	Close	Open	DPC	LINE01	xx.xx		Control	XCBR1	Pos	ctlVal		SBO	12	1	echo of request			
2	LINE_01	01YB-01	CLOSE/OPEN BY PASS COMMAND	Close	-	SCP	LINE01	xx.xx		Control	XCBR1	Pos	ctlVal		SBO	12	1	echo of request			
3	LINE_01	01YS-01	CLOSE/OPEN COMMAND	Close	Open	DCP	LINE01	xx.xx		Control	XSWI1	Pos	ctlVal		SBO	12	1	echo of request			
4	LINE_01	01YS-02	CLOSE/OPEN COMMAND	Close	Open	DCP	LINE01	xx.xx		Control	XSWI2	Pos	ctlVal		SBO	12	1	echo of request			
5	LINE_01	01YS-03	CLOSE/OPEN COMMAND	Close	Open	DCP	LINE01	xx.xx		Control	XSWI3	Pos	ctlVal		SBO	12	1	echo of request			
6	LINE_01	01YB-01	A/R ON/OFF COMMAND	On	Off	DCP	LINE01	cc		System	PloGGIO1/SPCSO1	Pos	ctlVal		SBO	12	1	echo of request			
7	LINE_01	01YB-01	50BF ON/OFF COMMAND	On	Off	DCP	LINE01	cc		System	PloGGIO1/SPCSO2	Pos	ctlVal		SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
1	LINE_01	01YB-01	CURRENT PHASE A	0-1200	0-32767	A	LINE01	xx.xx		Measurements	MMXU1/A1/phaA	MX	cVal		AI	32	2	00, 01	2		1200/1A
2	LINE_01	01YB-01	CURRENT PHASE B	0-1200	0-32767	A	LINE01	xx.xx		Measurements	MMXU1/A1/phaB	MX	cVal		AI	32	2	00, 01	2		1200/1A
3	LINE_01	01YB-01	CURRENT PHASE C	0-1200	0-32767	A	LINE01	xx.xx		Measurements	MMXU1/A1/phaC	MX	cVal		AI	32	2	00, 01	2		1200/1A
4	LINE_01	01YB-01	VOLTAGE A-B	0-150	0-32767	kV	LINE01	xx.xx		Measurements	MMXU1/PPV/phaAB	MX	cVal		AI	32	2	00, 01	2		11500/115
5	LINE_01	01YB-01	VOLTAGE B-C	0-150	0-32767	kV	LINE01	xx.xx		Measurements	MMXU1/PPV/phaBC	MX	cVal		AI	32	2	00, 01	2		11500/115
6	LINE_01	01YB-01	VOLTAGE C-A	0-150	0-32767	kV	LINE01	xx.xx		Measurements	MMXU1/PPV/phaCA	MX	cVal		AI	32	2	00, 01	2		11500/115
7	LINE_01	01YB-01	ACTIVE POWER	-467.64 - +467.64	-32767 - +32767	MW	LINE01	cc		Measurements	MMXU1/AI/TotW	MX	cVal		AI	32	2	00, 01	2		Calculation
8	LINE_01	01YB-01	RECATIVE POWER	-467.64 - +467.64	-32767 - +32767	Mvar	LINE01	cc		Measurements	MMXU1/AI/TotVAr	MX	cVal		AI	32	2	00, 01	2		Calculation
9	LINE_01	01YB-01	POWER FACTOR	+/-100	-32767 - +32767	%	LINE01	cc		Measurements	MMXU1/AI/TotPF	MX	cVal		AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)					
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address
				0	1	2	3														
1	LINE_01	01YB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINE01	xx.xx		Control	XCBR1	Pos	stVal	No	SOE	2	2	17, 28	1	
								LINE01	xx.xx							SOE	2	2	17, 28	1	
2	LINE_01	01YS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINE01	xx.xx		Control	XSWI1	Pos	stVal	No	DI	2	1	17, 28	1	
								LINE01	xx.xx							DI	2	1	17, 28	1	
3	LINE_01	01YS-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINE01	xx.xx		Control	XSWI2	Pos	stVal	No	DI	2	1	17, 28	1	
								LINE01	xx.xx							DI	2	1	17, 28	1	
4	LINE_01	01YS-03	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINE01	xx.xx		Control	XSWI3	Pos	stVal	No	DI	2	1	17, 28	1	
								LINE01	xx.xx							DI	2	1	17, 28	1	
5	LINE_01	01YG-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINE01	xx.xx		Control	XSWI4	Pos	stVal	No	DI	2	1	17, 28	1	
								LINE01	xx.xx							DI	2	1	17, 28	1	
6	LINE_01	01YB-01	CONTROL SET MODE	Undefine	Remote	Local	Fault	LINE01	xx.xx		Control	XSWI5	Pos	stVal	No	DI	2	1	17, 28	1	
								LINE01	xx.xx							DI	2	1	17, 28	1	
8	LINE_01	01YB-01	AUTO RECL ON/OFF STATUS	-	On	Off	-	LINE01	xx.xx		Control	XSWI6	Pos	stVal	No	DI	2	1	17, 28	1	
								LINE01	xx.xx							DI	2	1	17, 28	1	
9	LINE_01	01YB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	LINE01	cc		Control	XSWI7	Pos	stVal	No	DI	2	1	17, 28	1	
								LINE01	cc							DI	2	1	17, 28	1	
10	LINE_01	01YB-01	BUS ZONE TRIP STATUS	Undefine	Inservice	Isolate	Fault	LINE01	cc		Control	XSWI8	Pos	stVal	No	DI	2	1	17, 28	1	
								LINE01	cc							DI	2	1	17, 28	1	
11	LINE_01	01YB-01	DISTANCE RELAY DC FAIL	Normal	Alarm	-	-	LINE01	xx.xx		System	GosGGIO2	ST	Ind27.stVal		DI	2	1	17, 28	1	
12	LINE_01	01YB-01	DISTANCE RELAY VT FAIL	Normal	Alarm	-	-	LINE01	xx.xx		System	GosGGIO2	ST	Ind28.stVal		DI	2	1	17, 28	1	
13	LINE_01	01YB-01	DISTANCE RELAY	Normal	Trip	-	-	LINE01	cc		Protection	DisPSCH1	ST	Op.genaral		SOE	2	2	17, 28	1	
15	LINE_01	01YB-01	DISTANCE RELAY ZONE 1	Normal	Trip	-	-	LINE01	cc		Protection	DisPDIS1	ST	Op/general		SOE	2	2	17, 28	1	
16	LINE_01	01YB-01	DISTANCE RELAY ZONE 2	Normal	Trip	-	-	LINE01	cc		Protection	DisPDIS2	ST	Op/general		SOE	2	2	17, 28	1	
17	LINE_01	01YB-01	DISTANCE RELAY ZONE 3	Normal	Trip	-	-	LINE01	cc		Protection	DisPDIS3	ST	Op/general		SOE	2	2	17, 28	1	
18	LINE_01	01YB-01	DISTANCE RELAY PHASE A	Normal	Trip	-	-	LINE01	cc		System	GosGGIO2	ST	Ind1.stVal		SOE	2	2	17, 28	1	
19	LINE_01	01YB-01	DISTANCE RELAY PHASE B	Normal	Trip	-	-	LINE01	cc		System	GosGGIO2	ST	Ind2.stVal		SOE	2	2	17, 28	1	
20	LINE_01	01YB-01	DISTANCE RELAY PHASE C	Normal	Trip	-	-	LINE01	cc		System	GosGGIO2	ST	Ind3.stVal		SOE	2	2	17, 28	1	
21	LINE_01	01YB-01	DISTANCE RELAY PHASE N	Normal	Trip	-	-	LINE01	cc		System	GosGGIO2	ST	Ind4.stVal		SOE	2	2	17, 28	1	
22	LINE_01	01YB-01	DISTANCE SWITCH ON TO FAULT	Normal	Alarm	-	-	LINE01	cc		Protection	SofPSOF1	ST	Op.general		SOE	2	2	17, 28	1	
23	LINE_01	01YB-01	DISTANCE LINE AIDED TRIP	Normal	Trip	-	-	LINE01	cc		System	GosGGIO2	ST	Ind5.stVal		SOE	2	2	17, 28	1	
24	LINE_01	01YB-01	AUTO RECL. PROGRESS STATUS	Normal	Operated	-	-	LINE01	cc		Control	ArcRREC1	ST	Op.gerneral		SOE	2	2	17, 28	1	

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
25	LINE_01	01YB-01	AUTO RECL. LOCK OUT STATUS	Normal	Lockout	-	-	LINE01	cc		System	GosGGIO2	ST	Ind6.stVal		SOE	2	2	17, 28	1		
26	LINE_01	01YB-01	DIRECTIONAL OVERCURRENT PHASE A	Normal	Trip	-	-	LINE01	cc		Protection	OcpPTOC1	ST	Op/phsA		SOE	2	2	17, 28	1		
27	LINE_01	01YB-01	DIRECTIONAL OVERCURRENT PHASE B	Normal	Trip	-	-	LINE01	cc		Protection	OcpPTOC1	ST	Op/phsB		SOE	2	2	17, 28	1		
28	LINE_01	01YB-01	DIRECTIONAL OVERCURRENT PHASE C	Normal	Trip	-	-	LINE01	cc		Protection	OcpPTOC1	ST	Op/phsC		SOE	2	2	17, 28	1		
29	LINE_01	01YB-01	DIRECTIONAL EARTH FAULT	Normal	Trip	-	-	LINE01	cc		Protection	OcpPTOC1	ST	Op/neut		SOE	2	2	17, 28	1		
30	LINE_01	01YB-01	DIRECTIONAL INST OVERCURRENT PHASE A	Normal	Trip	-	-	LINE01	cc		Protection	OcpPTOC2	ST	Op/phsA		SOE	2	2	17, 28	1		
31	LINE_01	01YB-01	DIRECTIONAL INST OVERCURRENT PHASE B	Normal	Trip	-	-	LINE01	cc		Protection	OcpPTOC2	ST	Op/phsB		SOE	2	2	17, 28	1		
32	LINE_01	01YB-01	DIRECTIONAL INST OVERCURRENT PHASE C	Normal	Trip	-	-	LINE01	cc		Protection	OcpPTOC2	ST	Op/phsC		SOE	2	2	17, 28	1		
33	LINE_01	01YB-01	DIRECTIONAL INST EARTH FAULT	Normal	Trip	-	-	LINE01	cc		Protection	OcpPTOC2	ST	Op/neut		SOE	2	2	17, 28	1		
34	LINE_01	01YB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	LINE01	cc		Protection	CbfRBRF1	ST	OpEx.general		SOE	2	2	17, 28	1		
35	LINE_01	01YB-01	BUS ZONE TRIP	Normal	Trip	-	-	LINE01	cc		System	GosGGIO2	ST	Ind7.stVal		SOE	2	2	17, 28	1		
36	LINE_01	01YB-01	SYNCH. SWITCH SELECTION	Normal	Auto	-	-	LINE01	cc		System	GosGGIO2	ST	Ind8.stVal		DI	2	1	17, 28	1		
37	LINE_01	01YB-01	SYNCH. SWITCH SELECTION	Normal	Off	-	-	LINE01	cc		System	GosGGIO2	ST	Ind9.stVal		DI	2	1	17, 28	1		
38	LINE_01	01YB-01	SYNCH. SWITCH SELECTION	Normal	Manual	-	-	LINE01	cc		System	GosGGIO2	ST	Ind10.stVal		DI	2	1	17, 28	1		
39	LINE_01	01YB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	LINE01	xx.xx		System	GosGGIO2	ST	Ind11.stVal		DI	2	1	17, 28	1		
40	LINE_01	01YB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	LINE01	xx.xx		System	GosGGIO2	ST	Ind12.stVal		SOE	2	2	17, 28	1		
41	LINE_01	01YB-01	SPRING CHARGE	Normal	Fail	-	-	LINE01	xx.xx		System	GosGGIO2	ST	Ind13.stVal		DI	2	1	17, 28	1		
42	LINE_01	01YB-01	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	LINE01	xx.xx		System	GosGGIO2	ST	Ind14.stVal		DI	2	1	17, 28	1		
43	LINE_01	01YB-01	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail	-	-	LINE01	xx.xx		System	GosGGIO2	ST	Ind15.stVal		DI	2	1	17, 28	1		
44	LINE_01	01YB-01	TRIP TRANSFER STATUS	Normal	Tie	-	-	LINE01	cc		System	GosGGIO2	ST	Ind16.stVal		DI	2	1	17, 28	1		
45	LINE_01	01YB-01	AC SUPPLY FAILURE	Normal	Alarm	-	-	LINE01	xx.xx		System	GosGGIO2	ST	Ind17.stVal		DI	2	1	17, 28	1		
46	LINE_01	01YB-01	DC SUPPLY FAILURE	Normal	Alarm	-	-	LINE01	xx.xx		System	GosGGIO2	ST	Ind18.stVal		DI	2	1	17, 28	1		
47	LINE_01	01YB-01	AIR-CONDITION ALARM	Normal	Alarm	-	-	LINE01	xx.xx		System	GosGGIO2	ST	Ind19.stVal		DI	2	1	17, 28	1		
48	LINE_01	01YB-01	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	LINE01	xx.xx		System	GosGGIO2	ST	Ind20.stVal		DI	2	1	17, 28	1		
49	LINE_01	01YB-01	PROTECTION RELAY	Normal	Fail	-	-	LINE01	cc		System	GosGGIO2	ST	Ind21.stVal		DI	2	1	17, 28	1		
50	LINE_01	01YB-01	PROTECTION RELAY LAN A	Offline	Online	-	-	LINE01	cc		System	GosGGIO2	ST	Ind22.stVal		DI	2	1	17, 28	1		
51	LINE_01	01YB-01	PROTECTION RELAY LAN B	Offline	Online	-	-	LINE01	cc		System	GosGGIO2	ST	Ind23.stVal		DI	2	1	17, 28	1		
52	LINE_01	01YB-01	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	LINE01	cc		System	GosGGIO2	ST	Ind24.stVal		DI	2	1	17, 28	1		
53	LINE_01	01YB-01	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	LINE01	cc		System	GosGGIO2	ST	Ind25.stVal		DI	2	1	17, 28	1		
54	LINE_01	01YB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	LINE01	cc		System	GosGGIO2	ST	Ind26.stVal		DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.4

I/O POINT COUNTS FOR

115kV CONVENTIONAL CB, LINE BAY, SINGLE MAIN & TRANSFER BUS CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	115kV	Bay Name :	115kV Bus Tie Bay		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	Details: State 1	Details: State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	IEC 61850: Logical Node	IEC 61850: Data Object	IEC 61850: Data Attribute	IEC 61850: Logic	DMS (DNP Mapping): Type	DMS (DNP Mapping): Obj	DMS (DNP Mapping): Var	DMS (DNP Mapping): Qii	DMS (DNP Mapping): Class	DMS (DNP Mapping): Address	Remark
1	TIE	0BYB-01	CLOSE/OPEN COMMAND	Close	Open		TIE	xx.xx							SBO	12	1	echo of request			
2	TIE	0BYS-01	CLOSE/OPEN COMMAND	Close	Open		TIE	xx.xx							SBO	12	1	echo of request			
3	TIE	0BYS-02	CLOSE/OPEN COMMAND	Close	Open		TIE	xx.xx							SBO	12	1	echo of request			
4	TIE	0BYB-01	50HF ON/OFF COMMAND	On	Off		TIE	cc							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	Details: State 1	Details: State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	IEC 61850: Logical Node	IEC 61850: Data Object	IEC 61850: Data Attribute	IEC 61850: Logic	DMS (DNP Mapping): Type	DMS (DNP Mapping): Obj	DMS (DNP Mapping): Var	DMS (DNP Mapping): Qii	DMS (DNP Mapping): Class	DMS (DNP Mapping): Address	Remark
1	TIE	0BYB-01	VOLTAGE A-B	0-150	0-32767		TIE	xx.xx							AI	32	2	00, 01	2		115000/115V
2	TIE	0BYB-01	VOLTAGE B-C	0-150	0-32767		TIE	xx.xx							AI	32	2	00, 01	2		115000/115V
3	TIE	0BYB-01	VOLTAGE C-A	0-150	0-32767		TIE	xx.xx							AI	32	2	00, 01	2		115000/115V

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address
1	TIE	0BYB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	TIE	xx.xx							SOE	2	2	17, 28	1	
								TIE	xx.xx							SOE	2	2	17, 28	1	
2	TIE	0BYS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	TIE	xx.xx							DI	2	1	17, 28	1	
								TIE	xx.xx							DI	2	1	17, 28	1	
3	TIE	0BYS-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	TIE	xx.xx							DI	2	1	17, 28	1	
								TIE	xx.xx							DI	2	1	17, 28	1	
4	TIE	0BYB-01	CONTROL SET MODE	Undefine	Remote	Local	Fault	TIE	xx.xx							DI	2	1	17, 28	1	
								TIE	xx.xx							DI	2	1	17, 28	1	
6	TIE	0BYB-01	87B RELAY ON/OFF STATUS	-	On	Off	-	TIE	xx.xx							DI	2	1	17, 28	1	
								TIE	xx.xx							DI	2	1	17, 28	1	
7	TIE	0BYB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	TIE	xx.xx							DI	2	1	17, 28	1	
								TIE	xx.xx							DI	2	1	17, 28	1	
8	TIE	0BYB-01	BUS ZONE TRIP STATUS	-	Inservice	Isolate	-	TIE	xx.xx							DI	2	1	17, 28	1	
								TIE	xx.xx							SOE	2	2	17, 28	1	
9	TIE	0BYB-01	BUS DIFF PHASE A	Normal	Trip	-	-	TIE	cc		Protection	DifPDIF1	ST	Op.phsA		SOE	2	2	17, 28	1	
10	TIE	0BYB-01	BUS DIFF PHASE B	Normal	Trip	-	-	TIE	cc		Protection	DifPDIF1	ST	Op.phsB		SOE	2	2	17, 28	1	
11	TIE	0BYB-01	BUS DIFF PHASE C	Normal	Trip	-	-	TIE	cc		Protection	DifPDIF1	ST	Op.phsC		SOE	2	2	17, 28	1	
12	TIE	0BYB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	TIE	cc		System	Cbft01RBRF1	ST	OpEx.general		SOE	2	2	17, 28	1	
13	TIE	0BYB-01	AC SUPERVISION PHASE A	Normal	Alarm	-	-	TIE	cc		System	OptGGIO1	ST	In1.stVal		DI	2	1	17, 28	1	
14	TIE	0BYB-01	AC SUPERVISION PHASE B	Normal	Alarm	-	-	TIE	cc		Control	OptGGIO1	ST	In2.stVal		DI	2	1	17, 28	1	
15	TIE	0BYB-01	AC SUPERVISION PHASE C	Normal	Alarm	-	-	TIE	cc		System	OptGGIO1	ST	In3.stVal		DI	2	1	17, 28	1	
16	TIE	0BYB-01	BUS ZONE TRIP STATUS	Normal	Trip	-	-	TIE	cc		Protection	DifPDIF1	ST	Op.gerneral		SOE	2	2	17, 28	1	
17	TIE	0BYB-01	BUS DIFFERENTIAL RELAY LOCKOUT	Normal	Lockout	-	-	TIE	cc							SOE	2	2	17, 28	1	
18	TIE	0BYB-01	BUS OVER/UNDER VOLTAGE	Normal	Alarm	-	-	TIE	cc							DI	2	1	17, 28	1	
19	TIE	0BYB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	TIE	xx.xx							DI	2	1	17, 28	1	
20	TIE	0BYB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	TIE	xx.xx							SOE	2	2	17, 28	1	

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address
21	TIE	0BYB-01	SPRING CHARGE	Normal	Fail	-	-	TIE	xx.xx							DI	2	1	17, 28	1	
22	TIE	0BYB-01	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	TIE	xx.xx							DI	2	1	17, 28	1	
23	TIE	0BYB-01	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail	-	-	TIE	xx.xx							DI	2	1	17, 28	1	
24	TIE	0BYB-01	AC SUPPLY FAILURE	Normal	Alarm	-	-	TIE	xx.xx							DI	2	1	17, 28	1	
25	TIE	0BYB-01	DC SUPPLY FAILURE	Normal	Alarm	-	-	TIE	xx.xx							DI	2	1	17, 28	1	
26	TIE	0BYB-01	TRIP TRANSFER STATUS	Normal	Tie	-	-	TIE	cc							DI	2	1	17, 28	1	
27	TIE	0BYB-01	AIR-CONDITION ALARM	Normal	Alarm	-	-	TIE	xx.xx							DI	2	1	17, 28	1	
28	TIE	0BYB-01	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	TIE	xx.xx							DI	2	1	17, 28	1	
29	TIE	0BYB-01	PROTECTION RELAY	Normal	Fail	-	-	TIE	cc							DI	2	1	17, 28	1	
30	TIE	0BYB-01	PROTECTION RELAY LAN A	Offline	Online	-	-	TIE	cc							DI	2	1	17, 28	1	
31	TIE	0BYB-01	PROTECTION RELAY LAN B	Offline	Online	-	-	TIE	cc							DI	2	1	17, 28	1	
32	TIE	0BYB-01	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	TIE	cc							DI	2	1	17, 28	1	
33	TIE	0BYB-01	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	TIE	cc							DI	2	1	17, 28	1	
34	TIE	0BYB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	TIE	cc							DI	2	1	17, 28	1	

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1A

I/O POINT COUNTS FOR

115kV CONVENTIONAL CB, LINE BAY, SINGLE MAIN & TRANSFER BUS CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	115kV	Bay Name :	115kV Power Transformer Bay No.xx		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS(DNP Mapping): Type	Obj	Var	Qti	Class	Address	Remark
1	LINETP_01	02YB-01	CLOSE/OPEN COMMAND	Close	Open		LINETP01	xx.xx							SBO	12	1	echo of request			
2	LINETP_01	02YS-01	CLOSE/OPEN COMMAND	Close	Open		LINETP01	xx.xx							SBO	12	1	echo of request			
3	LINETP_01	02YS-02	CLOSE/OPEN COMMAND	Close	Open		LINETP01	xx.xx							SBO	12	1	echo of request			
4	LINETP_01	02YS-03	CLOSE/OPEN COMMAND	Close	Open		LINETP01	xx.xx							SBO	12	1	echo of request			
5	LINETP_01	02YB-01	50BF ON/OFF COMMAND	On	Off		LINETP01	cc							SBO	12	1	echo of request			
6	LINETP_01	02YB-01	87T1 ON/OFF COMMAND	On	Off		LINETP01	cc							SBO	12	1	echo of request			
7	LINETP_01	02YB-01	87T2 ON/OFF COMMAND	On	Off		LINETP01	cc							SBO	12	1	echo of request			
8	LINETP_01	02YB-01	87GL ON/OFF COMMAND	On	Off		LINETP01	cc							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS(DNP Mapping): Type	Obj	Var	Qti	Class	Address	Remark
1	LINETP_01	02YB-01	CURRENT PHASE A	0-400	0-32767		LINETP01	xx.xx							AI	32	2	00, 01	2		400/1A
2	LINETP_01	02YB-01	CURRENT PHASE B	0-400	0-32767		LINETP01	xx.xx							AI	32	2	00, 01	2		400/1A
3	LINETP_01	02YB-01	CURRENT PHASE C	0-400	0-32767		LINETP01	xx.xx							AI	32	2	00, 01	2		400/1A
4	LINETP_01	02YB-01	VOLTAGE A-B	0-150	0-32767		LINETP01	xx.xx							AI	32	2	00, 01	2		11500/115
5	LINETP_01	02YB-01	VOLTAGE B-C	0-150	0-32767		LINETP01	xx.xx							AI	32	2	00, 01	2		11500/115
6	LINETP_01	02YB-01	VOLTAGE C-A	0-150	0-32767		LINETP01	xx.xx							AI	32	2	00, 01	2		11500/115
7	LINETP_01	02YB-01	ACTIVE POWER	-467.64 - +467.64	-32767 - +32767		LINETP01	cc							AI	32	2	00, 01	2		Calculation
8	LINETP_01	02YB-01	RECATIVE POWER	-467.64 - +467.64	-32767 - +32767		LINETP01	cc							AI	32	2	00, 01	2		Calculation
9	LINETP_01	02YB-01	POWER FACTOR	+/- 100	-32767 - +32767		LINETP01	cc							AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)					
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address
				0	1	2	3														
1	LINETP_01	02YB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							SOE	2	2	17, 28	1	
								LINETP01	xx.xx							SOE	2	2	17, 28	1	
2	LINETP_01	02YS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1	
								LINETP01	xx.xx							DI	2	1	17, 28	1	
3	LINETP_01	02YS-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1	
								LINETP01	xx.xx							DI	2	1	17, 28	1	
4	LINETP_01	02YS-03	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1	
								LINETP01	xx.xx							DI	2	1	17, 28	1	
6	LINETP_01	02YB-01	CONTROL SET MODE	Undefine	Remote	Local	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1	
								LINETP01	xx.xx							DI	2	1	17, 28	1	
9	LINETP_01	02YB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	LINETP01	cc							DI	2	1	17, 28	1	
								LINETP01	cc							DI	2	1	17, 28	1	
10	LINETP_01	02YB-01	87T1 RELAY ON/OFF STATUS	-	On	Off	-	LINETP01	cc							DI	2	1	17, 28	1	
								LINETP01	cc							DI	2	1	17, 28	1	
12	LINETP_01	02YB-01	87TGL RELAY ON/OFF STATUS	-	On	Off	-	LINETP01	cc							DI	2	1	17, 28	1	
								LINETP01	cc							DI	2	1	17, 28	1	
13	LINETP_01	02YB-01	BUS ZONE TRIP STATUS	-	Inservice	Isolate	-	LINETP01	cc							DI	2	1	17, 28	1	
								LINETP01	cc							DI	2	1	17, 28	1	
14	LINETP_01	02YB-01	DIFFERENTIAL PHASE A	Normal	Trip	-	-	LINETP01	cc		Protection	PhsPDIF1	ST	Op.general		SOE	2	2	17, 28	1	
15	LINETP_01	02YB-01	DIFFERENTIAL PHASE B	Normal	Trip	-	-	LINETP01	cc		Protection	PhsPDIF1	ST	Op.phsA		SOE	2	2	17, 28	1	
16	LINETP_01	02YB-01	DIFFERENTIAL PHASE C	Normal	Trip	-	-	LINETP01	cc		Protection	PhsPDIF1	ST	Op.phsB		SOE	2	2	17, 28	1	
17	LINETP_01	02YB-01	DIFFERENTIAL RELAY	Normal	Trip	-	-	LINETP01	cc		Protection	PhsPDIF1	ST	Op.phsC		SOE	2	2	17, 28	1	
18	LINETP_01	02YB-01	O/C RELAY PHASE A	Normal	Trip	-	-	LINETP01	cc		Protection	OcpPTOC1	ST	Op/phsA		SOE	2	2	17, 28	1	
19	LINETP_01	02YB-01	O/C RELAY PHASE B	Normal	Trip	-	-	LINETP01	cc		Protection	OcpPTOC1	ST	Op/phsB		SOE	2	2	17, 28	1	
20	LINETP_01	02YB-01	O/C RELAY PHASE C	Normal	Trip	-	-	LINETP01	cc		Protection	OcpPTOC1	ST	Op/phsC		SOE	2	2	17, 28	1	
21	LINETP_01	02YB-01	O/C INST RELAY PHASE A	Normal	Trip	-	-	LINETP01	cc		Protection	OcpPTOC3	ST	Op/phsA		SOE	2	2	17, 28	1	
22	LINETP_01	02YB-01	O/C INST RELAY PHASE B	Normal	Trip	-	-	LINETP01	cc		Protection	OcpPTOC3	ST	Op/phsB		SOE	2	2	17, 28	1	
23	LINETP_01	02YB-01	O/C INST RELAY PHASE C	Normal	Trip	-	-	LINETP01	cc		Protection	OcpPTOC3	ST	Op/phsC		SOE	2	2	17, 28	1	
24	LINETP_01	02YB-01	O/C TIME DELAY	Normal	Trip	-	-	LINETP01	cc		Protection	OcpPTOC1	ST	Op/general		SOE	2	2	17, 28	1	

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)					
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address
				0	1	2	3														
25	LINETP_01	02YB-01	O/C EARTH FAULT TIME	Normal	Trip	-	-	LINETP01	cc		Protection	EfmPTOC1	ST	Op/general		SOE	2	2	17, 28	1	
26	LINETP_01	02YB-01	O/C PHASE INSTANTANEOUS	Normal	Trip	-	-	LINETP01	cc		Protection	OcpPTOC3	ST	Op/general		SOE	2	2	17, 28	1	
27	LINETP_01	02YB-01	O/C EARTH FAULT INSTANTANEOUS	Normal	Trip	-	-	LINETP01	cc		Protection	EfmPTOC3	ST	Op/general		SOE	2	2	17, 28	1	
28	LINETP_01	02YB-01	RESTRICTED EARTH FAULT (LV)	Normal	Trip	-	-	LINETP01	cc		Protection	Rf1PDIF1	ST	Op.general		SOE	2	2	17, 28	1	
29	LINETP_01	02YB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	LINETP01	cc		Protection	Bf1RBRF1	ST	OpEx.general		SOE	2	2	17, 28	1	
30	LINETP_01	02YB-01	TRANSFORMER INTERNAL PROTECTION	Normal	Trip	-	-	LINETP01	xx.xx							SOE	2	2	17, 28	1	
31	LINETP_01	02YB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1	
32	LINETP_01	02YB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	LINETP01	xx.xx							SOE	2	2	17, 28	1	
33	LINETP_01	02YB-01	SPRING CHARGE	Normal	Fail	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1	
34	LINETP_01	02YB-01	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1	
35	LINETP_01	02YB-01	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail			LINETP01	xx.xx							DI	2	1	17, 28	1	
36	LINETP_01	02YB-01	AC SUPPLY FAILURE	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1	
37	LINETP_01	02YB-01	DC SUPPLY FAILURE	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1	
	LINETP_01	02YB-01	TRIP TRANSFER STATUS	Normal	Tie			LINETP01	cc							DI	2	1	17, 28	1	
38	LINETP_01	02YB-01	AIR-CONDITION ALARM	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1	
39	LINETP_01	02YB-01	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1	
40	LINETP_01	02YB-01	MAIN PROTECTION RELAY LAN A	Offline	Online	-	-	LINETP01	cc							DI	2	1	17, 28	1	
41	LINETP_01	02YB-01	MAIN PROTECTION RELAY LAN B	Offline	Online	-	-	LINETP01	cc							DI	2	1	17, 28	1	
42	LINETP_01	02YB-01	BACK UP PROTECTION RELAY LAN A	Offline	Online	-	-	LINETP01	cc							DI	2	1	17, 28	1	
43	LINETP_01	02YB-01	BACK UP PROTECTION RELAY LAN B	Offline	Online	-	-	LINETP01	cc							DI	2	1	17, 28	1	
44	LINETP_01	02YB-01	MAIN PROTECTION RELAY	Normal	Fail	-	-	LINETP01	cc							DI	2	1	17, 28	1	
45	LINETP_01	02YB-01	BACK UP PROTECTION RELAY	Normal	Fail	-	-	LINETP01	cc							DI	2	1	17, 28	1	
46	LINETP_01	02YB-01	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	LINETP01	cc							DI	2	1	17, 28	1	
47	LINETP_01	02YB-01	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	LINETP01	cc							DI	2	1	17, 28	1	
48	LINETP_01	02YB-01	MAIN PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	LINETP01	cc							DI	2	1	17, 28	1	
49	LINETP_01	02YB-01	BACK UP PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	LINETP01	cc							DI	2	1	17, 28	1	

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.5

I/O POINT COUNTS FOR

115kV OUTDOOR TYPE SWITCHYARD, BREAKER AND A-HALF CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	115kV	Bay Name :	115kV Incoming Line From EGAT No.xx		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
1	LINE INC_xx	xxYB-xx	CLOSE/OPEN COMMAND	Close	Open	DPC	LINExx	xx.xx							SBO	12	1	echo of request			
2	LINE INC_xx	xxYS-xx	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xx.xx							SBO	12	1	echo of request			
3	LINE INC_xx	xxYS-xx	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xx.xx							SBO	12	1	echo of request			
4	LINE INC_xx	xxYS-xx	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xx.xx							SBO	12	1	echo of request			
5	LINE INC_xx	xxYB-xx	A/R ON/OFF COMMAND	On	Off	DCP	LINExx	cc							SBO	12	1	echo of request			
6	LINE INC_xx	xxYB-xx	50BF ON/OFF COMMAND	On	Off	DCP	LINExx	cc							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
1	LINE INC_xx	xxYB-xx	CURRENT PHASE A	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2		1200/1A
2	LINE INC_xx	xxYB-xx	CURRENT PHASE B	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2		1200/1A
3	LINE INC_xx	xxYB-xx	CURRENT PHASE C	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2		1200/1A
4	LINE INC_xx	xxYB-xx	ACTIVE POWER	-467.64 - +467.64	-32767 - +32767	MW	LINExx	cc							AI	32	2	00, 01	2		Calculation
5	LINE INC_xx	xxYB-xx	RECATIVE POWER	-467.64 - +467.64	-32767 - +32767	Mvar	LINExx	cc							AI	32	2	00, 01	2		Calculation
6	LINE INC_xx	xxYB-xx	POWER FACTOR	+/-100	-32767 - +32767	%	LINExx	cc							AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINE INC_xx	xxYB-xx	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							SOE	2	2	17, 28	1		
								LINExx	xx.xx							SOE	2	2	17, 28	1		
2	LINE INC_xx	xxYS-xx	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
3	LINE INC_xx	xxYS-xx	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
4	LINE INC_xx	xxYS-xx	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
5	LINE INC_xx	xxYG-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
6	LINE INC_xx	xxYB-xx	CONTROL SET MODE	Undefine	Remote	Local	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
7	LINE INC_xx	xxYB-xx	AUTO RECL ON/OFF STATUS	-	On	Off	-	LINExx	cc							DI	2	1	17, 28	1		
								LINExx	cc							DI	2	1	17, 28	1		
8	LINE INC_xx	xxYB-xx	50BF RELAY ON/OFF STATUS	-	On	Off	-	LINExx	cc							DI	2	1	17, 28	1		
								LINExx	cc							DI	2	1	17, 28	1		
9	LINE INC_xx	xxYB-xx	LINE DIFFERENTIL RELAY STATUS	-	On	Off	-	LINExx	cc							DI	2	1	17, 28	1		
								LINExx	cc							DI	2	1	17, 28	1		
10	LINE INC_xx	xxYB-xx	DIRECT TRANSFER TRIP (DTT) CUTOFF STATUS	Undefine	On	Off	Fault	LINExx	cc							DI	2	1	17, 28	1		
								LINExx	cc							DI	2	1	17, 28	1		
11	LINE INC_xx	xxYB-xx	LINE DIFFERENTIAL PHASE A	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
12	LINE INC_xx	xxYB-xx	LINE DIFFERENTIAL PHASE B	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
13	LINE INC_xx	xxYB-xx	LINE DIFFERENTIAL PHASE C	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
14	LINE INC_xx	xxYB-xx	LINE DIFFERENTIAL RELAY	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
15	LINE INC_xx	xxYB-xx	LINE DIFFERENTIAL RELAY LOCKOUT	Normal	Lockout	-	-	LINExx	cc							SOE	2	2	17, 28	1		
16	LINE INC_xx	xxYB-xx	AUTO RECL. PROGRESS STATUS	Normal	Operated	-	-	LINExx	cc							SOE	2	2	17, 28	1		
17	LINE INC_xx	xxYB-xx	AUTO RECL. LOCK OUT STATUS	Normal	Lockout	-	-	LINExx	cc							SOE	2	2	17, 28	1		

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
18	LINE INC_xx	xxYB-xx	DIRECTIONAL OVERCURRENT PHASE A	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
19	LINE INC_xx	xxYB-xx	DIRECTIONAL OVERCURRENT PHASE B	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
20	LINE INC_xx	xxYB-xx	DIRECTIONAL OVERCURRENT PHASE C	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
21	LINE INC_xx	xxYB-xx	DIRECTIONAL EARTH FAULT	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
22	LINE INC_xx	xxYB-xx	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
23	LINE INC_xx	xxYB-xx	SYNCH. SWITCH SELECTION	Normal	Auto	-	-	LINExx	cc							DI	2	1	17, 28	1		
24	LINE INC_xx	xxYB-xx	SYNCH. SWITCH SELECTION	Normal	Off	-	-	LINExx	cc							DI	2	1	17, 28	1		
25	LINE INC_xx	xxYB-xx	SYNCH. SWITCH SELECTION	Normal	Manual	-	-	LINExx	cc							DI	2	1	17, 28	1		
26	LINE INC_xx	xxYB-xx	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
27	LINE INC_xx	xxYB-xx	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	LINExx	xx.xx							SOE	2	2	17, 28	1		
28	LINE INC_xx	xxYB-xx	SPRING CHARGE	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
29	LINE INC_xx	xxYB-xx	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
30	LINE INC_xx	xxYB-xx	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
31	LINE INC_xx	xxYB-xx	AC SUPPLY FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
32	LINE INC_xx	xxYB-xx	DC SUPPLY FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
33	LINE INC_xx	xxYB-xx	PROTECTION RELAY DC FAIL	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
34	LINE INC_xx	xxYB-xx	AIR-CONDITION ALARM	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
35	LINE INC_xx	xxYB-xx	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
36	LINE INC_xx	xxYB-xx	PROTECTION RELAY	Normal	Fail	-	-	LINExx	cc							DI	2	1	17, 28	1		
37	LINE INC_xx	xxYB-xx	PROTECTION RELAY LAN A	Offline	Online	-	-	LINExx	cc							DI	2	1	17, 28	1		
38	LINE INC_xx	xxYB-xx	PROTECTION RELAY LAN B	Offline	Online	-	-	LINExx	cc							DI	2	1	17, 28	1		
39	LINE INC_xx	xxYB-xx	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	LINExx	cc							DI	2	1	17, 28	1		
40	LINE INC_xx	xxYB-xx	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	LINExx	cc							DI	2	1	17, 28	1		
41	LINE INC_xx	xxYB-xx	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	LINExx	cc							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.5

I/O POINT COUNTS FOR

115KV OUTDOOR TYPE SWITCHYARD, BREAKER AND A-HALF CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	**115kV**	Bay Name :	**115kV Outgoing Line No.xx**		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs :

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
1	LINE OUT_xx	xxYB-xx	CLOSE/OPEN COMMAND	Close	Open	DPC	LINExx	xx.xx							SBO	12	1	echo of request		6	
2	LINE OUT_xx	xxYB-xx	CLOSE/OPEN BY PASS COMMAND	Close	-	SCP	LINExx	xx.xx							SBO	12	1	echo of request		7	
3	LINE OUT_xx	xxYS-xx	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xx.xx							SBO	12	1	echo of request		8	
4	LINE OUT_xx	xxYS-xx	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xx.xx							SBO	12	1	echo of request		9	
5	LINE OUT_xx	xxYS-xx	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xx.xx							SBO	12	1	echo of request		10	
6	LINE OUT_xx	xxYB-xx	AR ON/OFF COMMAND	On	Off	DCP	LINExx	cc							SBO	12	1	echo of request		11	
7	LINE INC_xx	xxYB-xx	50BF ON/OFF COMMAND	On	Off	DCP	LINExx	cc							SBO	12	1	echo of request		12	

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
1	LINE OUT_xx	xxYB-xx	CURRENT PHASE A	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2	6	1200/1A
2	LINE OUT_xx	xxYB-xx	CURRENT PHASE B	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2	7	1200/1A
3	LINE OUT_xx	xxYB-xx	CURRENT PHASE C	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2	8	1200/1A
4	LINE OUT_xx	xxYB-xx	ACTIVE POWER	-467.64 - +467.64	-32767 - +32767	MW	LINExx	cc							AI	32	2	00, 01	2	9	Calculation
5	LINE OUT_xx	xxYB-xx	RECATIVE POWER	-467.64 - +467.64	-32767 - +32767	Mvar	LINExx	cc							AI	32	2	00, 01	2	10	Calculation
6	LINE OUT_xx	xxYB-xx	POWER FACTOR	+/- 100	-32767 - +32767	%	LINExx	cc							AI	32	2	00, 01	2	11	Calculation

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINE OUT_xx	xxYB-xx	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							SOE	2	2	17, 28	1	51	
								LINExx	xx.xx							SOE	2	2	17, 28	1	52	
2	LINE OUT_xx	xxYS-xx	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1	53	
								LINExx	xx.xx							DI	2	1	17, 28	1	54	
3	LINE OUT_xx	xxYS-xx	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1	55	
								LINExx	xx.xx							DI	2	1	17, 28	1	56	
4	LINE OUT_xx	xxYS-xx	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1	57	
								LINExx	xx.xx							DI	2	1	17, 28	1	58	
5	LINE OUT_xx	xxYG-xx	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1	59	
								LINExx	xx.xx							DI	2	1	17, 28	1	60	
6	LINE OUT_xx	xxYB-xx	CONTROL SET MODE	Undefine	Remote	Local	Fault	LINExx	xx.xx							DI	2	1	17, 28	1	61	
								LINExx	xx.xx							DI	2	1	17, 28	1	62	
7	LINE OUT_xx	xxYB-xx	AUTO RECL ON/OFF STATUS	-	On	Off	-	LINExx	cc							DI	2	1	17, 28	1	63	
								LINExx	cc							DI	2	1	17, 28	1	64	
8	LINE OUT_xx	xxYB-xx	50BF RELAY ON/OFF STATUS	-	On	Off	-	LINExx	cc							DI	2	1	17, 28	1	65	
								LINExx	cc							DI	2	1	17, 28	1	66	
9	LINE OUT_xx	xxYB-xx	DISTANCE RELAY VT CIRCUIT FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	67	
10	LINE OUT_xx	xxYB-xx	DISTANCE RELAY	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	68	
11	LINE OUT_xx	xxYB-xx	DISTANCE RELAY ZONE 1	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	69	
12	LINE OUT_xx	xxYB-xx	DISTANCE RELAY ZONE 2	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	70	
13	LINE OUT_xx	xxYB-xx	DISTANCE RELAY ZONE 3	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	71	
14	LINE OUT_xx	xxYB-xx	DISTANCE RELAY PHASE A	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	72	
15	LINE OUT_xx	xxYB-xx	DISTANCE RELAY PHASE B	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	73	
16	LINE OUT_xx	xxYB-xx	DISTANCE RELAY PHASE C	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	74	
17	LINE OUT_xx	xxYB-xx	DISTANCE RELAY PHASE N	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	75	
18	LINE OUT_xx	xxYB-xx	DISTANCE SWITCH ON TO FAULT	Normal	Alarm	-	-	LINExx	cc							SOE	2	2	17, 28	1	76	
19	LINE OUT_xx	xxYB-xx	DISTANCE LINE AIDED TRIP	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	77	
20	LINE OUT_xx	xxYB-xx	AUTO RECL. PROGRESS STATUS	Normal	Operated	-	-	LINExx	cc							SOE	2	2	17, 28	1	78	
21	LINE OUT_xx	xxYB-xx	AUTO RECL. LOCK OUT STATUS	Normal	Lockout	-	-	LINExx	cc							SOE	2	2	17, 28	1	79	

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State					Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
22	LINE OUT_xx	xxYB-xx	DIRECTIONAL OVERCURRENT PHASE A	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	80	
23	LINE OUT_xx	xxYB-xx	DIRECTIONAL OVERCURRENT PHASE B	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	81	
24	LINE OUT_xx	xxYB-xx	DIRECTIONAL OVERCURRENT PHASE C	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	82	
25	LINE OUT_xx	xxYB-xx	DIRECTIONAL EARTH FAULT	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	83	
26	LINE OUT_xx	xxYB-xx	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1	84	
27	LINE OUT_xx	xxYB-xx	SYNCH. SWITCH SELECTION	Normal	Auto	-	-	LINExx	cc							DI	2	1	17, 28	1	85	
28	LINE OUT_xx	xxYB-xx	SYNCH. SWITCH SELECTION	Normal	Off	-	-	LINExx	cc							DI	2	1	17, 28	1	86	
29	LINE OUT_xx	xxYB-xx	SYNCH. SWITCH SELECTION	Normal	Manual	-	-	LINExx	cc							DI	2	1	17, 28	1	87	
30	LINE OUT_xx	xxYB-xx	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	88	
31	LINE OUT_xx	xxYB-xx	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	LINExx	xx.xx							SOE	2	2	17, 28	1	89	
32	LINE OUT_xx	xxYB-xx	SPRING CHARGE	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	90	
33	LINE OUT_xx	xxYB-xx	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	91	
34	LINE OUT_xx	xxYB-xx	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	92	
35	LINE OUT_xx	xxYB-xx	AC SUPPLY FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	93	
36	LINE OUT_xx	xxYB-xx	DC SUPPLY FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	94	
37	LINE OUT_xx	xxYB-xx	PROTECTION RELAY DC FAIL	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	95	
38	LINE OUT_xx	xxYB-xx	AIR-CONDITION ALARM	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	96	
39	LINE OUT_xx	xxYB-xx	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1	97	
40	LINE OUT_xx	xxYB-xx	PROTECTION RELAY	Normal	Fail	-	-	LINExx	cc							DI	2	1	17, 28	1	98	
41	LINE OUT_xx	xxYB-xx	PROTECTION RELAY LAN A	Offline	Online	-	-	LINExx	cc							DI	2	1	17, 28	1	99	
42	LINE OUT_xx	xxYB-xx	PROTECTION RELAY LAN B	Offline	Online	-	-	LINExx	cc							DI	2	1	17, 28	1	100	
43	LINE OUT_xx	xxYB-xx	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	LINExx	cc							DI	2	1	17, 28	1	101	
44	LINE OUT_xx	xxYB-xx	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	LINExx	cc							DI	2	1	17, 28	1	102	
45	LINE OUT_xx	xxYB-xx	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	LINExx	cc							DI	2	1	17, 28	1	103	

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.5

I/O POINT COUNTS FOR

115kV OUTDOOR TYPE SWITCHYARD, BREAKER AND A-HALF CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :
Voltage Level :	115kV	Bay Name :	115kV Center Breaker	
IED Product :		IED Model/Type :		
IED IP Address :				

Control Outputs:

Item	Feeder Name	Bay Name	Detail			Data	Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State		Class		Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qfl	Class	Address	
				1	2																
1	CENTER CB_xx	xxYB-02	CLOSE/OPEN COMMAND	Close	Open	DPC	LINExx	xx.xx							SBO	12	1	echo of request			
2	CENTER CB_xx	xxYS-03	CLOSE/OPEN COMMAND	Close	Open	DPC	LINExx	xx.xx							SBO	12	1	echo of request			
3	CENTER CB_xx	xxYS-04	CLOSE/OPEN COMMAND	Close	Open	DPC	LINExx	xx.xx							SBO	12	1	echo of request			
4	CENTER CB_xx	xxYB-02	A/R ON/OFF COMMAND	On	Off	DPC	LINExx	cc							SBO	12	1	echo of request			
5	CENTER CB_xx	xxYB-02	50BF ON/OFF COMMAND	On	Off	DPC	LINExx	cc							SBO	12	1	echo of request			

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State					Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
1	CENTER CB_xx	xxYB-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							SOE	2	2	17, 28	1		
								LINExx	xx.xx							SOE	2	2	17, 28	1		
2	CENTER CB_xx	xxYS-03	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
3	CENTER CB_xx	xxYS-04	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
4	CENTER CB_xx	xxYB-02	CONTROL SET MODE	Undefine	Remote	Local	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
5	CENTER CB_xx	xxYB-02	AUTO RECL ON/OFF STATUS	-	On	Off	-	LINExx	cc							DI	2	1	17, 28	1		
								LINExx	cc							DI	2	1	17, 28	1		
6	CENTER CB_xx	xxYB-02	50BF RELAY ON/OFF STATUS	-	On	Off	-	LINExx	cc							DI	2	1	17, 28	1		
								LINExx	cc							DI	2	1	17, 28	1		
7	CENTER CB_xx	xxYB-02	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
8	CENTER CB_xx	xxYB-02	SYNCH. SWITCH SELECTION	Normal	Auto	-	-	LINExx	cc							DI	2	1	17, 28	1		
9	CENTER CB_xx	xxYB-02	SYNCH. SWITCH SELECTION	Normal	Off	-	-	LINExx	cc							DI	2	1	17, 28	1		
10	CENTER CB_xx	xxYB-02	SYNCH. SWITCH SELECTION	Normal	Manual	-	-	LINExx	cc							DI	2	1	17, 28	1		
11	CENTER CB_xx	xxYB-02	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
12	CENTER CB_xx	xxYB-02	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	LINExx	xx.xx							SOE	2	2	17, 28	1		
13	CENTER CB_xx	xxYB-02	SPRING CHARGE	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
14	CENTER CB_xx	xxYB-02	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
15	CENTER CB_xx	xxYB-02	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail			LINExx	xx.xx							DI	2	1	17, 28	1		
16	CENTER CB_xx	xxYB-02	AC SUPPLY FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
17	CENTER CB_xx	xxYB-02	DC SUPPLY FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.5

I/O POINT COUNTS FOR

115kV OUTDOOR TYPE SWITCHYARD, BREAKER AND A-HALF CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	**115kV**	Bay Name :	**115kV Main Bus**		
IED Product :		IED Model/Type :			
IED IP Address :					

Analog Points:

Item	Feeder Name	Bay Name	Details			Unit	Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State						Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				1	2																
1	MAINBUS_01	BUS	BUS 1 VOLTAGE B-N	0-150	0-32767	kV	BUS	xx.xx							AI	32	2	00, 01	2	12	115000:115V
2	MAINBUS_01	BUS	BUS 1 FREQUENCY	0-60	0-32767	Hz	BUS	cc							AI	32	2	00, 01	2	13	-
3	MAINBUS_01	BUS	BUS 2 VOLTAGE B-N	0-150	0-32767	kV	BUS	xx.xx							AI	32	2	00, 01	2	14	115000:115V
4	MAINBUS_01	BUS	BUS 2 FREQUENCY	0-60	0-32767	Hz	BUS	cc							AI	32	2	00, 01	2	15	-

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
1	MAINBUS_01	BUS	87B RELAY BUS 1 ON/OFF STATUS	-	On	Off	-	BUS	cc							DI	2	1	17, 28	1	127	
								BUS	cc							DI	2	1	17, 28	1	128	
2	MAINBUS_01	BUS	87B RELAY BUS 2 ON/OFF STATUS	-	On	Off	-	BUS	cc							DI	2	1	17, 28	1	129	
								BUS	cc							DI	2	1	17, 28	1	130	
3	MAINBUS_01	BUS	BUS 1 DIFFERENTIAL PHASE A	Normal	Operate	-	-	BUS	cc							SOE	2	2	17, 28	1	131	
4	MAINBUS_01	BUS	BUS 1 DIFFERENTIAL PHASE B	Normal	Operate	-	-	BUS	cc							SOE	2	2	17, 28	1	132	
5	MAINBUS_01	BUS	BUS 1 DIFFERENTIAL PHASE C	Normal	Operate	-	-	BUS	cc							SOE	2	2	17, 28	1	133	
6	MAINBUS_01	BUS	BUS 2 DIFFERENTIAL PHASE A	Normal	Operate	-	-	BUS	cc							SOE	2	2	17, 28	1	134	
7	MAINBUS_01	BUS	BUS 2 DIFFERENTIAL PHASE B	Normal	Operate	-	-	BUS	cc							SOE	2	2	17, 28	1	135	
8	MAINBUS_01	BUS	BUS 2 DIFFERENTIAL PHASE C	Normal	Operate	-	-	BUS	cc							SOE	2	2	17, 28	1	136	
9	MAINBUS_01	BUS	BUS 1 AC SUPERVISION PHASE A	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1	137	
10	MAINBUS_01	BUS	BUS 1 AC SUPERVISION PHASE B	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1	138	
11	MAINBUS_01	BUS	BUS 1 AC SUPERVISION PHASE C	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1	139	
12	MAINBUS_01	BUS	BUS 2 AC SUPERVISION PHASE A	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1	140	
13	MAINBUS_01	BUS	BUS 2 AC SUPERVISION PHASE B	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1	141	
14	MAINBUS_01	BUS	BUS 2 AC SUPERVISION PHASE C	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1	142	

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State					Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
15	MAIN BUS_01	BUS	BUS 1 DC SUPPLY FAILURE	Normal	Alarm	-	-	BUS								DI	2	1	17, 28	1	143	
16	MAIN BUS_01	BUS	BUS 2 DC SUPPLY FAILURE	Normal	Alarm	-	-	BUS								DI	2	1	17, 28	1	144	
17	MAIN BUS_01	BUS	BUS 1 VOLTAGE RECORDER	Normal	Fail	-	-	BUS								DI	2	1	17, 28	1	145	
18	MAIN BUS_01	BUS	BUS 2 VOLTAGE RECORDER	Normal	Fail	-	-	BUS								DI	2	1	17, 28	1	146	
19	MAIN BUS_01	BUS	BUS 1 PT CIRCUIT	Normal	Fail	-	-	BUS								DI	2	1	17, 28	1	147	
20	MAIN BUS_01	BUS	BUS 2 PT CIRCUIT	Normal	Fail	-	-	BUS								DI	2	1	17, 28	1	148	
21	MAIN BUS_01	BUS	PROTECTION RELAY DC FAIL	Normal	Alarm	-	-	BUS								DI	2	1	17, 28	1	149	
22	MAIN BUS_01	BUS	AIR-CONDITION ALARM	Normal	Alarm	-	-	BUS								DI	2	1	17, 28	1	150	
23	MAIN BUS_01	BUS	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	BUS								DI	2	1	17, 28	1	151	
24	MAIN BUS_01	BUS	PROTECTION RELAY	Normal	Fail	-	-	BUS								DI	2	1	17, 28	1	152	
25	MAIN BUS_01	BUS	PROTECTION RELAY LAN A	Offline	Online	-	-	BUS								DI	2	1	17, 28	1	153	
26	MAIN BUS_01	BUS	PROTECTION RELAY LAN B	Offline	Online	-	-	BUS								DI	2	1	17, 28	1	154	
27	MAIN BUS_01	BUS	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	BUS								DI	2	1	17, 28	1	155	
28	MAIN BUS_01	BUS	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	BUS								DI	2	1	17, 28	1	156	
29	MAIN BUS_01	BUS	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	BUS								DI	2	1	17, 28	1	157	

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.0

I/O POINT COUNTS FOR

115kV AIS DOUBLE BUS-SINGLE BREAKER

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	115kV	Bay Name :	115 kV Incoming or Outgoing Line No.__		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINE_xx	xxYB-01	CLOSE/OPEN COMMAND	Close	Open	DPC	LINExx	xx.xx							SBO	12	1	echo of request			
2	LINE_xx	xxYB-01	CLOSE/OPEN BY PASS COMMAND	Close	-	SCP	LINExx	xx.xx							SBO	12	1	echo of request			
3	LINE_xx	xxYS-01	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xx.xx							SBO	12	1	echo of request			
4	LINE_xx	xxYS-02	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xx.xx							SBO	12	1	echo of request			
5	LINE_xx	xxYS-03	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xx.xx							SBO	12	1	echo of request			
6	LINE_xx	xxYB-01	A/R ON/OFF COMMAND	On	Off	DCP	LINExx	cc							SBO	12	1	echo of request			
7	LINE_xx	xxYB-01	50BF ON/OFF COMMAND	On	Off	DCP	LINExx	cc							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINE_xx	xxYB-01	CURRENT PHASE A	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2		1200/1A
2	LINE_xx	xxYB-01	CURRENT PHASE B	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2		1200/1A
3	LINE_xx	xxYB-01	CURRENT PHASE C	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2		1200/1A
4	LINE_xx	xxYB-01	VOLTAGE A-B	0-150	0-32767	kV	LINExx	xx.xx							AI	32	2	00, 01	2		115000/115
5	LINE_xx	xxYB-01	VOLTAGE B-C	0-150	0-32767	kV	LINExx	xx.xx							AI	32	2	00, 01	2		115000/115
6	LINE_xx	xxYB-01	VOLTAGE C-A	0-150	0-32767	kV	LINExx	xx.xx							AI	32	2	00, 01	2		115000/115
7	LINE_xx	xxYB-01	ACTIVE POWER	-467.64 - +467.64	-32767 - +32767	MW	LINExx	cc							AI	32	2	00, 01	2		Calculation
8	LINE_xx	xxYB-01	RECATIVE POWER	-467.64 - +467.64	-32767 - +32767	Mvar	LINExx	cc							AI	32	2	00, 01	2		Calculation
9	LINE_xx	xxYB-01	POWER FACTOR	+/-100	-32767 - +32767	%	LINExx	cc							AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
1	LINE_xx	xxYB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							SOE	2	2	17, 28	1		
								LINExx	xx.xx							SOE	2	2	17, 28	1		
2	LINE_xx	xxYS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
3	LINE_xx	xxYS-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
4	LINE_xx	xxYS-03	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
5	LINE_xx	xxYG-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
6	LINE_xx	xxYB-01	CONTROL SET MODE	Undefine	Remote	Local	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
8	LINE_xx	xxYB-01	AUTO RECL ON/OFF STATUS	-	On	Off	-	LINExx	cc							DI	2	1	17, 28	1		
								LINExx	cc							DI	2	1	17, 28	1		
9	LINE_xx	xxYB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	LINExx	cc							DI	2	1	17, 28	1		
								LINExx	cc							DI	2	1	17, 28	1		
10	LINE_xx	xxYB-01	BUS ZONE 1 TRIP STATUS	-	Inservice	Isolate	-	LINExx	cc							DI	2	1	17, 28	1		
								LINExx	cc							DI	2	1	17, 28	1		
11	LINE_xx	xxYB-01	BUS ZONE 2 TRIP STATUS	-	Inservice	Isolate	-	LINExx	cc							DI	2	1	17, 28	1		
								LINExx	cc							DI	2	1	17, 28	1		
12	LINE_xx	xxYB-01	DISTANCE RELAY VT CIRCUIT FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
13	LINE_xx	xxYB-01	DISTANCE RELAY	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
14	LINE_xx	xxYB-01	DISTANCE RELAY ZONE 1	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
15	LINE_xx	xxYB-01	DISTANCE RELAY ZONE 2	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
16	LINE_xx	xxYB-01	DISTANCE RELAY ZONE 3	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
17	LINE_xx	xxYB-01	DISTANCE RELAY PHASE A	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
18	LINE_xx	xxYB-01	DISTANCE RELAY PHASE B	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
19	LINE_xx	xxYB-01	DISTANCE RELAY PHASE C	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
20	LINE_xx	xxYB-01	DISTANCE RELAY PHASE N	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
21	LINE_xx	xxYB-01	DISTANCE SWITCH ON TO FAULT	Normal	Alarm	-	-	LINExx	cc							SOE	2	2	17, 28	1		
22	LINE_xx	xxYB-01	DISTANCE LINE AIDED TRIP	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
23	LINE_xx	xxYB-01	AUTO RECL. PROGRESS STATUS	Normal	Operated	-	-	LINExx	cc							SOE	2	2	17, 28	1		
24	LINE_xx	xxYB-01	AUTO RECL. LOCK OUT STATUS	Normal	Lockout	-	-	LINExx	cc							SOE	2	2	17, 28	1		
25	LINE_xx	xxYB-01	DIRECTIONAL OVERCURRENT PHASE A	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
26	LINE_xx	xxYB-01	DIRECTIONAL OVERCURRENT PHASE B	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
27	LINE_xx	xxYB-01	DIRECTIONAL OVERCURRENT PHASE C	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
28	LINE_xx	xxYB-01	DIRECTIONAL EARTH FAULT	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
29	LINE_xx	xxYB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
30	LINE_xx	xxYB-01	BUS ZONE 1 TRIP	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
31	LINE_xx	xxYB-01	BUS ZONE 2 TRIP	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
32	LINE_xx	xxYB-01	SYNCH. SWITCH SELECTION	Normal	Auto	-	-	LINExx	cc							DI	2	1	17, 28	1		
33	LINE_xx	xxYB-01	SYNCH. SWITCH SELECTION	Normal	Off	-	-	LINExx	cc							DI	2	1	17, 28	1		
34	LINE_xx	xxYB-01	SYNCH. SWITCH SELECTION	Normal	Manual	-	-	LINExx	cc							DI	2	1	17, 28	1		
35	LINE_xx	xxYB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
36	LINE_xx	xxYB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	LINExx	xx.xx							SOE	2	2	17, 28	1		
37	LINE_xx	xxYB-01	SPRING CHARGE	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
38	LINE_xx	xxYB-01	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
39	LINE_xx	xxYB-01	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
40	LINE_xx	xxYB-01	TRIP TRANSFER STATUS	Normal	Tie	-	-	LINExx	cc							DI	2	1	17, 28	1		
41	LINE_xx	xxYB-01	AC SUPPLY FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
42	LINE_xx	xxYB-01	DC SUPPLY FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
43	LINE_xx	xxYB-01	PROTECTION RELAY DC FAIL	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
44	LINE_xx	xxYB-01	AIR-CONDITION ALARM	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
45	LINE_xx	xxYB-01	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
46	LINE_xx	xxYB-01	PROTECTION RELAY	Normal	Fail	-	-	LINExx	cc							DI	2	1	17, 28	1		
47	LINE_xx	xxYB-01	PROTECTION RELAY LAN A	Offline	Online	-	-	LINExx	cc							DI	2	1	17, 28	1		
48	LINE_xx	xxYB-01	PROTECTION RELAY LAN B	Offline	Online	-	-	LINExx	cc							DI	2	1	17, 28	1		
49	LINE_xx	xxYB-01	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	LINExx	cc							DI	2	1	17, 28	1		
50	LINE_xx	xxYB-01	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	LINExx	cc							DI	2	1	17, 28	1		
51	LINE_xx	xxYB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	LINExx	cc							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.6

I/O POINT COUNTS FOR

115kV AIS DOUBLE BUS-SINGLE BREAKER

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	**115kV**	Bay Name :	**115 kV Bus Coupling Breaker**		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	BUS	0BYB-01	CLOSE/OPEN COMMAND	Close	Open	DCP	BUS	xx.xx							SBO	12	1	echo of request			
2	BUS	0BYS-01	CLOSE/OPEN COMMAND	Close	Open	Class	BUS	xx.xx							SBO	12	1	echo of request			
3	BUS	0BYS-02	CLOSE/OPEN COMMAND	Close	Open	DCP	BUS	xx.xx							SBO	12	1	echo of request			
4	BUS	0BYB-01	50BF ON/OFF COMMAND	On	Off	DCP	BUS	cc							SBO	12	1	echo of request			
5	BUS	0BYB-01	87B ON/OFF COMMAND	On	Off	DCP	BUS	cc							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	BUS	0BYB-01	BUS 1 VOLTAGE	0-150	0-32767	kV	BUS	xx.xx							AI	32	2	00, 01	2		115000/115V
2	BUS	0BYB-01	BUS 1 FREQUENCY	0-60	0-32767	Hz	BUS	cc							AI	32	2	00, 01	2		-
3	BUS	0BYB-01	BUS 2 VOLTAGE	0-150	0-32767	kV	BUS	xx.xx							AI	32	2	00, 01	2		115000/115V
4	BUS	0BYB-01	BUS 2 FREQUENCY	0-60	0-32767	Hz	BUS	cc							AI	32	2	00, 01	2		-

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
1	BUS	0BYB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BUS	xx.xx							SOE	2	2	17, 28	1		
								BUS	xx.xx							SOE	2	2	17, 28	1		
2	BUS	0BYS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BUS	xx.xx							DI	2	1	17, 28	1		
								BUS	xx.xx							DI	2	1	17, 28	1		
3	BUS	0BYS-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BUS	xx.xx							DI	2	1	17, 28	1		
								BUS	xx.xx							DI	2	1	17, 28	1		
4	BUS	0BYB-01	CONTROL SET MODE	Undefine	Remote	Local	Fault	BUS	xx.xx							DI	2	1	17, 28	1		
								BUS	xx.xx							DI	2	1	17, 28	1		
5	BUS	0BYB-01	87B RELAY ON/OFF STATUS	-	On	Off	-	BUS	xx.xx							DI	2	1	17, 28	1		
								BUS	xx.xx							DI	2	1	17, 28	1		
6	BUS	0BYB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	BUS	xx.xx							DI	2	1	17, 28	1		
								BUS	xx.xx							DI	2	1	17, 28	1		
7	BUS	0BYB-01	BUS ZONE 1 TRIP STATUS		Inservice	Isolate		BUS	cc							DI	2	1	17, 28	1		
								BUS	cc							DI	2	1	17, 28	1		
8	BUS	0BYB-01	BUS ZONE 2 TRIP STATUS		Inservice	Isolate		BUS	cc							DI	2	1	17, 28	1		
								BUS	cc							DI	2	1	17, 28	1		
9	BUS	0BYB-01	BUS 1 DIFFERENTIAL PHASE A	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1		
10	BUS	0BYB-01	BUS 1 DIFFERENTIAL PHASE B	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1		
11	BUS	0BYB-01	BUS 1 DIFFERENTIAL PHASE B	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1		
12	BUS	0BYB-01	BUS 2 DIFFERENTIAL PHASE A	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1		
13	BUS	0BYB-01	BUS 2 DIFFERENTIAL PHASE B	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1		
14	BUS	0BYB-01	BUS 2 DIFFERENTIAL PHASE B	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1		
15	BUS	0BYB-01	BUS 1 AC SUPERVISION PHASE A	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1		
16	BUS	0BYB-01	BUS 1 AC SUPERVISION PHASE B	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1		
17	BUS	0BYB-01	BUS 1 AC SUPERVISION PHASE C	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1		
18	BUS	0BYB-01	BUS 2 AC SUPERVISION PHASE A	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1		
19	BUS	0BYB-01	BUS 2 AC SUPERVISION PHASE B	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1		
20	BUS	0BYB-01	BUS 2 AC SUPERVISION PHASE C	Normal	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1		
21	BUS	0BYB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1		
22	BUS	0BYB-01	BUS ZONE 1 TRIP STATUS	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1		
23	BUS	0BYB-01	BUS ZONE 2 TRIP STATUS	Normal	Trip	-	-	BUS	cc							SOE	2	2	17, 28	1		

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
24	BUS	0BYB-01	BUS 1 DC SUPPLY	Normal	Fail	-	-	BUS	cc							SOE	2	2	17, 28	1		
25	BUS	0BYB-01	BUS 2 DC SUPPLY	Normal	Fail	-	-	BUS	cc							DI	2	1	17, 28	1		
26	BUS	0BYB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	BUS	xx.xx							DI	2	1	17, 28	1		
27	BUS	0BYB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	BUS	xx.xx							SOE	2	2	17, 28	1		
28	BUS	0BYB-01	SPRING CHARGE	Normal	Fail	-	-	BUS	xx.xx							DI	2	1	17, 28	1		
29	BUS	0BYB-01	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	BUS	xx.xx							DI	2	1	17, 28	1		
30	BUS	0BYB-01	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail	-	-	BUS	xx.xx							DI	2	1	17, 28	1		
31	BUS	0BYB-01	AC SUPPLY FAILURE	Normal	Alarm	-	-	BUS	xx.xx							DI	2	1	17, 28	1		
32	BUS	0BYB-01	DC SUPPLY FAILURE	Normal	Alarm	-	-	BUS	xx.xx							DI	2	1	17, 28	1		
33	BUS	0BYB-01	PROTECTION RELAY DC FAIL	Normal	Alarm	-	-	BUS	xx.xx							DI	2	1	17, 28	1		
34	BUS	0BYB-01	AIR-CONDITION ALARM	Normal	Alarm	-	-	BUS	xx.xx							DI	2	1	17, 28	1		
35	BUS	0BYB-01	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	BUS	xx.xx							DI	2	1	17, 28	1		
36	BUS	0BYB-01	PROTECTION RELAY	Normal	Fail	-	-	BUS	cc							DI	2	1	17, 28	1		
37	BUS	0BYB-01	PROTECTION RELAY LAN A	Offline	Online	-	-	BUS	cc							DI	2	1	17, 28	1		
38	BUS	0BYB-01	PROTECTION RELAY LAN B	Offline	Online	-	-	BUS	cc							DI	2	1	17, 28	1		
39	BUS	0BYB-01	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1		
40	BUS	0BYB-01	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	BUS	cc							DI	2	1	17, 28	1		
41	BUS	0BYB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	BUS	cc							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.6

I/O POINT COUNTS FOR

115kV AIS DOUBLE BUS-SINGLE BREAKER

Substation Name :		Substation Code Name :	Substation DNP Adress :
Voltage Level :	115kV	Bay Name :	115 kV Power Transformer Bay No.xx
IED Product :		IED Model/Type :	
IED IP Address :			

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qli	Class	Address	Remark
1	LINETP_01	xxYB-01	CLOSE/OPEN COMMAND	Close	Open	DCP	LINETP01	xxxx							SBO	12	1	echo of request			
2	LINETP_01	xxYS-01	CLOSE/OPEN COMMAND	Close	Open	DCP	LINETP01	xxxx							SBO	12	1	echo of request			
3	LINETP_01	xxYS-02	CLOSE/OPEN COMMAND	Close	Open	DCP	LINETP01	xxxx							SBO	12	1	echo of request			
4	LINETP_01	xxYB-01	50BF ON/OFF COMMAND	On	Off	DCP	LINETP01	cc							SBO	12	1	echo of request			
5	LINETP_01	xxYB-01	87T ON/OFF COMMAND	On	Off	DCP	LINETP01	cc							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qli	Class	Address	Remark
1	LINETP_01	xxYB-01	CURRENT PHASE A	0-400	0-32767	A	LINETP01	xx.xx							AI	32	2	00, 01	2		400/1A
2	LINETP_01	xxYB-01	CURRENT PHASE B	0-400	0-32767	A	LINETP01	xx.xx							AI	32	2	00, 01	2		400/1A
3	LINETP_01	xxYB-01	CURRENT PHASE C	0-400	0-32767	A	LINETP01	xx.xx							AI	32	2	00, 01	2		400/1A
4	LINETP_01	xxYB-01	VOLTAGE A-B	0-150	0-32767	kV	LINETP01	xx.xx							AI	32	2	00, 01	2		115000/115
5	LINETP_01	xxYB-01	VOLTAGE B-C	0-150	0-32767	kV	LINETP01	xx.xx							AI	32	2	00, 01	2		115000/115
6	LINETP_01	xxYB-01	VOLTAGE C-A	0-150	0-32767	kV	LINETP01	xx.xx							AI	32	2	00, 01	2		115000/115
7	LINETP_01	xxYB-01	ACTIVE POWER	-467.64 - +467.64	-32767 - +32767	MW	LINETP01	cc							AI	32	2	00, 01	2		Calculation
8	LINETP_01	xxYB-01	RECATIVE POWER	-467.64 - +467.64	-32767 - +32767	Mvar	LINETP01	cc							AI	32	2	00, 01	2		Calculation
9	LINETP_01	xxYB-01	POWER FACTOR	+/- 100	-32767 - +32767	%	LINETP01	cc							AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINETP_01	xxYB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							SOE	2	2	17, 28	1		
								LINETP01	xx.xx							SOE	2	2	17, 28	1		
2	LINETP_01	xxYS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1		
								LINETP01	xx.xx							DI	2	1	17, 28	1		
3	LINETP_01	xxYS-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1		
								LINETP01	xx.xx							DI	2	1	17, 28	1		
4	LINETP_01	xxYS-03	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1		
								LINETP01	xx.xx							DI	2	1	17, 28	1		
5	LINETP_01	xxYB-01	CONTROL SET MODE	Undefine	Remote	Local	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1		
								LINETP01	xx.xx							DI	2	1	17, 28	1		
6	LINETP_01	xxYB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	LINETP01	cc							DI	2	1	17, 28	1		
								LINETP01	cc							DI	2	1	17, 28	1		
7	LINETP_01	xxYB-01	87T RELAY ON/OFF STATUS	-	On	Off	-	LINETP01	cc							DI	2	1	17, 28	1		
								LINETP01	cc							DI	2	1	17, 28	1		
8	LINETP_01	xxYB-01	BUS ZONE 1 TRIP STATUS	-	Inservice	Isolate	-	LINETP01	cc							DI	2	1	17, 28	1		
								LINETP01	cc							DI	2	1	17, 28	1		
9	LINETP_01	xxYB-01	BUS ZONE 2 TRIP STATUS	-	Inservice	Isolate	-	LINETP01	cc							DI	2	1	17, 28	1		
								LINETP01	cc							DI	2	1	17, 28	1		
10	LINETP_01	xxYB-01	TRANSFORMER DIFFERENTIAL PHASE A	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
11	LINETP_01	xxYB-01	TRANSFORMER DIFFERENTIAL PHASE B	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
12	LINETP_01	xxYB-01	TRANSFORMER DIFFERENTIAL PHASE C	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
13	LINETP_01	xxYB-01	TRANSFORMER DIFFERENTIAL RELAY	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
14	LINETP_01	xxYB-01	O/C RELAY TIME PHASE A (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
15	LINETP_01	xxYB-01	O/C RELAY TIME PHASE B (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
16	LINETP_01	xxYB-01	O/C RELAY TIME PHASE C (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
17	LINETP_01	xxYB-01	O/C INST RELAY PHASE A (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
18	LINETP_01	xxYB-01	O/C INST RELAY PHASE B (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
19	LINETP_01	xxYB-01	O/C INST RELAY PHASE C (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
20	LINETP_01	xxYB-01	E/F TIME RELAY (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
21	LINETP_01	xxYB-01	E/F INSTANTANEOUS RELAY (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
22	LINETP_01	xxYB-01	RESTRICTED EARTH FAULT (LV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
23	LINETP_01	xxYB-01	O/C GROUND BACKUP (LV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
24	LINETP_01	xxYB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
25	LINETP_01	xxYB-01	BUS ZONE 1 TRIP STATUS	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
26	LINETP_01	xxYB-01	BUS ZONE 2 TRIP STATUS	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
27	LINETP_01	xxYB-01	TRANSFORMER INTERNAL PROTECTION	Normal	Trip	-	-	LINETP01	xx.xx							SOE	2	2	17, 28	1		
28	LINETP_01	xxYB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
29	LINETP_01	xxYB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	LINETP01	xx.xx							SOE	2	2	17, 28	1		
30	LINETP_01	xxYB-01	SPRING CHARGE	Normal	Fail	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
31	LINETP_01	xxYB-01	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
32	LINETP_01	xxYB-01	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail			LINETP01	xx.xx							DI	2	1	17, 28	1		
33	LINETP_01	xxYB-01	AC SUPPLY FAILURE	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
34	LINETP_01	xxYB-01	DC SUPPLY FAILURE	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
35	LINETP_01	xxYB-01	PROTECTION RELAY DC FAIL	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
36	LINETP_01	xxYB-01	AIR-CONDITION ALARM	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
37	LINETP_01	xxYB-01	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
38	LINETP_01	xxYB-01	PROTECTION RELAY	Normal	Fail	-	-	LINETP01	cc							DI	2	1	17, 28	1		
39	LINETP_01	xxYB-01	PROTECTION RELAY LAN A	Offline	Online	-	-	LINETP01	cc							DI	2	1	17, 28	1		
40	LINETP_01	xxYB-01	PROTECTION RELAY LAN B	Offline	Online	-	-	LINETP01	cc							DI	2	1	17, 28	1		
41	LINETP_01	xxYB-01	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	LINETP01	cc							DI	2	1	17, 28	1		
42	LINETP_01	xxYB-01	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	LINETP01	cc							DI	2	1	17, 28	1		
43	LINETP_01	xxYB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	LINETP01	cc							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.7
I/O POINT COUNTS FOR
115kV GIS H-CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	**115kV**	Bay Name :	**115 kV Incoming or Outgoing Line No.xx**		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINE_xx	xxYB-01	CLOSE/OPEN COMMAND	Close	Open	DPC	LINExx	xx.xx							SBO	12	1	echo of request			
2	LINE_xx	xxYB-01	CLOSE/OPEN BY PASS COMMAND	Close	-	SCP	LINExx	xx.xx							SBO	12	1	echo of request			
3	LINE_xx	xxYS-01	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xx.xx							SBO	12	1	echo of request			
4	LINE_xx	xxYS-02	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xx.xx							SBO	12	1	echo of request			
5	LINE_xx	xxYB-01	AR ON/OFF COMMAND	On	Off	DCP	LINExx	cc							SBO	12	1	echo of request			
6	LINE_xx	xxYB-01	SOEF ON/OFF COMMAND	On	Off	DCP	LINExx	cc							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINE_xx	xxYB-01	CURRENT PHASE A	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2		1200/1A
2	LINE_xx	xxYB-01	CURRENT PHASE B	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2		1200/1A
3	LINE_xx	xxYB-01	CURRENT PHASE C	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2		1200/1A
4	LINE_xx	xxYB-01	VOLTAGE A-B	0-150	0-32767	kV	LINExx	xx.xx							AI	32	2	00, 01	2		11500/115
5	LINE_xx	xxYB-01	VOLTAGE B-C	0-150	0-32767	kV	LINExx	xx.xx							AI	32	2	00, 01	2		11500/115
6	LINE_xx	xxYB-01	VOLTAGE C-A	0-150	0-32767	kV	LINExx	xx.xx							AI	32	2	00, 01	2		11500/115
7	LINE_xx	xxYB-01	ACTIVE POWER	-467.64 - +467.64	-32767 - +32767	MW	LINExx	cc							AI	32	2	00, 01	2		Calculation
8	LINE_xx	xxYB-01	REACTIVE POWER	-467.64 - +467.64	-32767 - +32767	Mvar	LINExx	cc							AI	32	2	00, 01	2		Calculation
9	LINE_xx	xxYB-01	POWER FACTOR	+/-100	-32767 - +32767	%	LINExx	cc							AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINE_xx	xxYB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							SOE	2	2	17, 28	1		
								LINExx	xx.xx							SOE	2	2	17, 28	1		
2	LINE_xx	xxYS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
3	LINE_xx	xxYS-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
4	LINE_xx	xxYG-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
5	LINE_xx	xxYB-01	CONTROL SET MODE	Undefine	Remote	Local	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
6	LINE_xx	xxYB-01	AUTO RECL ON/OFF STATUS	-	On	Off	-	LINExx	cc							DI	2	1	17, 28	1		
								LINExx	cc							DI	2	1	17, 28	1		
7	LINE_xx	xxYB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	LINExx	cc							DI	2	1	17, 28	1		
								LINExx	cc							DI	2	1	17, 28	1		
8	LINE_xx	xxYB-01	DISTANCE RELAY VT CIRCUIT FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
9	LINE_xx	xxYB-01	DISTANCE RELAY	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
10	LINE_xx	xxYB-01	DISTANCE RELAY ZONE 1	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
11	LINE_xx	xxYB-01	DISTANCE RELAY ZONE 2	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
12	LINE_xx	xxYB-01	DISTANCE RELAY ZONE 3	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
13	LINE_xx	xxYB-01	DISTANCE RELAY PHASE A	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
14	LINE_xx	xxYB-01	DISTANCE RELAY PHASE B	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
15	LINE_xx	xxYB-01	DISTANCE RELAY PHASE C	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
16	LINE_xx	xxYB-01	DISTANCE RELAY PHASE N	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
17	LINE_xx	xxYB-01	DISTANCE SWITCH ON TO FAULT	Normal	Alarm	-	-	LINExx	cc							SOE	2	2	17, 28	1		
18	LINE_xx	xxYB-01	DISTANCE LINE AIDED TRIP	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
19	LINE_xx	xxYB-01	AUTO RECL. PROGRESS STATUS	Normal	Operated	-	-	LINExx	cc							SOE	2	2	17, 28	1		
20	LINE_xx	xxYB-01	AUTO RECL. LOCK OUT STATUS	Normal	Lockout	-	-	LINExx	cc							SOE	2	2	17, 28	1		

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
21	LINE_xx	xxYB-01	DIRECTIONAL OVERCURRENT PHASE A	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
22	LINE_xx	xxYB-01	DIRECTIONAL OVERCURRENT PHASE B	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
23	LINE_xx	xxYB-01	DIRECTIONAL OVERCURRENT PHASE C	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
24	LINE_xx	xxYB-01	DIRECTIONAL EARTH FAULT	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
25	LINE_xx	xxYB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
26	LINE_xx	xxYB-01	SYNCH. SWITCH SELECTION	Normal	Auto	-	-	LINExx	cc							DI	2	1	17, 28	1		
27	LINE_xx	xxYB-01	SYNCH. SWITCH SELECTION	Normal	Off	-	-	LINExx	cc							DI	2	1	17, 28	1		
28	LINE_xx	xxYB-01	SYNCH. SWITCH SELECTION	Normal	Manual	-	-	LINExx	cc							DI	2	1	17, 28	1		
29	LINE_xx	xxYB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
30	LINE_xx	xxYB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	LINExx	xx.xx							SOE	2	2	17, 28	1		
31	LINE_xx	xxYB-01	SPRING CHARGE	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
32	LINE_xx	xxYB-01	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
33	LINE_xx	xxYB-01	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
34	LINE_xx	xxYB-01	AC SUPPLY FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
35	LINE_xx	xxYB-01	DC SUPPLY FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
36	LINE_xx	xxYB-01	PROTECTION RELAY DC FAIL	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
37	LINE_xx	xxYB-01	AIR-CONDITION ALARM	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
38	LINE_xx	xxYB-01	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
39	LINE_xx	xxYB-01	PROTECTION RELAY	Normal	Fail	-	-	LINExx	cc							DI	2	1	17, 28	1		
40	LINE_xx	xxYB-01	PROTECTION RELAY LAN A	Offline	Online	-	-	LINExx	cc							DI	2	1	17, 28	1		
41	LINE_xx	xxYB-01	PROTECTION RELAY LAN B	Offline	Online	-	-	LINExx	cc							DI	2	1	17, 28	1		
42	LINE_xx	xxYB-01	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	LINExx	cc							DI	2	1	17, 28	1		
43	LINE_xx	xxYB-01	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	LINExx	cc							DI	2	1	17, 28	1		
44	LINE_xx	xxYB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	LINExx	cc							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.7

I/O POINT COUNTS FOR

115kV GIS H-CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	**115kV**	Bay Name :	**115 kV Main Bus**		
IED Product :		IED Model/Type :			
IED IP Address :					

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	BUS	0BYS01	BUS 1 VOLTAGE B-N	0-150	0-32767	kV	BUS	xx.xx							AI	32	2	00, 01	2		115000/115V
2	BUS	0BYS01	BUS 1 FREQUENCY	0-60	0-32767	Hz	BUS								AI	32	2	00, 01	2		-
3	BUS	0BYS01	BUS 2 VOLTAGE B-N	0-150	0-32767	kV	BUS	xx.xx							AI	32	2	00, 01	2		115000/115V
4	BUS	0BYS01	BUS 2 FREQUENCY	0-60	0-32767	Hz	BUS	xx.xx							AI	32	2	00, 01	2		-

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	BUS	0BYS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BUS	xx.xx							DI	2	1	17, 28	1		
								BUS	xx.xx							DI	2	1	17, 28	1		
2	BUS	0BYG-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BUS	xx.xx							DI	2	1	17, 28	1		
								BUS	xx.xx							DI	2	1	17, 28	1		
3	BUS	0BYG-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BUS	xx.xx							DI	2	1	17, 28	1		
								BUS	xx.xx							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before "/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.7

I/O POINT COUNTS FOR

115kV GIS H-CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	115kV	Bay Name :	115 kV Power Transformer Bay No.xx		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qli	Class	Address	Remark
1	LINETP_xx	xxYB-01	CLOSE/OPEN COMMAND	Close	Open		LINETPxx	xxxx							SBO	12	1	echo of request			
2	LINETP_xx	xxYB-01	CLOSE/OPEN BY PASS COMMAND	Close	-	SCP	LINETPxx	xxxx							SBO	12	1	echo of request			
3	LINETP_xx	xxYS-01	CLOSE/OPEN COMMAND	Close	Open		LINETPxx	xxxx							SBO	12	1	echo of request			
4	LINETP_xx	xxYS-02	CLOSE/OPEN COMMAND	Close	Open	DCP	LINETPxx	xxxx							SBO	12	1	echo of request			
4	LINETP_xx	xxYB-01	50BF ON/OFF COMMAND	On	Off		LINETPxx	cc							SBO	12	1	echo of request			
5	LINETP_xx	xxYB-01	87T ON/OFF COMMAND	On	Off		LINETPxx	cc							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qli	Class	Address	Remark
1	LINETP_xx	xxYB-01	CURRENT PHASE A	0-400	0-32767		LINETPxx	xx.xx							AI	32	2	00, 01	2		400/1A
2	LINETP_xx	xxYB-01	CURRENT PHASE B	0-400	0-32767		LINETPxx	xx.xx							AI	32	2	00, 01	2		400/1A
3	LINETP_xx	xxYB-01	CURRENT PHASE C	0-400	0-32767		LINETPxx	xx.xx							AI	32	2	00, 01	2		400/1A
4	LINETP_xx	xxYB-01	VOLTAGE A-B	0-150	0-32767		LINETPxx	xx.xx							AI	32	2	00, 01	2		115000/115
5	LINETP_xx	xxYB-01	VOLTAGE B-C	0-150	0-32767		LINETPxx	xx.xx							AI	32	2	00, 01	2		115000/115
6	LINETP_xx	xxYB-01	VOLTAGE C-A	0-150	0-32767		LINETPxx	xx.xx							AI	32	2	00, 01	2		115000/115
7	LINETP_xx	xxYB-01	ACTIVE POWER	-467.64 - +467.64	-32767 - +32767		LINETPxx	cc							AI	32	2	00, 01	2		Calculation
8	LINETP_xx	xxYB-01	RECATIVE POWER	-467.64 - +467.64	-32767 - +32767		LINETPxx	cc							AI	32	2	00, 01	2		Calculation
9	LINETP_xx	xxYB-01	POWER FACTOR	+/- [illegible]	-32767 - +32767		LINETPxx	cc							AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State					Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
1	LINETP_xx	xxYB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETPxx	xx.xx							SOE	2	2	17, 28	1		
								LINETPxx	xx.xx							SOE	2	2	17, 28	1		
2	LINETP_xx	xxYS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETPxx	xx.xx							DI	2	1	17, 28	1		
								LINETPxx	xx.xx							DI	2	1	17, 28	1		
3	LINETP_xx	xxYS-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETPxx	xx.xx							DI	2	1	17, 28	1		
								LINETPxx	xx.xx							DI	2	1	17, 28	1		
4	LINETP_xx	xxYB-01	CONTROL SET MODE	Undefine	Remote	Local	Fault	LINETPxx	xx.xx							DI	2	1	17, 28	1		
								LINETPxx	xx.xx							DI	2	1	17, 28	1		
5	LINETP_xx	xxYB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	LINETPxx	cc							DI	2	1	17, 28	1		
								LINETPxx	cc							DI	2	1	17, 28	1		
6	LINETP_xx	xxYB-01	87T RELAY ON/OFF STATUS	-	On	Off	-	LINETPxx	cc							DI	2	1	17, 28	1		
								LINETPxx	cc							DI	2	1	17, 28	1		
7	LINETP_xx	xxYB-01	TRANSFORMER DIFFERENTIAL PHASE A	Normal	Trip	-	-	LINETPxx	cc							SOE	2	2	17, 28	1		
8	LINETP_xx	xxYB-01	TRANSFORMER DIFFERENTIAL PHASE B	Normal	Trip	-	-	LINETPxx	cc							SOE	2	2	17, 28	1		
9	LINETP_xx	xxYB-01	TRANSFORMER DIFFERENTIAL PHASE C	Normal	Trip	-	-	LINETPxx	cc							SOE	2	2	17, 28	1		
10	LINETP_xx	xxYB-01	TRANSFORMER DIFFERENTIAL RELAY	Normal	Trip	-	-	LINETPxx	cc							SOE	2	2	17, 28	1		
11	LINETP_xx	xxYB-01	O/C RELAY TIME PHASE A (HV)	Normal	Trip	-	-	LINETPxx	cc							SOE	2	2	17, 28	1		
12	LINETP_xx	xxYB-01	O/C RELAY TIME PHASE B (HV)	Normal	Trip	-	-	LINETPxx	cc							SOE	2	2	17, 28	1		
13	LINETP_xx	xxYB-01	O/C RELAY TIME PHASE C (HV)	Normal	Trip	-	-	LINETPxx	cc							SOE	2	2	17, 28	1		
14	LINETP_xx	xxYB-01	O/C INST RELAY PHASE A (HV)	Normal	Trip	-	-	LINETPxx	cc							SOE	2	2	17, 28	1		
15	LINETP_xx	xxYB-01	O/C INST RELAY PHASE B (HV)	Normal	Trip	-	-	LINETPxx	cc							SOE	2	2	17, 28	1		
16	LINETP_xx	xxYB-01	O/C INST RELAY PHASE C (HV)	Normal	Trip	-	-	LINETPxx	cc							SOE	2	2	17, 28	1		
17	LINETP_xx	xxYB-01	E/F TIME RELAY (HV)	Normal	Trip	-	-	LINETPxx	cc							SOE	2	2	17, 28	1		
18	LINETP_xx	xxYB-01	E/F INSTANTANEOUS RELAY (HV)	Normal	Trip	-	-	LINETPxx	cc							SOE	2	2	17, 28	1		
19	LINETP_xx	xxYB-01	RESTRICTED EARTH FAULT (LV)	Normal	Trip	-	-	LINETPxx	cc							SOE	2	2	17, 28	1		
20	LINETP_xx	xxYB-01	O/C GROUND BACKUP (LV)	Normal	Trip	-	-	LINETPxx	cc							SOE	2	2	17, 28	1		

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State					Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
21	LINETP_xx	xxYB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	LINETPxx	cc							SOE	2	2	17, 28	1	1	
22	LINETP_xx	xxYB-01	TRANSFORMER INTERNAL PROTECTION	Normal	Trip	-	-	LINETPxx	xx.xx							SOE	2	2	17, 28	1	2	
23	LINETP_xx	xxYB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	LINETPxx	xx.xx							DI	2	1	17, 28	1	3	
24	LINETP_xx	xxYB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	LINETPxx	xx.xx							SOE	2	2	17, 28	1	4	
25	LINETP_xx	xxYB-01	SPRING CHARGE	Normal	Fail	-	-	LINETPxx	xx.xx							DI	2	1	17, 28	1	5	
26	LINETP_xx	xxYB-01	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	LINETPxx	xx.xx							DI	2	1	17, 28	1	6	
27	LINETP_xx	xxYB-01	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail			LINETPxx	xx.xx							DI	2	1	17, 28	1	7	
28	LINETP_xx	xxYB-01	AC SUPPLY FAILURE	Normal	Alarm	-	-	LINETPxx	xx.xx							DI	2	1	17, 28	1	8	
29	LINETP_xx	xxYB-01	DC SUPPLY FAILURE	Normal	Alarm	-	-	LINETPxx	xx.xx							DI	2	1	17, 28	1	9	
30	LINETP_xx	xxYB-01	PROTECTION RELAY DC FAIL	Normal	Alarm	-	-	LINETPxx	xx.xx							DI	2	1	17, 28	1	10	
31	LINETP_xx	xxYB-01	AIR-CONDITION ALARM	Normal	Alarm	-	-	LINETPxx	xx.xx							DI	2	1	17, 28	1	11	
32	LINETP_xx	xxYB-01	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	LINETPxx	xx.xx							DI	2	1	17, 28	1	12	
33	LINETP_xx	xxYB-01	PROTECTION RELAY	Normal	Fail	-	-	LINETPxx	cc							DI	2	1	17, 28	1	13	
34	LINETP_xx	xxYB-01	PROTECTION RELAY LAN A	Offline	Online	-	-	LINETPxx	cc							DI	2	1	17, 28	1	14	
35	LINETP_xx	xxYB-01	PROTECTION RELAY LAN B	Offline	Online	-	-	LINETPxx	cc							DI	2	1	17, 28	1	15	
36	LINETP_xx	xxYB-01	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	LINETPxx	cc							DI	2	1	17, 28	1	16	
37	LINETP_xx	xxYB-01	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	LINETPxx	cc							DI	2	1	17, 28	1	17	
38	LINETP_xx	xxYB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	LINETPxx	cc							DI	2	1	17, 28	1	18	

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.3

I/O POINT COUNTS FOR

115kV AIS COMPACT H-CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	115kV	Bay Name :	115kV Incoming or Outgoing Line No.xx		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINE_xx	xxYB-01	CLOSE/OPEN COMMAND	Close	Open	DPC	LINExx	xxxx							SBO	12	1	echo of request			
2	LINE_xx	xxYB-01	CLOSE/OPEN BY PASS COMMAND	Close	-	SCP	LINExx	xxxx							SBO	12	1	echo of request			
3	LINE_xx	xxYS-01	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xxxx							SBO	12	1	echo of request			
4	LINE_xx	xxYS-02	CLOSE/OPEN COMMAND	Close	Open	DCP	LINExx	xxxx							SBO	12	1	echo of request			
5	LINE_xx	xxYB-01	A/R ON/OFF COMMAND	On	Off	DCP	LINExx	cc							SBO	12	1	echo of request			
6	LINE_xx	xxYB-01	50BF ON/OFF COMMAND	On	Off	DCP	LINExx	cc							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINE_xx	xxYB-01	CURRENT PHASE A	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2		1200/1A
2	LINE_xx	xxYB-01	CURRENT PHASE B	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2		1200/1A
3	LINE_xx	xxYB-01	CURRENT PHASE C	0-1200	0-32767	A	LINExx	xx.xx							AI	32	2	00, 01	2		1200/1A
4	LINE_xx	xxYB-01	VOLTAGE A-B	0-150	0-32767	kV	LINExx	xx.xx							AI	32	2	00, 01	2		11500/115
5	LINE_xx	xxYB-01	VOLTAGE B-C	0-150	0-32767	kV	LINExx	xx.xx							AI	32	2	00, 01	2		11500/115
6	LINE_xx	xxYB-01	VOLTAGE C-A	0-150	0-32767	kV	LINExx	xx.xx							AI	32	2	00, 01	2		11500/115
7	LINE_xx	xxYB-01	ACTIVE POWER	-467.64 - +467.64	-32767 - +32767	MW	LINExx	cc							AI	32	2	00, 01	2		Calculation
8	LINE_xx	xxYB-01	REACTIVE POWER	-467.64 - +467.64	-32767 - +32767	Mvar	LINExx	cc							AI	32	2	00, 01	2		Calculation
9	LINE_xx	xxYB-01	POWER FACTOR	+/- 100	-32767 - +32767	%	LINExx	cc							AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State					Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
1	LINE_xx	xxYB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							SOE	2	2	17, 28	1		
								LINExx	xx.xx							SOE	2	2	17, 28	1		
2	LINE_xx	xxYS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
3	LINE_xx	xxYS-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
4	LINE_xx	xxYG-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
5	LINE_xx	xxYB-01	CONTROL SET MODE	Undefine	Remote	Local	Fault	LINExx	xx.xx							DI	2	1	17, 28	1		
								LINExx	xx.xx							DI	2	1	17, 28	1		
6	LINE_xx	xxYB-01	AUTO RECL ON/OFF STATUS	-	On	Off	-	LINExx	cc							DI	2	1	17, 28	1		
								LINExx	cc							DI	2	1	17, 28	1		
7	LINE_xx	xxYB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	LINExx	cc							DI	2	1	17, 28	1		
								LINExx	cc							DI	2	1	17, 28	1		
8	LINE_xx	xxYB-01	DISTANCE RELAY VT CIRCUIT FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
9	LINE_xx	xxYB-01	DISTANCE RELAY	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
10	LINE_xx	xxYB-01	DISTANCE RELAY ZONE 1	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
11	LINE_xx	xxYB-01	DISTANCE RELAY ZONE 2	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
12	LINE_xx	xxYB-01	DISTANCE RELAY ZONE 3	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
13	LINE_xx	xxYB-01	DISTANCE RELAY PHASE A	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
14	LINE_xx	xxYB-01	DISTANCE RELAY PHASE B	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
15	LINE_xx	xxYB-01	DISTANCE RELAY PHASE C	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
16	LINE_xx	xxYB-01	DISTANCE RELAY PHASE N	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
17	LINE_xx	xxYB-01	DISTANCE SWITCH ON TO FAULT	Normal	Alarm	-	-	LINExx	cc							SOE	2	2	17, 28	1		
18	LINE_xx	xxYB-01	DISTANCE LINE AIDED TRIP	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
19	LINE_xx	xxYB-01	AUTO RECL. PROGRESS STATUS	Normal	Operated	-	-	LINExx	cc							SOE	2	2	17, 28	1		
20	LINE_xx	xxYB-01	AUTO RECL. LOCK OUT STATUS	Normal	Lockout	-	-	LINExx	cc							SOE	2	2	17, 28	1		

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
21	LINE_xx	xxYB-01	DIRECTIONAL OVERCURRENT PHASE A	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
22	LINE_xx	xxYB-01	DIRECTIONAL OVERCURRENT PHASE B	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
23	LINE_xx	xxYB-01	DIRECTIONAL OVERCURRENT PHASE C	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
24	LINE_xx	xxYB-01	DIRECTIONAL EARTH FAULT	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
25	LINE_xx	xxYB-01	TIME DELAY FAIL (CB Fail)	Normal	Trip	-	-	LINExx	cc							SOE	2	2	17, 28	1		
26	LINE_xx	xxYB-01	SYNCH. SWITCH SELECTION	Normal	Auto	-	-	LINExx	cc							DI	2	1	17, 28	1		
27	LINE_xx	xxYB-01	SYNCH. SWITCH SELECTION	Normal	Off	-	-	LINExx	cc							DI	2	1	17, 28	1		
28	LINE_xx	xxYB-01	SYNCH. SWITCH SELECTION	Normal	Manual	-	-	LINExx	cc							DI	2	1	17, 28	1		
29	LINE_xx	xxYB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
30	LINE_xx	xxYB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	LINExx	xx.xx							SOE	2	2	17, 28	1		
31	LINE_xx	xxYB-01	SPRING CHARGE	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
32	LINE_xx	xxYB-01	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
33	LINE_xx	xxYB-01	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
34	LINE_xx	xxYB-01	AC SUPPLY FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
35	LINE_xx	xxYB-01	DC SUPPLY FAILURE	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
36	LINE_xx	xxYB-01	PROTECTION RELAY DC FAIL	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
37	LINE_xx	xxYB-01	AIR-CONDITION ALARM	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
38	LINE_xx	xxYB-01	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	LINExx	xx.xx							DI	2	1	17, 28	1		
39	LINE_xx	xxYB-01	PROTECTION RELAY	Normal	Fail	-	-	LINExx	cc							DI	2	1	17, 28	1		
40	LINE_xx	xxYB-01	PROTECTION RELAY LAN A	Offline	Online	-	-	LINExx	cc							DI	2	1	17, 28	1		
41	LINE_xx	xxYB-01	PROTECTION RELAY LAN B	Offline	Online	-	-	LINExx	cc							DI	2	1	17, 28	1		
42	LINE_xx	xxYB-01	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	LINExx	cc							DI	2	1	17, 28	1		
43	LINE_xx	xxYB-01	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	LINExx	cc							DI	2	1	17, 28	1		
44	LINE_xx	xxYB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	LINExx	cc							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.8

I/O POINT COUNTS FOR

115kV AIS COMPACT H-CONFIGURATION

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	115kV	Bay Name :	115 kV Main Bus		
IED Product :		IED Model/Type :			
IED IP Address :					

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	BUS	0BYS-01	BUS 1 VOLTAGE B-N	0-150	0-32767	kV	BUS	xx.xx							AI	32	2	00, 01	2		115000/115V
2	BUS	0BYS-01	BUS 1 FREQUENCY	0-60	0-32767	Hz	BUS	cc							AI	32	2	00, 01	2		-
3	BUS	0BYS-01	BUS 2 VOLTAGE B-N	0-150	0-32767	kV	BUS	xx.xx							AI	32	2	00, 01	2		115000/115V
4	BUS	0BYS-01	BUS 2 FREQUENCY	0-60	0-32767	Hz	BUS	cc							AI	32	2	00, 01	2		-

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	BUS	0BYS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	BUS	xx.xx							DI	2	1	17, 28	1		
								BUS	xx.xx							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programmable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before "/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.8

I/O POINT COUNTS FOR

115kV AIS DOUBLE BUS-SINGLE BREAKER

Substation Name :		Substation Code Name :	
Substation DNP Adress :			
Voltage Level :	115kV	Bay Name :	115 kV Power Transformer Bay No.xx
IED Product :		IED Model/Type :	
IED IP Address :			

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qli	Class	Address	Remark
1	LINETP_01	xxYB-01	CLOSE/OPEN COMMAND	Close	Open	DPC	LINETP01	xxxx							SBO	12	1	echo of request			
2	LINETP_xx	xxYB-01	CLOSE/OPEN BY PASS COMMAND	Close	-	SPC	LINETPxx	xxxx							SBO	12	1	echo of request			
3	LINETP_01	xxYS-01	CLOSE/OPEN COMMAND	Close	Open	DPC	LINETP01	xxxx							SBO	12	1	echo of request			
4	LINETP_01	xxYS-02	CLOSE/OPEN COMMAND	Close	Open	DPC	LINETP01	xxxx							SBO	12	1	echo of request			
5	LINETP_01	xxYB-01	50BF ON/OFF COMMAND	On	Off	DPC	LINETP01	cc							SBO	12	1	echo of request			
6	LINETP_01	xxYB-01	87T ON/OFF COMMAND	On	Off	DPC	LINETP01	cc							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qli	Class	Address	Remark
1	LINETP_01	xxYB-01	CURRENT PHASE A	0-400	0-32767		LINETP01	xx.xx							AI	32	2	00, 01	2		400/1A
2	LINETP_01	xxYB-01	CURRENT PHASE B	0-400	0-32767		LINETP01	xx.xx							AI	32	2	00, 01	2		400/1A
3	LINETP_01	xxYB-01	CURRENT PHASE C	0-400	0-32767		LINETP01	xx.xx							AI	32	2	00, 01	2		400/1A
4	LINETP_01	xxYB-01	VOLTAGE A-B	0-150	0-32767		LINETP01	xx.xx							AI	32	2	00, 01	2		115000/115
5	LINETP_01	xxYB-01	VOLTAGE B-C	0-150	0-32767		LINETP01	xx.xx							AI	32	2	00, 01	2		115000/115
6	LINETP_01	xxYB-01	VOLTAGE C-A	0-150	0-32767		LINETP01	xx.xx							AI	32	2	00, 01	2		115000/115
7	LINETP_01	xxYB-01	ACTIVE POWER	-467.64 - +467.64	-32767 - +32767		LINETP01	cc							AI	32	2	00, 01	2		Calculation
8	LINETP_01	xxYB-01	REACTIVE POWER	-467.64 - +467.64	-32767 - +32767		LINETP01	cc							AI	32	2	00, 01	2		Calculation
9	LINETP_01	xxYB-01	POWER FACTOR	+/- [illegible]	-32767 - +32767		LINETP01	cc							AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINETP_01	xxYB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							SOE	2	2	17, 28	1		
								LINETP01	xx.xx							SOE	2	2	17, 28	1		
2	LINETP_01	xxYS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1		
								LINETP01	xx.xx							DI	2	1	17, 28	1		
3	LINETP_01	xxYS-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1		
								LINETP01	xx.xx							DI	2	1	17, 28	1		
4	LINETP_01	xxYB-01	CONTROL SET MODE	Undefine	Remote	Local	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1		
								LINETP01	xx.xx							DI	2	1	17, 28	1		
5	LINETP_01	xxYB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	LINETP01	cc							DI	2	1	17, 28	1		
								LINETP01	cc							DI	2	1	17, 28	1		
6	LINETP_01	xxYB-01	87T RELAY ON/OFF STATUS	-	On	Off	-	LINETP01	cc							DI	2	1	17, 28	1		
								LINETP01	cc							DI	2	1	17, 28	1		
7	LINETP_01	xxYB-01	TRANSFORMER DIFFERENTIAL PHASE A	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
8	LINETP_01	xxYB-01	TRANSFORMER DIFFERENTIAL PHASE B	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
9	LINETP_01	xxYB-01	TRANSFORMER DIFFERENTIAL PHASE C	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
10	LINETP_01	xxYB-01	TRANSFORMER DIFFERENTIAL RELAY	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
11	LINETP_01	xxYB-01	O/C RELAY TIME PHASE A (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
12	LINETP_01	xxYB-01	O/C RELAY TIME PHASE B (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
13	LINETP_01	xxYB-01	O/C RELAY TIME PHASE C (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
14	LINETP_01	xxYB-01	O/C INST RELAY PHASE A (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
15	LINETP_01	xxYB-01	O/C INST RELAY PHASE B (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
16	LINETP_01	xxYB-01	O/C INST RELAY PHASE C (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
17	LINETP_01	xxYB-01	E/F TIME RELAY (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
18	LINETP_01	xxYB-01	E/F INSTANTANEOUS RELAY (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
19	LINETP_01	xxYB-01	RESTRICTED EARTH FAULT (LV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
20	LINETP_01	xxYB-01	O/C GROUND BACKUP (LV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850 Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping) Type	Obj	Var	Qii	Class	Address	Remark
21	LINETP_01	xxYB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
22	LINETP_01	xxYB-01	TRANSFORMER INTERNAL PROTECTION	Normal	Trip	-	-	LINETP01	xx.xx							SOE	2	2	17, 28	1		
23	LINETP_01	xxYB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
24	LINETP_01	xxYB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	LINETP01	xx.xx							SOE	2	2	17, 28	1		
25	LINETP_01	xxYB-01	SPRING CHARGE	Normal	Fail	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
26	LINETP_01	xxYB-01	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
27	LINETP_01	xxYB-01	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail			LINETP01	xx.xx							DI	2	1	17, 28	1		
28	LINETP_01	xxYB-01	AC SUPPLY FAILURE	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
29	LINETP_01	xxYB-01	DC SUPPLY FAILURE	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
30	LINETP_01	xxYB-01	PROTECTION RELAY DC FAIL	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
31	LINETP_01	xxYB-01	AIR-CONDITION ALARM	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
32	LINETP_01	xxYB-01	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
33	LINETP_01	xxYB-01	PROTECTION RELAY	Normal	Fail	-	-	LINETP01	cc							DI	2	1	17, 28	1		
34	LINETP_01	xxYB-01	PROTECTION RELAY LAN A	Offline	Online	-	-	LINETP01	cc							DI	2	1	17, 28	1		
35	LINETP_01	xxYB-01	PROTECTION RELAY LAN B	Offline	Online	-	-	LINETP01	cc							DI	2	1	17, 28	1		
36	LINETP_01	xxYB-01	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	LINETP01	cc							DI	2	1	17, 28	1		
37	LINETP_01	xxYB-01	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	LINETP01	cc							DI	2	1	17, 28	1		
38	LINETP_01	xxYB-01	PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	LINETP01	cc							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.9

I/O POINT COUNTS FOR

115kV SUBSTATION CONNECTED BY TIE LINE

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	115kV	Bay Name :	115kV Power Transformer Bay No.01		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Data Class	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINETP_01	01YB-01	CLOSE/OPEN COMMAND	Close	Open	DPC	LINETP01	xx.xx							SBO	12	1	echo of request			
2	LINETP_01	01YB-01	CLOSE/OPEN BY PASS COMMAND	Close	-	SCP	LINETP01	xx.xx							SBO	12	1	echo of request			
3	LINETP_01	01YS-01	CLOSE/OPEN COMMAND	Close	Open	DCP	LINETP01	xx.xx							SBO	12	1	echo of request			
4	LINETP_01	01YS-02	CLOSE/OPEN COMMAND	Close	Open	DCP	LINETP01	xx.xx							SBO	12	1	echo of request			
5	LINETP_01	01YB-01	50BF ON/OFF COMMAND	On	Off	DCP	LINETP01	cc							SBO	12	1	echo of request			
6	LINETP_01	01YB-01	87T ON/OFF COMMAND	On	Off	DCP	LINETP01	cc							SBO	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 1	State 2	Unit	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINETP_01	01YB-01	CURRENT PHASE A	0-1200	0-32767	A	LINETP01	xx.xx							AI	32	2	00, 01	2		1800/1A
2	LINETP_01	01YB-01	CURRENT PHASE B	0-1200	0-32767	A	LINETP01	xx.xx							AI	32	2	00, 01	2		1800/1A
3	LINETP_01	01YB-01	CURRENT PHASE C	0-1200	0-32767	A	LINETP01	xx.xx							AI	32	2	00, 01	2		1800/1A
4	LINETP_01	01YB-01	VOLTAGE A-B	0-150	0-32767	kV	LINETP01	xx.xx							AI	32	2	00, 01	2		115000/115
5	LINETP_01	01YB-01	VOLTAGE B-C	0-150	0-32767	kV	LINETP01	xx.xx							AI	32	2	00, 01	2		115000/115
6	LINETP_01	01YB-01	VOLTAGE C-A	0-150	0-32767	kV	LINETP01	xx.xx							AI	32	2	00, 01	2		115000/115
7	LINETP_01	01YB-01	ACTIVE POWER	-467.64 - +467.64	-32767 - +32767	MW	LINETP01	cc							AI	32	2	00, 01	2		Calculation
8	LINETP_01	01YB-01	RECATIVE POWER	-467.64 - +467.64	-32767 - +32767	Mvar	LINETP01	cc							AI	32	2	00, 01	2		Calculation
9	LINETP_01	01YB-01	POWER FACTOR	+/- 100	-32767 - +32767	%	LINETP01	cc							AI	32	2	00, 01	2		Calculation

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINETP_01	01YB-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							SOE	2	2	17, 28	1		
								LINETP01	xx.xx							SOE	2	2	17, 28	1		
2	LINETP_01	01YS-01	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1		
								LINETP01	xx.xx							DI	2	1	17, 28	1		
3	LINETP_01	01YS-02	CLOSE/OPEN STATUS	Undefine	Closed	Open	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1		
								LINETP01	xx.xx							DI	2	1	17, 28	1		
4	LINETP_01	01YB-01	CONTROL SET MODE	Undefine	Remote	Local	Fault	LINETP01	xx.xx							DI	2	1	17, 28	1		
								LINETP01	xx.xx							DI	2	1	17, 28	1		
5	LINETP_01	01YB-01	50BF RELAY ON/OFF STATUS	-	On	Off	-	LINETP01	cc							DI	2	1	17, 28	1		
								LINETP01	cc							DI	2	1	17, 28	1		
6	LINETP_01	01YB-01	87T RELAY ON/OFF STATUS	-	On	Off	-	LINETP01	cc							DI	2	1	17, 28	1		
								LINETP01	cc							DI	2	1	17, 28	1		
7	LINETP_01	01YB-01	TRANSFORMER DIFFERENTIAL PHASE A	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
8	LINETP_01	01YB-01	TRANSFORMER DIFFERENTIAL PHASE B	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
9	LINETP_01	01YB-01	TRANSFORMER DIFFERENTIAL PHASE C	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
10	LINETP_01	01YB-01	TRANSFORMER DIFFERENTIAL RELAY	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
11	LINETP_01	01YB-01	O/C RELAY TIME PHASE A (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
12	LINETP_01	01YB-01	O/C RELAY TIME PHASE B (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
13	LINETP_01	01YB-01	O/C RELAY TIME PHASE C (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
14	LINETP_01	01YB-01	O/C INST RELAY PHASE A (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
15	LINETP_01	01YB-01	O/C INST RELAY PHASE B (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
16	LINETP_01	01YB-01	O/C INST RELAY PHASE C (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
17	LINETP_01	01YB-01	E/F TIME RELAY (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
18	LINETP_01	01YB-01	E/F INSTANTANEOUS RELAY (HV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
19	LINETP_01	01YB-01	RESTRICTED EARTH FAULT (LV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
20	LINETP_01	01YB-01	O/C GROUND BACKUP (LV)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State					Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
21	LINETP_01	01YB-01	TIME DELAY FAIL (CB FAIL)	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
22	LINETP_01	01YB-01	TRANSFORMER INTERNAL PROTECTION	Normal	Trip	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
23	LINETP_01	01YB-01	GAS LOW PRESSURE WARNING	Normal	Alarm	-	-	LINETP01	cc							DI	2	1	17, 28	1		
24	LINETP_01	01YB-01	GAS LOW PRESSURE LOCKOUT	Normal	Lockout	-	-	LINETP01	cc							SOE	2	2	17, 28	1		
25	LINETP_01	01YB-01	SPRING CHARGE	Normal	Fail	-	-	LINETP01	cc							DI	2	1	17, 28	1		
26	LINETP_01	01YB-01	TRIP CCT. SUPERVISION 1 (TC1)	Normal	Fail	-	-	LINETP01	cc							DI	2	1	17, 28	1		
27	LINETP_01	01YB-01	TRIP CCT. SUPERVISION 2 (TC2)	Normal	Fail	-	-	LINETP01	cc							DI	2	1	17, 28	1		
28	LINETP_01	01YB-01	AC SUPPLY FAILURE	Normal	Alarm	-	-	LINETP01	cc							DI	2	1	17, 28	1		
29	LINETP_01	01YB-01	DC SUPPLY FAILURE	Normal	Alarm	-	-	LINETP01	cc							DI	2	1	17, 28	1		
30	LINETP_01	01YB-01	AIR-CONDITION ALARM	Normal	Alarm	-	-	LINETP01	cc							DI	2	1	17, 28	1		
31	LINETP_01	01YB-01	AIR-CONDITION POWER LOST	Normal	Alarm	-	-	LINETP01	cc							DI	2	1	17, 28	1		
32	LINETP_01	01YB-01	MAIN PROTECTION RELAY LAN A	Offline	Online	-	-	LINETP01	cc							DI	2	1	17, 28	1		
33	LINETP_01	01YB-01	MAIN PROTECTION RELAY LAN B	Offline	Online	-	-	LINETP01	cc							DI	2	1	17, 28	1		
34	LINETP_01	01YB-01	BACK UP PROTECTION RELAY LAN A	Offline	Online	-	-	LINETP01	cc							DI	2	1	17, 28	1		
35	LINETP_01	01YB-01	BACK UP PROTECTION RELAY LAN B	Offline	Online	-	-	LINETP01	cc							DI	2	1	17, 28	1		
36	LINETP_01	01YB-01	MAIN PROTECTION RELAY	Normal	Fail	-	-	LINETP01	cc							DI	2	1	17, 28	1		
37	LINETP_01	01YB-01	BACK UP PROTECTION RELAY	Normal	Fail	-	-	LINETP01	cc							DI	2	1	17, 28	1		
38	LINETP_01	01YB-01	PROTECTION RELAY SV ALARM	Offline	Alarm	-	-	LINETP01	cc							DI	2	1	17, 28	1		
39	LINETP_01	01YB-01	PROTECTION RELAY GOOSE ALARM	Offline	Alarm	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
40	LINETP_01	01YB-01	MAIN PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		
41	LINETP_01	01YB-01	BACK UP PROTECTION RELAY TIME SYNCHONIZING	Normal	Fail	-	-	LINETP01	xx.xx							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.10

I/O POINT COUNTS FOR

115/22 kV POWER TRANSFORMER CONFIGURATION

Substation Name :		Substation Code Nam		Substation DNP Adress :	
Voltage Level :	115kV	Bay Name :	115kV Power Transformer No.xx		
IED Product :		IED Model/Type :			
IED IP Address :					

Control Outputs:

Item	Feeder Name	Bay Name	Details			Data	Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State		Class		Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				1	2																
1	TP_01	TP01	FAN AUTO/MANUAL COMMAND	Auto	Manual	DCP	TP01	xx.xx							SBO	12	1	echo of request			
2	TP_01	TP01	FAN GROUP 1 COMMAND	On	Off	DCP	TP01	xx.xx							SBO	12	1	echo of request			
3	TP_01	TP01	FAN GROUP 2 COMMAND	On	Off	DCP	TP01	xx.xx							SBO	12	1	echo of request			
4	TP_01	TP01	OLTC AUTO/MANUAL COMMAND	Auto	Manual	DCP	TP01	xx.xx							SBO	12	1	echo of request			
5	TP_01	TP01	OLTC RAISE/LOWER COMMAND	Raise	Lower	DCP	TP01	xx.xx							DOP	12	1	echo of request			

Analog Points:

Item	Feeder Name	Bay Name	Details				Panel	Terminal	Device	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State		Unit		Connection	Name	Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				1	2																
1	TP_01	TP01	WINDING TEMPERATURE PHASE A	0-150'C	0-32767		TP01	xx.xx							AI	32	2	00,01	2		-
2	TP_01	TP01	WINDING TEMPERATURE PHASE B	0-150'C	0-32767		TP01	xx.xx							AI	32	2	00,01	2		-
3	TP_01	TP01	WINDING TEMPERATURE PHASE C	0-150'C	0-32767		TP01	xx.xx							AI	32	2	00,01	2		-
4	TP_01	TP01	OIL TEMPERATURE	0-150'C	0-32767		TP01	xx.xx							AI	32	2	00,01	2		-
5	TP_01	TP01	TAP POSITION	1-17	0-32767		TP01	xx.xx							AI	32	2	00,01	2		-

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
1	TP_01	TP01	OLTC LOCAL/REMOTE STATUS	Undefine	Local	Remote	Fault	TP01	xx.xx							DI	2	1	17, 28	1		
								TP01	xx.xx							DI	2	1	17, 28	1		
2	TP_01	TP01	OLTC MANUAL/AUTO STATUS	Undefine	Manual	Auto	Fault	TP01	xx.xx							DI	2	1	17, 28	1		
								TP01	xx.xx							DI	2	1	17, 28	1		
3	TP_01	TP01	OLTC INDIVIDUAL/PARALLEL STATUS	Undefine	Individual	Parallel	Fault	TP01	xx.xx							DI	2	1	17, 28	1		
								TP01	xx.xx							DI	2	1	17, 28	1		
5	TP_01	TP01	FAN MANUAL/AUTO STATUS	Undefine	Manual	Auto	Fault	TP01	xx.xx							DI	2	1	17, 28	1		
								TP01	xx.xx							DI	2	1	17, 28	1		
6	TP_01	TP01	FAN GROUP 1 ON/OFF STATUS	Undefine	On	Off	Fault	TP01	xx.xx							DI	2	1	17, 28	1		
								TP01	xx.xx							DI	2	1	17, 28	1		
7	TP_01	TP01	FAN GROUP 2 ON/OFF STATUS	Undefine	On	Off	Fault	TP01	xx.xx							DI	2	1	17, 28	1		
								TP01	xx.xx							DI	2	1	17, 28	1		
8	TP_01	TP01	AVR CONTROL SET MODE	Undefine	RCC	CSCS	Fault	TP01	xx.xx							DI	2	1	17, 28	1		
								TP01	xx.xx							DI	2	1	17, 28	1		
9	TP_01	TP01	PRESSURE RELIEF	Normal	Trip	-	-	TP01	xx.xx							SOE	2	2	17, 28	1		
10	TP_01	TP01	BUCHHOLZ RELAY	Normal	Trip	-	-	TP01	xx.xx							SOE	2	2	17, 28	1		
11	TP_01	TP01	WINDING TEMPERATURE	Normal	Trip	-	-	TP01	xx.xx							SOE	2	2	17, 28	1		
12	TP_01	TP01	DIVERTER SW PRSSURE LEVEL	Normal	Trip	-	-	TP01	xx.xx							SOE	2	2	17, 28	1		
13	TP_01	TP01	DIVERTER SW SUDDEN OIL FLOW	Normal	Trip	-	-	TP01	xx.xx							SOE	2	2	17, 28	1		
14	TP_01	TP01	OLTC O/C INSTANTANEOUS	Normal	Trip	-	-	TP01	xx.xx							SOE	2	2	17, 28	1		
15	TP_01	TP01	VT FAILURE	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
16	TP_01	TP01	OIL LEVEL (MAX)	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
17	TP_01	TP01	OIL LEVEL (MIN)	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
18	TP_01	TP01	OIL TEMPERATURE ALARM (MAX)	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
19	TP_01	TP01	OIL TEMPERATURE ALARM (MIN)	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
20	TP_01	TP01	WINDING TEMPERATURE	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
21	TP_01	TP01	BUCHHOLZ RELAY	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
22	TP_01	TP01	TAP CHANG DELAY	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
23	TP_01	TP01	TAP CHANG IN PROGRESS	Normal	Operated	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
24	TP_01	TP01	AC SUPPLY	Normal	Fail	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
25	TP_01	TP01	AC CONTROL CIRCUIT	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
26	TP_01	TP01	DC CONTROL CIRCUIT	Normal	Fail	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
27	TP_01	TP01	OLTC MOTOR BREAKER TRIP	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
28	TP_01	TP01	OLTC OIL PURIFIER ALARM	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
29	TP_01	TP01	FAN MOTOR BREAK TRIP	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
30	TP_01	TP01	MOTOR BREAKER O/C TRIP	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
31	TP_01	TP01	AVR FUILURE	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
32	TP_01	TP01	TRAFORMER MONITOR ERROR	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
33	TP_01	TP01	OLTC OIL PURIFIER ALARM	Normal	Operated	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
34	TP_01	TP01	AVR UNDER VOLTAGE	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
35	TP_01	TP01	AVR OVER VOLTAGE	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		
36	TP_01	TP01	AVR OVERCURRENT BLOCK	Normal	Alarm	-	-	TP01	xx.xx							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A4-1.11

I/O POINT COUNTS FOR

115kV/22kV SUBSTATION MONITORING, SINGLE BUS CONFIGURATION

Substation Name :		Substation Code Name :	
Voltage Level :	115/22kV	Bay Name :	Common
Substation DNP Adress :			
IED Product :		IED Model/Type :	
IED IP Address :			

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	COMM	COMM	CSCS CONTROL SET ON	Undefine	CSCS	Center	Fault	COMM	xx.xx							DI	2	1	17, 28	1		
								COMM	xx.xx							DI	2	1	17, 28	1		
2	COMM	COMM	GPS POWER SUPPLY	Normal	Fail	-	-	COMM	xx.xx							DI	2	1	17, 28	1		
3	COMM	COMM	GPS TIME SYNCRONIZING	Normal	Fail	-	-	COMM	cc							DI	2	1	17, 28	1		
4	COMM	COMM	DC DISTRIBUTION BOARD NO.1	Normal	Fail	-	-	COMM	xx.xx							DI	2	1	17, 28	1		
5	COMM	COMM	DC DISTRIBUTION BOARD NO.2	Normal	Fail	-	-	COMM	xx.xx							DI	2	1	17, 28	1		
6	COMM	COMM	AC DISTRIBUTION BOARD NO.1	Normal	Fail	-	-	COMM	xx.xx							DI	2	1	17, 28	1		
7	COMM	COMM	AC DISTRIBUTION BOARD NO.2	Normal	Fail	-	-	COMM	xx.xx							DI	2	1	17, 28	1		
8	COMM	COMM	BATT. CHARGER NO.1 FAILURE	Normal	Alarm	-	-	COMM	xx.xx							DI	2	1	17, 28	1		
9	COMM	COMM	BATT. CHARGER NO.1 OVERVOLTAGE	Normal	Alarm	-	-	COMM	xx.xx							DI	2	1	17, 28	1		
10	COMM	COMM	BATT. CHARGER NO.1 UNDERVOLTAGE	Normal	Alarm	-	-	COMM	xx.xx							DI	2	1	17, 28	1		
11	COMM	COMM	BATT. CHAR. NO.1 EARTH FAULT POS.	Normal	Alarm	-	-	COMM	xx.xx							DI	2	1	17, 28	1		
12	COMM	COMM	BATT. CHAR. NO.1 EARTH FAULT NEG.	Normal	Alarm	-	-	COMM	xx.xx							DI	2	1	17, 28	1		
13	COMM	COMM	BATT. CHARGER NO.2 FAILURE	Normal	Alarm	-	-	COMM	xx.xx							DI	2	1	17, 28	1		
14	COMM	COMM	BATT. CHARGER NO.2 OVERVOLTAGE	Normal	Alarm	-	-	COMM	xx.xx							DI	2	1	17, 28	1		
15	COMM	COMM	BATT. CHARGER NO.2 UNDERVOLTAGE	Normal	Alarm	-	-	COMM	xx.xx							DI	2	1	17, 28	1		
16	COMM	COMM	BATT. CHAR. NO.2 EARTH FAULT POS.	Normal	Alarm	-	-	COMM	xx.xx							DI	2	1	17, 28	1		
17	COMM	COMM	BATT. CHAR. NO.2 EARTH FAULT NEG.	Normal	Alarm	-	-	COMM	xx.xx							DI	2	1	17, 28	1		
18	COMM	COMM	FIRE ALARM PROTECTION	Normal	Alarm	-	-	COMM	cc							DI	2	1	17, 28	1		
19	COMM	COMM	FIRE ALARM POWER SUPPLY	Normal	Fail	-	-	COMM	cc							DI	2	1	17, 28	1		
20	COMM	COMM	CCTV POWER SUPPLY	Normal	Fail	-	-	COMM	cc							DI	2	1	17, 28	1		

Status Points:

Item	Feeder Name	Bay Name	Details					Panel	Terminal Connection	Device Name	IEC 61850					DMS (DNP Mapping)						Remark
			Point Name	State							Logical Device	Logical Node	Data Object	Data Attribute	Logic	Type	Obj	Var	Qii	Class	Address	
				0	1	2	3															
21	COMM	COMM	BATTERY FAILURE	Normal	Alarm	-	-	COMM	cc							DI	2	1	17, 28	1		
22	COMM	COMM	STATION SWITCH NO.xx POWER LOST	Normal	Fail	-	-	COMM	cc							DI	2	1	17, 28	1		
23	COMM	COMM	PROCESS SWITCH NO.xx POWER LOST	Normal	Fail	-	-	COMM	cc							DI	2	1	17, 28	1		

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programable

SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

The Meaning of Descriptor is before"/" is state "1" after "/" is state "0" for binary point; first line is state "0,1" second line is state "1,0" for ternary point.

Table A-1.12

I/O POINT COUNTS FOR

SCPS CONNECTED WITH PROTECTION RELAY (FOR DOUBLE MAIN PROTECTION CONCEPT) 115kV INCOMING & OUTGOING LINE

Substation Name :		Substation Code Name :		Substation DNP Adress :	
Voltage Level :	115kV	Bay Name :	115kV Incoming & Outgoing Line		
IED Product :		IED Model/Type :			
IED IP Address :					

Status Points:

Item	Feeder Name	Bay Name	Details: Point Name	State 0	State 1	State 2	State 3	Panel	Terminal Connection	Device Name	IEC 61850: Logical Device	Logical Node	Data Object	Data Attribute	Logic	DMS (DNP Mapping): Type	Obj	Var	Qii	Class	Address	Remark
1	LINE_01	01YB-01	DISTANCE RELAY TRIP (MAIN No. 1)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
2	LINE_01	01YB-01	DISTANCE ZONE 1 TRIP (MAIN No. 1)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
3	LINE_01	01YB-01	DISTANCE ZONE 2 TRIP (MAIN No. 1)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
4	LINE_01	01YB-01	DISTANCE ZONE 3 TRIP (MAIN No. 1)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
5	LINE_01	01YB-01	DISTANCE PHASE A TRIP (MAIN No. 1)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
6	LINE_01	01YB-01	DISTANCE PHASE B TRIP (MAIN No. 1)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
7	LINE_01	01YB-01	DISTANCE PHASE C TRIP (MAIN No. 1)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
8	LINE_01	01YB-01	DISTANCE EARTHFAULT TRIP (MAIN No. 1)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
9	LINE_01	01YB-01	DISTANCE SWITCH ONTO FAULT TRIP (MAIN No. 1)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
10	LINE_01	01YB-01	DISTANCE RELAY VT CIRCUIT FAIL (MAIN No. 1)	Normal	Fail	-	-	LINE01	xx.xx							DI						Main Protection No. 1
11	LINE_01	01YB-01	DISTANCE OVER CURRENT PHASE A TRIP (MAIN No. 1)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
12	LINE_01	01YB-01	DISTANCE OVER CURRENT PHASE B TRIP (MAIN No. 1)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
13	LINE_01	01YB-01	DISTANCE OVER CURRENT PHASE C TRIP (MAIN No. 1)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
14	LINE_01	01YB-01	DISTANCE OVER CURRENT E/F RELAY TRIP (MAIN No.	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
15	LINE_01	01YB-01	LINE DIFFERENTIAL RELAY TRIP (MAIN No. 1)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
16	LINE_01	01YB-01	AUTO-RECLOSE OPERATED (MAIN No. 1)	Normal	Operated	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
17	LINE_01	01YB-01	AUTO-RECLOSE LOCKOUT (MAIN No. 1)	Normal	Lockout	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
18	LINE_01	01YB-01	TIME DELAYED (CB FAIL) TRIP (MAIN No. 1)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
19	LINE_01	01YB-01	PROTECTIONRELAY GENERAL TRIP (MAIN No. 1)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 1
20	LINE_01	01YB-01	PROTECTIONRELAY FAIL (MAIN No. 1)	Normal	Fail	-	-	LINE01	xx.xx							DI						Main Protection No. 1
21	LINE_01	01YB-01	PROTECTIONRELAY DC SUPPLY FAIL (MAIN No. 1)	Normal	Fail	-	-	LINE01	xx.xx							DI						Main Protection No. 1
22	LINE_01	01YB-01	DISTANCE RELAY TRIP (MAIN No. 2)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 2
23	LINE_01	01YB-01	DISTANCE ZONE 1 TRIP (MAIN No. 2)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 2
24	LINE_01	01YB-01	DISTANCE ZONE 2 TRIP (MAIN No. 2)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 2
25	LINE_01	01YB-01	DISTANCE ZONE 3 TRIP (MAIN No. 2)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 2
26	LINE_01	01YB-01	DISTANCE PHASE A TRIP (MAIN No. 2)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 2
27	LINE_01	01YB-01	DISTANCE PHASE B TRIP (MAIN No. 2)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 2
28	LINE_01	01YB-01	DISTANCE PHASE C TRIP (MAIN No. 2)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 2
29	LINE_01	01YB-01	DISTANCE EARTHFAULT TRIP (MAIN No. 2)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 2
30	LINE_01	01YB-01	DISTANCE SWITCH ONTO FAULT TRIP (MAIN No. 2)	Normal	Trip	-	-	LINE01	xx.xx							SOE						Main Protection No. 2

NOTE:

xx.xx = By Terminal, cc = By Communication or Soft Switch or Programmable

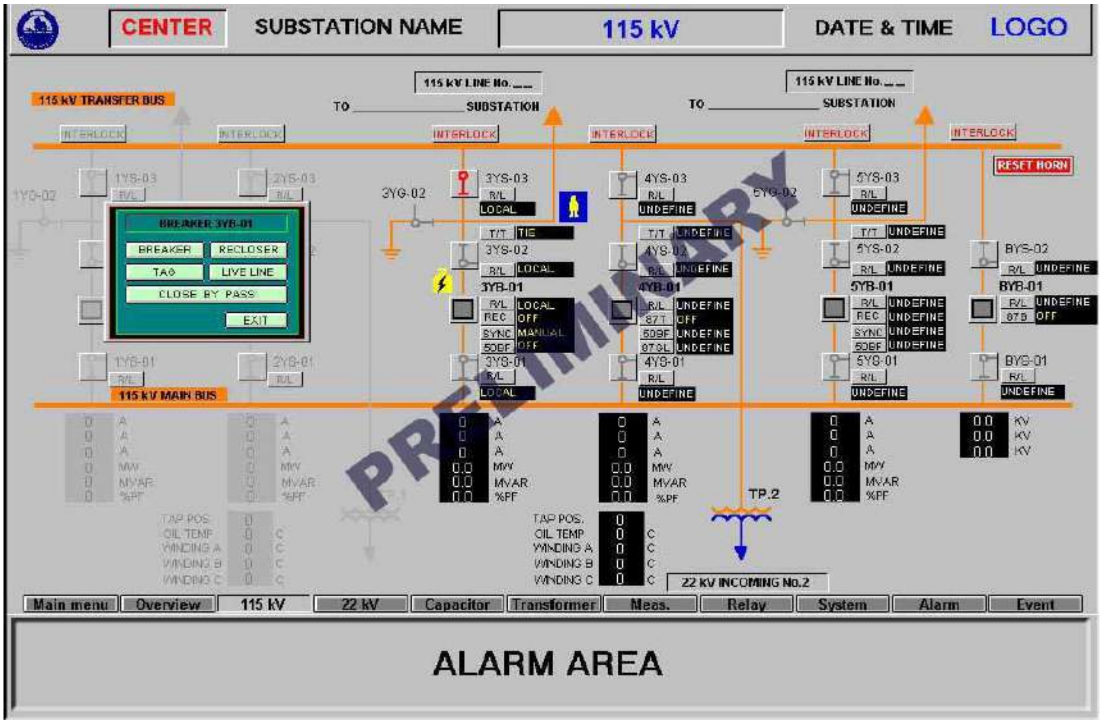
SBO = Output Command (Select before operate) , DOP = Output Command (Direct operate)

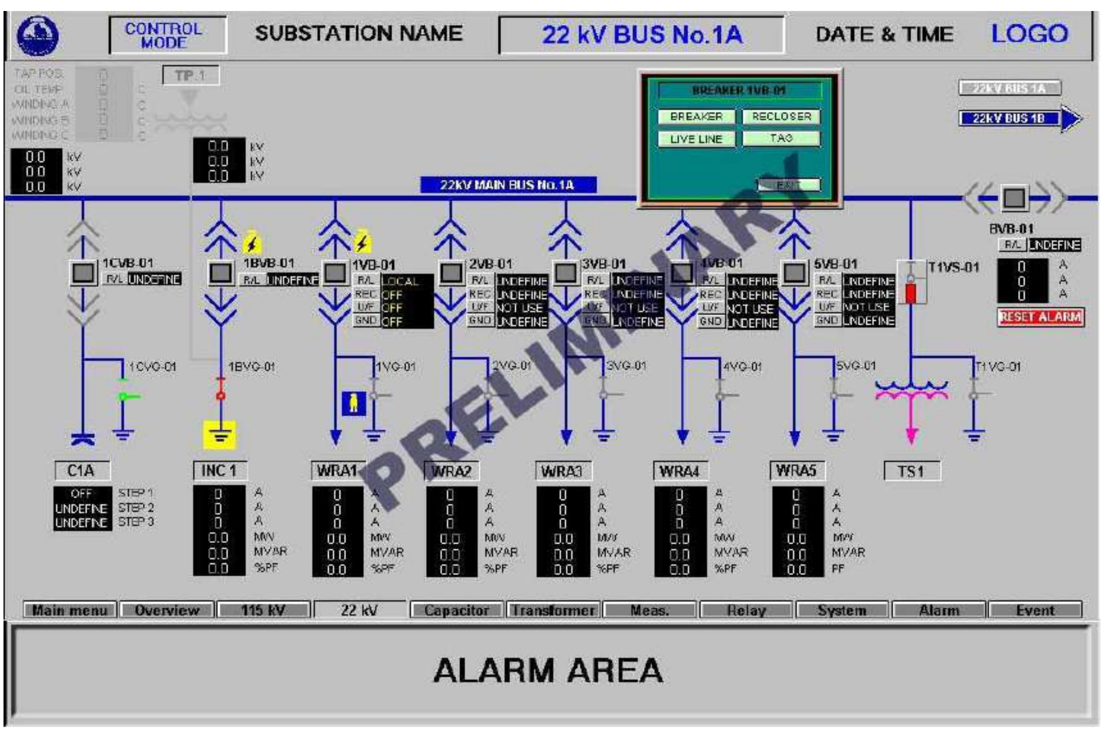
AI = Analog input (Measurement)

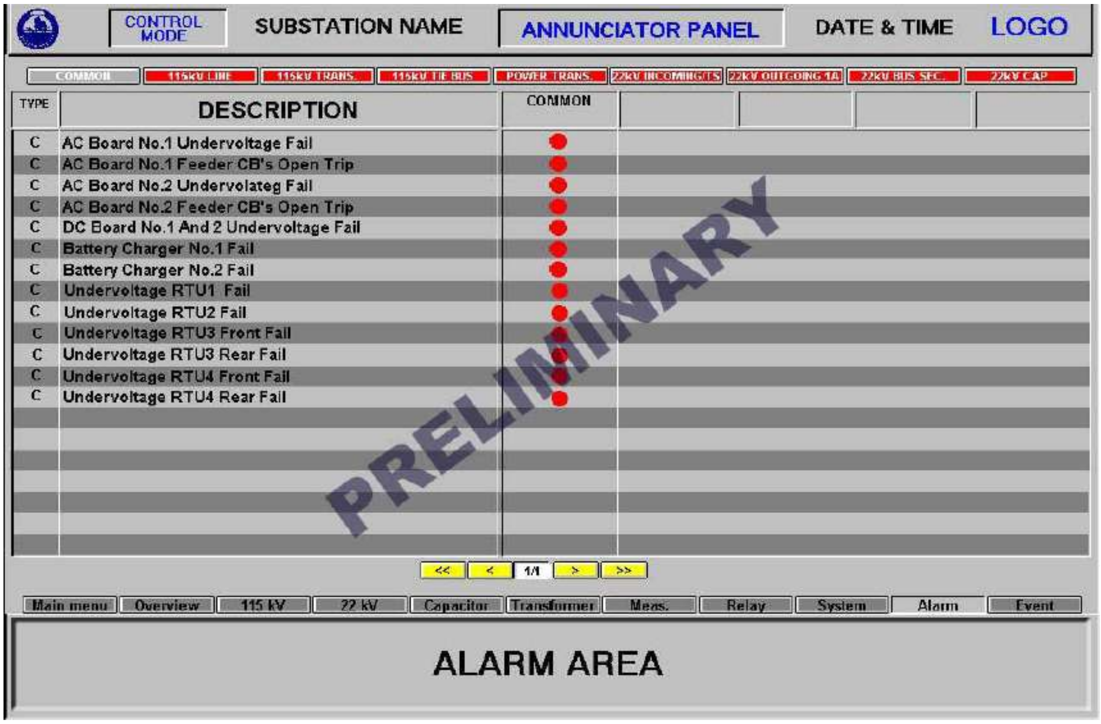
DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

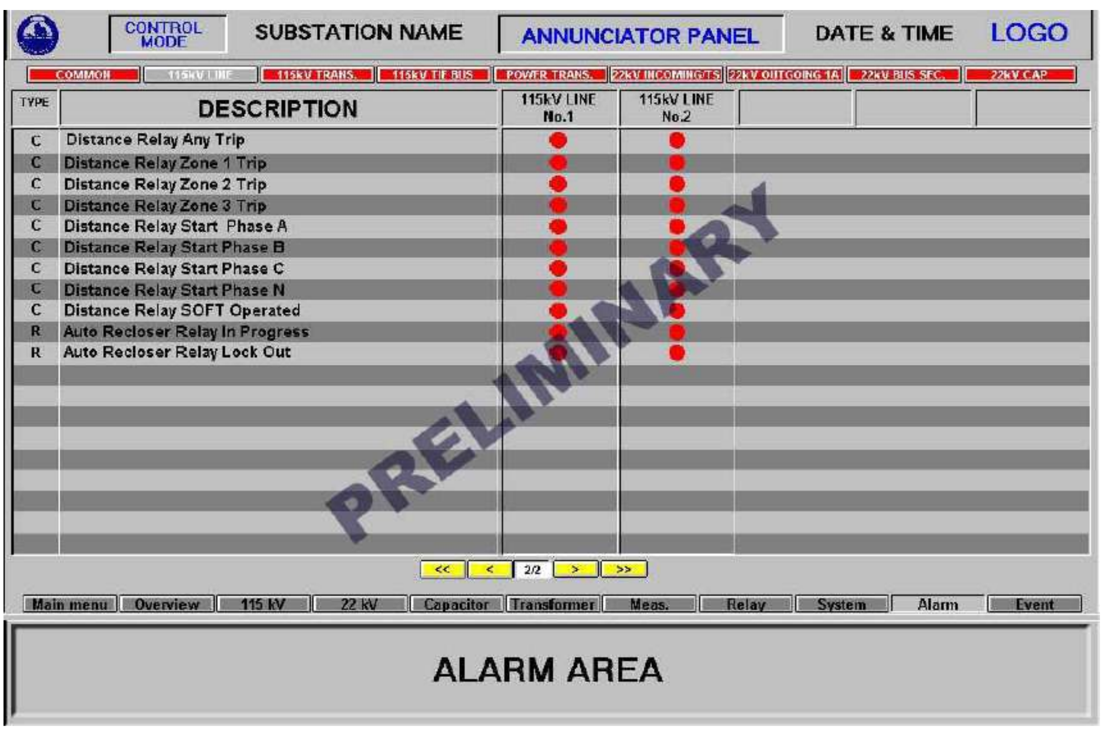
ANNEX 5 – TYPICAL SCREEN DISPLAY AND PRINTOUT REPORT FORMATS

A5.1 Typical Screen Display

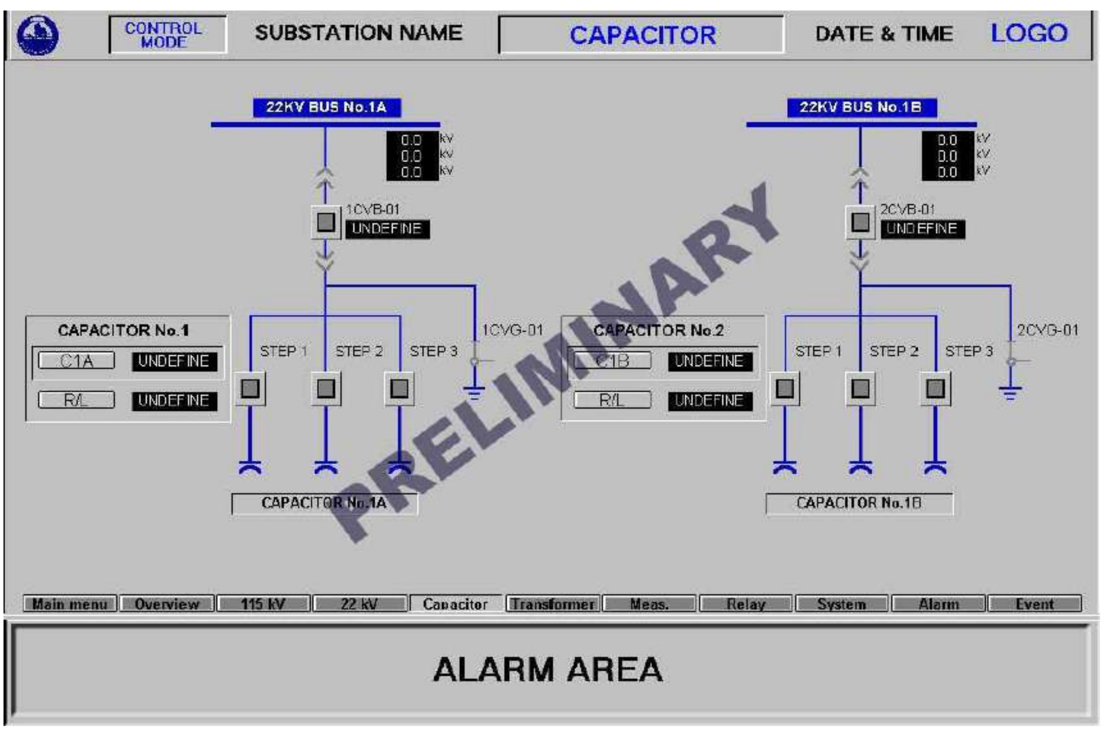





CONTROL MODE
SUBSTATION NAME
ANNUNCIATOR PANEL
DATE & TIME
LOGO
COMMON
115kV LINE
115kV TRANS.
115kV TIE BUS
POWER TRANS.
22kV INCOMING/TS
22kV OUTGOING 1A
22kV BUS SEC.
22kV CAP
TYPE
DESCRIPTION
COMMON
C AC Board No.1 Undervoltage Fail
C AC Board No.1 Feeder CB's Open Trip
C AC Board No.2 Undervolateg Fail
C AC Board No.2 Feeder CB's Open Trip
C DC Board No.1 And 2 Undervoltage Fail
C Battery Charger No.1 Fail
C Battery Charger No.2 Fail
C Undervoltage RTU1 Fail
C Undervoltage RTU2 Fail
C Undervoltage RTU3 Front Fail
C Undervoltage RTU3 Rear Fail
C Undervoltage RTU4 Front Fail
C Undervoltage RTU4 Rear Fail
PRELIMINARY
<< < 1/1 > >>
Main menu
Overview
115 kV
22 kV
Capacitor
Transformer
Meas.
Relay
System
Alarm
Event
ALARM AREA


CONTROL MODE
SUBSTATION NAME
ANNUNCIATOR PANEL
DATE & TIME
LOGO
COMMON
115kV LINE
115kV TRANS.
115kV TIE BUS
POWER TRANS.
22kV INCOMING/TS
22kV OUTGOING 1A
22kV BUS SEC.
22kV CAP
TYPE
DESCRIPTION
115kV LINE No.1
115kV LINE No.2
C Distance Relay Any Trip
C Distance Relay Zone 1 Trip
C Distance Relay Zone 2 Trip
C Distance Relay Zone 3 Trip
C Distance Relay Start Phase A
C Distance Relay Start Phase B
C Distance Relay Start Phase C
C Distance Relay Start Phase N
C Distance Relay SOFT Operated
R Auto Recloser Relay In Progress
R Auto Recloser Relay Lock Out
PRELIMINARY
<< < 2/2 > >>
Main menu
Overview
115 kV
22 kV
Capacitor
Transformer
Meas.
Relay
System
Alarm
Event
ALARM AREA


CONTROL MODE
SUBSTATION NAME
ALARM LIST
DATE & TIME
LOGO
Date
Time
Description
Status
4/5/00 4:20:17 AM NHA 22kV OUT. 7 OVER CURRENT E/F ALARM
4/5/00 4:20:17 AM NHA 22kV OUT. 7 O/C TIME DELAY TRIP
4/5/00 4:20:20 AM NHA 22kV OUT. 7 E/F RELAY START
4/5/00 4:20:21 AM NHA 22kV OUT. 7 O/C TIME DELAY TRIP
4/5/00 4:20:21 AM NHA 22kV OUT. 7 OVER CURRENT E/F ALARM
4/5/00 4:20:39 AM NHA 22kV OUT. 7 O/C TIME DELAY TRIP
4/5/00 4:20:39 AM NHA 22kV OUT. 7 OVER CURRENT E/F ALARM
4/5/00 4:20:41 AM NHA 22kV OUT. 7 7VB-01 AUTO RECLOSE LOCKOUT
4/5/00 4:25:56 AM NHA 22kV OUT. 7 O/C TIME DELAY TRIP
4/5/00 4:25:56 AM NHA 22kV OUT. 7 OVER CURRENT E/F ALARM
4/5/00 4:26:00 AM NHA 22kV OUT. 7 E/F RELAY START
4/5/00 6:27:40 AM NHA 22kV OUT. 7 7VB-01 AUTO RECLOSE LOCKOUT
4/5/00 9:25:58 AM NHA 22kV OUT. 6 RECLOSER OFF COMMAN
4/5/00 9:26:00 AM NHA 22kV OUT. 6 RECLOSER EXECUTE COMN
4/5/00 9:26:06 AM NHA 22kV OUT. 6 6VB-01 AUTO RECLOSE LOCKOUT
4/5/00 9:26:14 AM NHA 22kV OUT. 1 RECLOSER OFF COMMAN
4/5/00 9:26:15 AM NHA 22kV OUT. 1 RECLOSER EXECUTE COMN
4/5/00 9:26:21 AM NHA 22kV OUT. 1 1VB-01 AUTO RECLOSE LOCKOUT
4/5/00 9:43:15 AM NHA 22kV OUT. 6 RECLOSER ON COMMAN
4/5/00 9:43:15 AM NHA 22kV OUT. 6 RECLOSER EXECUTE COMN
4/5/00 3:04:27 PM NHA 22kV OUT. 6 RECLOSER OFF COMMAN
4/5/00 3:04:28 PM NHA 22kV OUT. 6 RECLOSER EXECUTE COMN
4/5/00 3:04:31 PM NHA 22kV OUT. 6 6VB-01 AUTO RECLOSE LOCKOUT
Record: 1 of 1
PRELIMINARY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SUBSTATION NAME
CAPACITOR
DATE & TIME
LOGO
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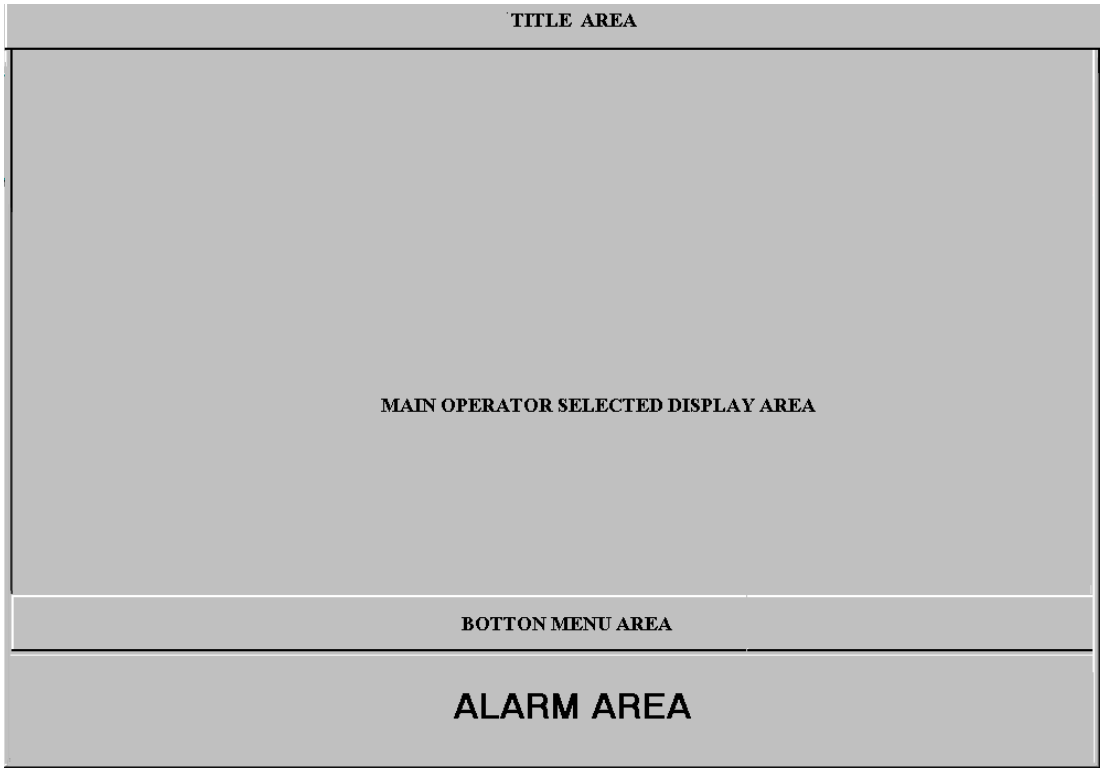
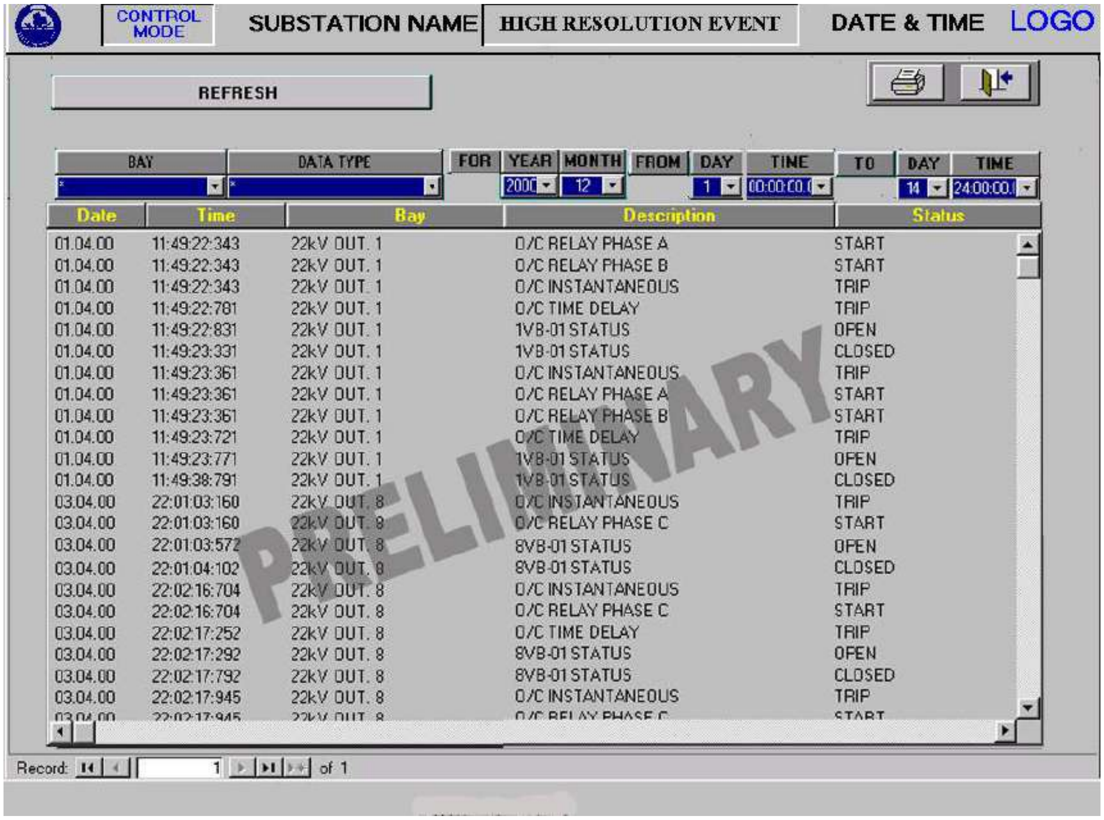
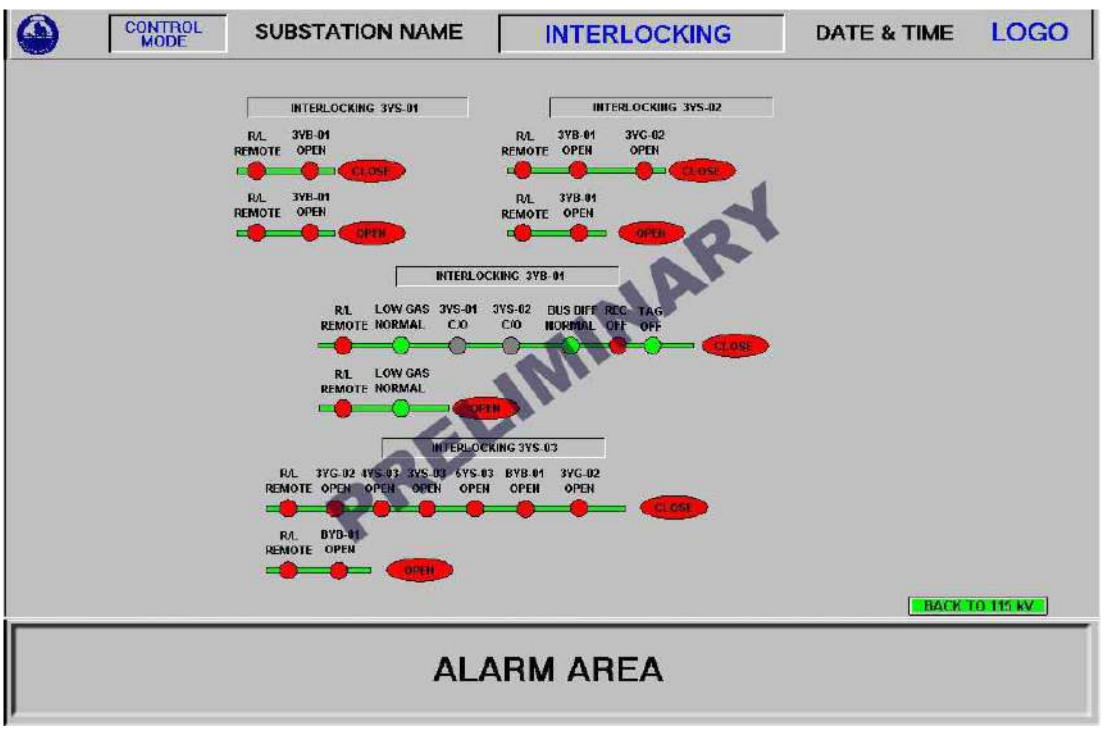
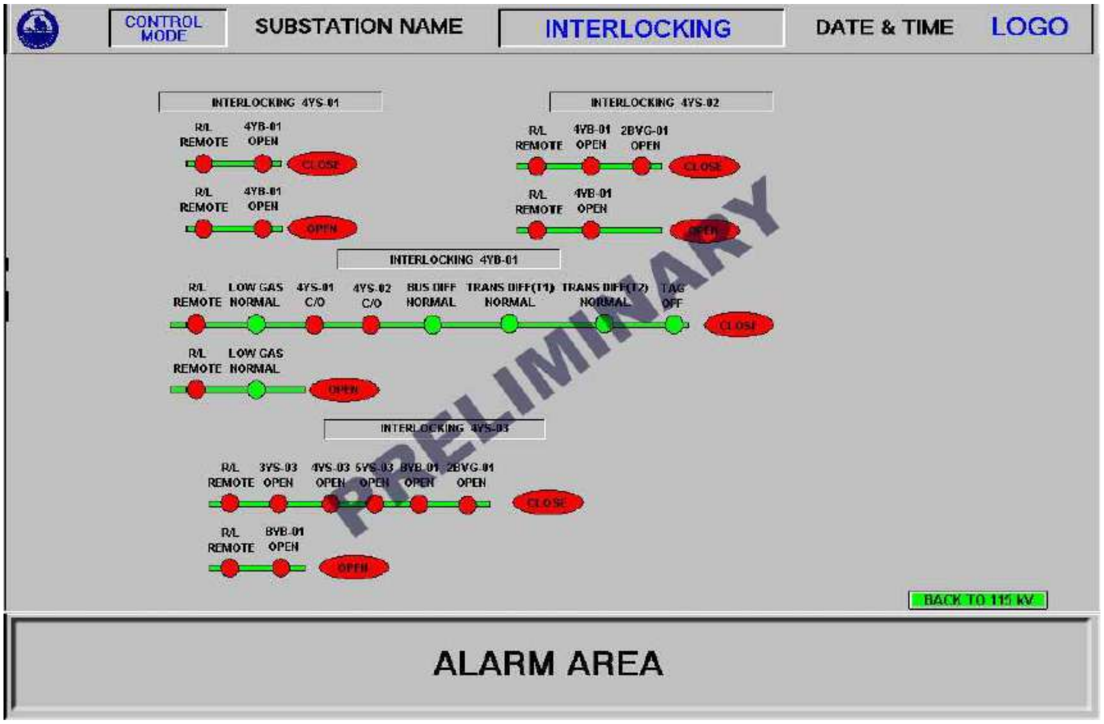
22KV BUS No.1B
0.0 kV
0.0 kV
0.0 kV
1CVB-01
UNDEFINE
2CVB-01
UNDEFINE
CAPACITOR No.1
C1A UNDEFINE
R/L UNDEFINE
STEP 1
STEP 2
STEP 3
1CVG-01
CAPACITOR No.2
C1B UNDEFINE
R/L UNDEFINE
2CVG-01
CAPACITOR No.1A
CAPACITOR No.1B
Main menu
Overview
115 kV
22 kV
Capacitor
Transformer
Meas.
Relay
System
Alarm
Event
ALARM AREA
PRELIMINARY

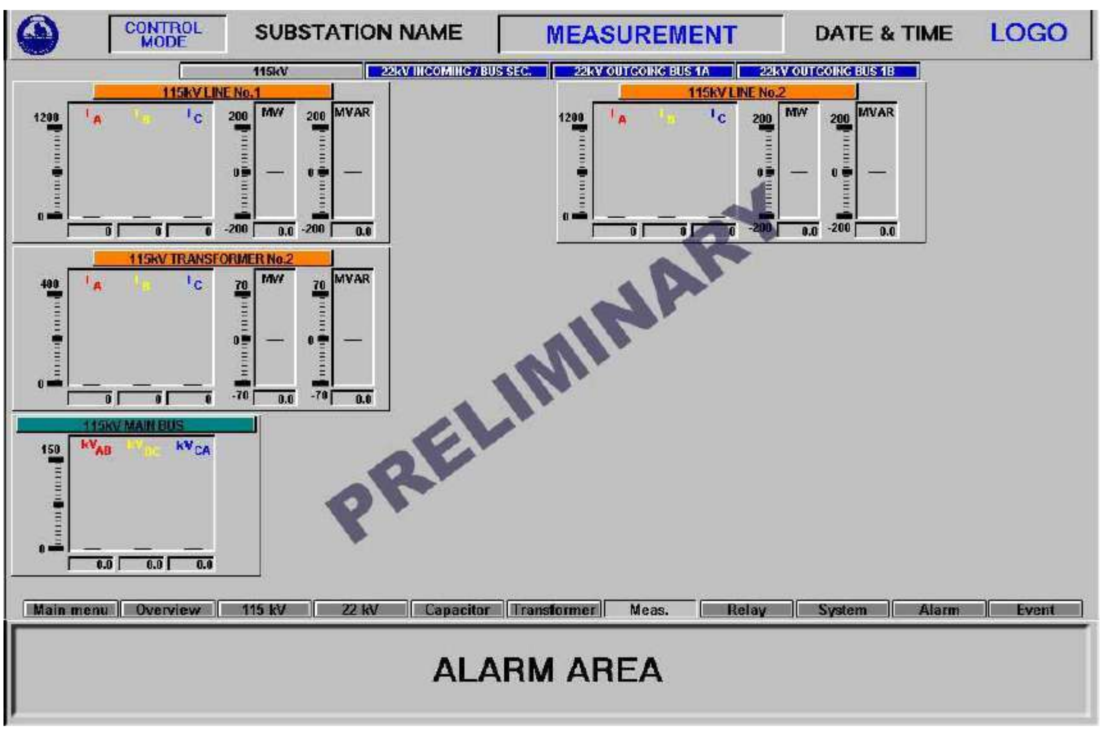

TITLE AREA
MAIN OPERATOR SELECTED DISPLAY AREA
BOTTON MENU AREA
ALARM AREA

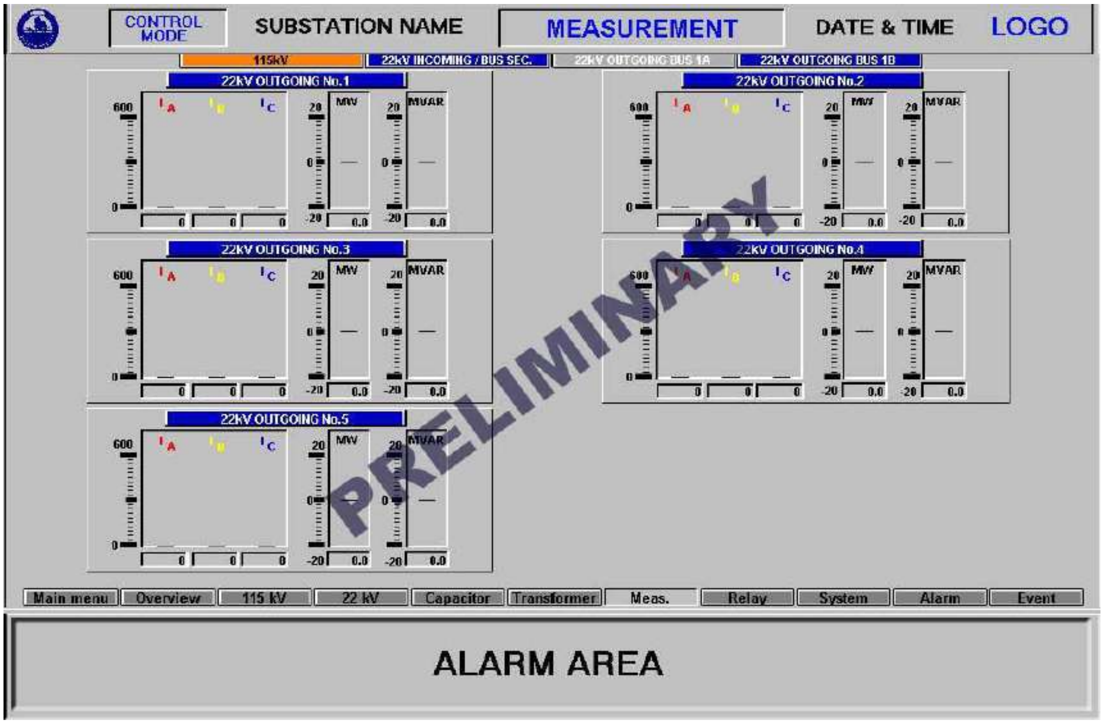

CONTROL MODE
SUBSTATION NAME
EVENT LIST
DATE & TIME
LOGO
REFRESH
BAY
DATA TYPE
FOR
YEAR
MONTH
FROM
DAY
TIME
TO
DAY
TIME
2000
12
1
00:00:00.0
14
24:00:00.0
Date
Time
Description
Status
12/4/00 3:19:55 PM CBA 22kV OUT. 13 13VB-01 CONTROL ON LOCAL
12/4/00 3:19:55 PM CBA 22kV OUT. 13 U/F RELAY STATUS OFF
12/4/00 3:19:55 PM CBA 22kV OUT. 13 13VB-01 STATUS OPEN
12/4/00 3:19:55 PM CBA 22kV OUT. 13 13VB-01 STATUS OPEN
12/4/00 3:19:55 PM CBA 22kV OUT. 13 13VG-01 STATUS OFF
12/4/00 3:19:55 PM CBA 22kV OUT. 14 14VB-01 AUTO REC. STAT OPEN
12/4/00 3:19:55 PM CBA 22kV OUT. 14 14VB-01 STATUS OPEN
12/4/00 3:19:55 PM CBA 22kV OUT. 14 14VB-01 WITHD. UNIT ST OPEN
12/4/00 3:19:55 PM CBA 22kV OUT. 14 14VG-01 STATUS ON
12/4/00 3:19:55 PM CBA 22kV OUT. 14 14VB-01 BREAKER FAIL S OFF
12/4/00 3:19:55 PM CBA 22kV OUT. 14 U/F RELAY STATUS LOCAL
12/4/00 3:19:55 PM CBA 22kV OUT. 15 15VB-01 STATUS OPEN
12/4/00 3:19:55 PM CBA 22kV OUT. 3 3VB-01 WITHD. UNIT ST. OPEN
12/4/00 3:19:55 PM CBA 22kV OUT. 3 3VB-01 STATUS OPEN
12/4/00 3:19:55 PM CBA 22kV OUT. 6 6VG-01 STATUS OPEN
12/4/00 3:19:55 PM CBA 22kV OUT. 6 6VB-01 WITHD. UNIT ST. OPEN
12/4/00 3:19:55 PM CBA 22kV OUT. 8 8VB-01 CONTROL ON LOCAL
12/4/00 3:19:55 PM CBA 22kV OUT. 8 8VB-01 BREAKER FAIL SW ON
12/4/00 3:20:01 PM CBA 22kV BS 1-2 CAU09 FIELD MOD.FAULT OK
12/4/00 3:20:01 PM CBA 22kV BS 1-2 SIE08 FIELD MOD.FAULT OK
12/4/00 3:20:01 PM CBA 22kV C3 CAU25 FIELD MOD.FAULT OK
12/4/00 3:20:01 PM CBA 22kV INC. 2 SIE09 FIELD MOD.FAULT OK
12/4/00 3:20:01 PM CBA 22kV INC. 2 CAU11 FIELD MOD.FAULT OK
12/4/00 3:20:01 PM CBA 22kV OUT. 12 SIE19 FIELD MOD.FAULT OK
12/4/00 3:20:01 PM CBA 22kV OUT. 13 SIE20 FIELD MOD.FAULT OK
PRELIMINARY
Record: 1 of 1

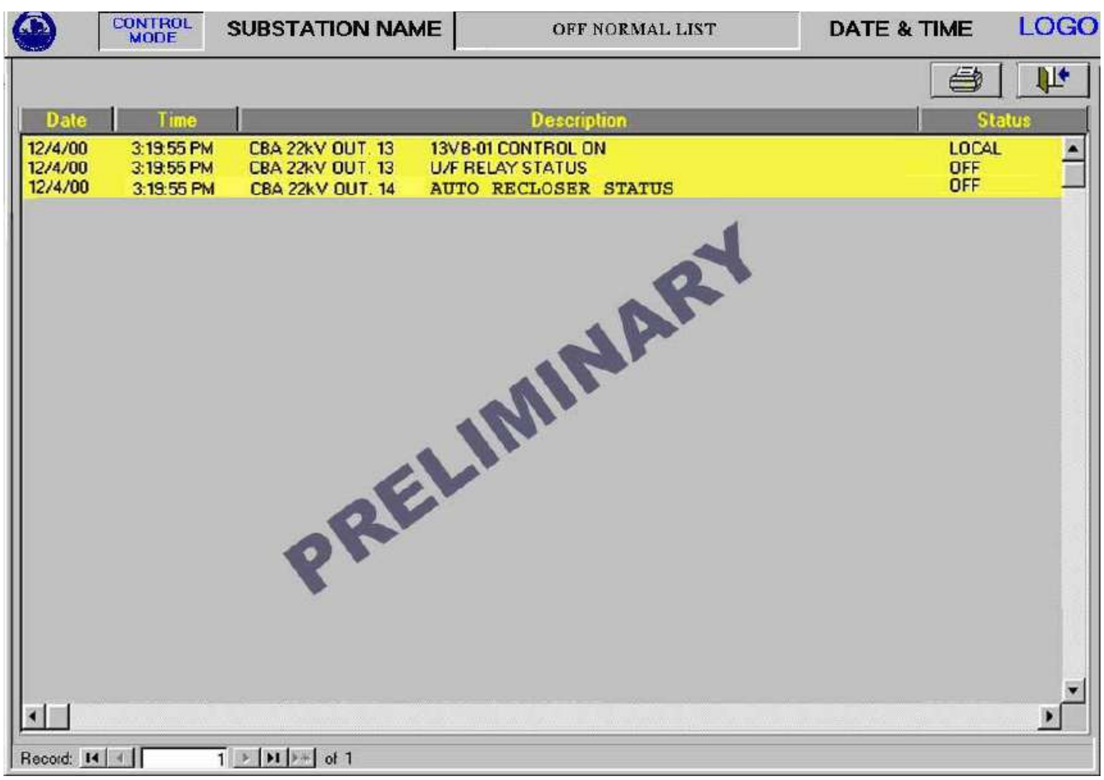

CONTROL MODE
SUBSTATION NAME
HIGH RESOLUTION EVENT
DATE & TIME
LOGO
REFRESH
BAY
DATA TYPE
FOR
YEAR
MONTH
FROM
DAY
TIME
TO
DAY
TIME
2000
12
1
00:00:00.0
14
24:00:00.
Date
Time
Bay
Description
Status
01.04.00 11:49:22:343 22kV OUT. 1 O/C RELAY PHASE A START
01.04.00 11:49:22:343 22kV OUT. 1 O/C RELAY PHASE B START
01.04.00 11:49:22:343 22kV OUT. 1 O/C INSTANTANEOUS TRIP
01.04.00 11:49:22:781 22kV OUT. 1 O/C TIME DELAY TRIP
01.04.00 11:49:22:831 22kV OUT. 1 1VB-01 STATUS OPEN
01.04.00 11:49:23:331 22kV OUT. 1 1VB-01 STATUS CLOSED
01.04.00 11:49:23:361 22kV OUT. 1 O/C INSTANTANEOUS TRIP
01.04.00 11:49:23:361 22kV OUT. 1 O/C RELAY PHASE A START
01.04.00 11:49:23:361 22kV OUT. 1 O/C RELAY PHASE B START
01.04.00 11:49:23:721 22kV OUT. 1 O/C TIME DELAY TRIP
01.04.00 11:49:23:771 22kV OUT. 1 1VB-01 STATUS OPEN
01.04.00 11:49:38:791 22kV OUT. 1 1VB-01 STATUS CLOSED
03.04.00 22:01:03:160 22kV OUT. 8 O/C INSTANTANEOUS TRIP
03.04.00 22:01:03:160 22kV OUT. 8 O/C RELAY PHASE C START
03.04.00 22:01:03:572 22kV OUT. 8 8VB-01 STATUS OPEN
03.04.00 22:01:04:102 22kV OUT. 8 8VB-01 STATUS CLOSED
03.04.00 22:02:16:704 22kV OUT. 8 O/C INSTANTANEOUS TRIP
03.04.00 22:02:16:704 22kV OUT. 8 O/C RELAY PHASE C START
03.04.00 22:02:17:252 22kV OUT. 8 O/C TIME DELAY TRIP
03.04.00 22:02:17:292 22kV OUT. 8 8VB-01 STATUS OPEN
03.04.00 22:02:17:792 22kV OUT. 8 8VB-01 STATUS CLOSED
03.04.00 22:02:17:945 22kV OUT. 8 O/C INSTANTANEOUS TRIP
Record: 1 of 1
PRELIMINARY

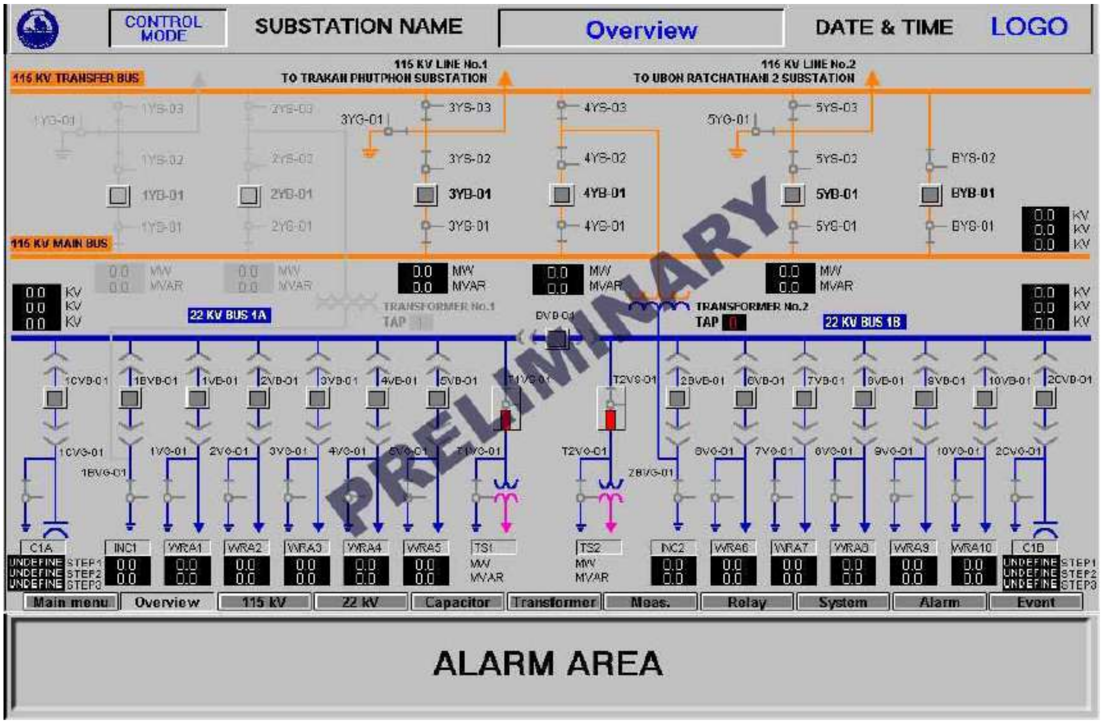

CONTROL MODE
SUBSTATION NAME
INTERLOCKING
DATE & TIME
LOGO
INTERLOCKING 3VS-01
R/L REMOTE
3VB-01 OPEN
CLOSE
OPEN
INTERLOCKING 3VS-02
3VB-01 OPEN
3VG-02 OPEN
INTERLOCKING 3VB-01
LOW GAS NORMAL
3VS-01 C/O
3VS-02 C/O
BUS DIFF NORMAL
REC OFF
TAG OFF
INTERLOCKING 3VS-03
3VG-02 OPEN
4VS-03 OPEN
3VS-03 OPEN
6VS-03 OPEN
BYB-01 OPEN
BYD-01 OPEN
BACK TO 115 kV
ALARM AREA
PRELIMINARY

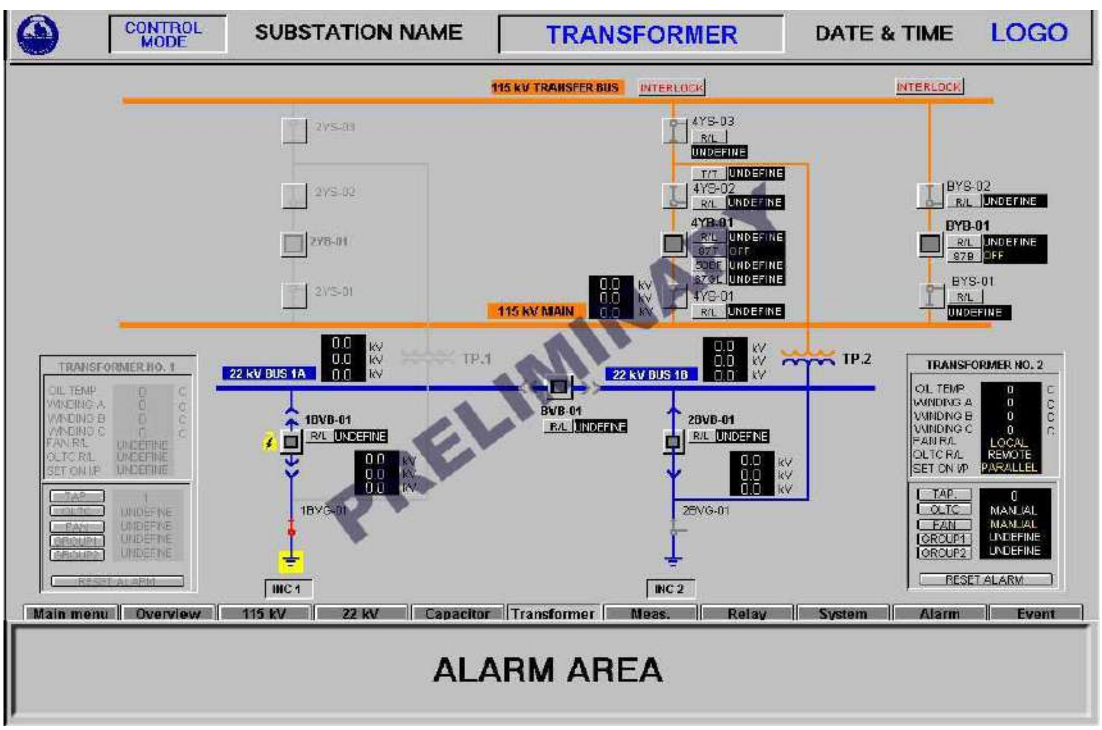

CONTROL MODE
SUBSTATION NAME
INTERLOCKING
DATE & TIME
LOGO
INTERLOCKING 4YS-01
INTERLOCKING 4YS-02
INTERLOCKING 4YB-01
INTERLOCKING 4YS-03
PRELIMINARY
BACK TO 115 kV
ALARM AREA


CONTROL MODE
SUBSTATION NAME
MEASUREMENT
DATE & TIME
LOGO
115kV
22kV INCOMING / BUS SEC.
22kV OUTGOING BUS 1A
22kV OUTGOING BUS 1B
115kV LINE No.1
115kV LINE No.2
115kV TRANSFORMER No.2
115kV MAIN BUS
PRELIMINARY
Main menu
Overview
115 kV
22 kV
Capacitor
Transformer
Meas.
Relay
System
Alarm
Event
ALARM AREA


CONTROL MODE
SUBSTATION NAME
MEASUREMENT
DATE & TIME
LOGO
115kV
22kV INCOMING / BUS SEC.
22kV OUTGOING BUS 1A
22kV OUTGOING BUS 1B
22kV OUTGOING No.1
22kV OUTGOING No.2
22kV OUTGOING No.3
22kV OUTGOING No.4
22kV OUTGOING No.5
Main menu
Overview
115 kV
22 kV
Capacitor
Transformer
Meas.
Relay
System
Alarm
Event
ALARM AREA
PRELIMINARY


CONTROL MODE
SUBSTATION NAME
OFF NORMAL LIST
DATE & TIME
LOGO
Date
Time
Description
Status
12/4/00 3:19:55 PM CBA 22kV OUT. 13 13VB-01 CONTROL ON LOCAL
12/4/00 3:19:55 PM CBA 22kV OUT. 13 U/F RELAY STATUS OFF
12/4/00 3:19:55 PM CBA 22kV OUT. 14 AUTO RECLOSER STATUS OFF
PRELIMINARY
Record: 1 of 1


CONTROL MODE
SUBSTATION NAME
Overview
DATE & TIME
LOGO
115 KV TRANSFER BUS
115 KV LINE No.1 TO TRAKAN PHUTPHON SUBSTATION
115 KV LINE No.2 TO UBON RATCHATHANI 2 SUBSTATION
115 KV MAIN BUS
TRANSFORMER No.1
TRANSFORMER No.2
22 KV BUS 1A
22 KV BUS 1B
PRELIMINARY
Main menu
Overview
115 kV
22 kV
Capacitor
Transformer
Meas.
Relay
System
Alarm
Event
ALARM AREA


CONTROL MODE
SUBSTATION NAME
TRANSFORMER
DATE & TIME
LOGO
115 kV TRANSFER BUS
INTERLOCK
115 kV MAIN
22 kV BUS 1A
22 kV BUS 1B
TRANSFORMER NO. 1
TRANSFORMER NO. 2
RESET ALARM
PRELIMINARY
Main menu
Overview
115 kV
22 kV
Capacitor
Transformer
Meas.
Relay
System
Alarm
Event
ALARM AREA

A5.2 Printout Report Format

Please see the report format,

1) Daily Load Report
2) Monthly Load Report
3) XXX kV Yearly Report

as shown below.

ANNEX 5.2

1) Daily Load Report

Substation Name

XXX kV Incoming No. XX												
Date	Time	kV(AB)	kV(BC)	kV(CA)	IA	IB	IC	MW	Mvar	%PF	%THDi(B)	%THDv(B)
01/01/00	0:00	XX.X	XX.X	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X	X.X
01/01/00	0:30	XX.X	XX.X	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X	X.X
01/01/00	1:00	XX.X	XX.X	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X	X.X
01/01/00	1:30	XX.X	XX.X	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X	X.X
:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:
01/01/00	23:30	XX.X	XX.X	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X	X.X

ANNEX 5.2

1) Daily Load Report

Substation Name

XXX kV Outgoing No. XX											
Date	Time	kV(AB)	kV(BC)	kV(CA)	IA	IB	IC	MW	Mvar	%PF	%THDi(B)
01/01/00	0:00	XX.X	XX.X	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X
01/01/00	0:30	XX.X	XX.X	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X
01/01/00	1:00	XX.X	XX.X	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X
01/01/00	1:30	XX.X	XX.X	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X
:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:
01/01/00	23:30	XX.X	XX.X	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X

ANNEX 5.2

2)Monthly Load Report

Substation Name

XXX kV Incoming No. XX																																			
Day Time Peak												Night Time Peak												Day & Night Light Load											
08:00-15:30												0:000-07:30, 16:00-23:30												00:00-23:30											
Date	Time	kV	IA	IB	IC	%UN	MW	Mvar	%PF	%THDi	%THDv	Date	Time	kV	IA	IB	IC	%UN	MW	Mvar	%PF	%THDi	%THDv	Date	Time	kV	IA	IB	IC	%UN	MW	Mvar	%PF	%THDi	%THDv
		(BC)								(B)	(BN)			(BC)								(B)	(BN)			(BC)								(B)	(BN)
01/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	X.X	01/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	X.X	01/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	X.X
02/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	X.X	02/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	X.X	02/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	X.X
03/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	X.X	03/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	X.X	03/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	X.X
04/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	X.X	04/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	X.X	04/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	X.X
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
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31/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	X.X	31/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	X.X	31/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	X.X

ANNEX 5.2

2) Monthly Load Report

Substation Name

XXX kV Outgoing No. XX																																
Day Time Peak											Night Time Peak											Day & Night Light Load										
08:00-15:30											0:000-07:30, 16:00-23:30											00:00-23:30										
Date	Time	kV (BC)	IA	IB	IC	%UN	MW	Mvar	%PF	%THDi (B)	Date	Time	kV (BC)	IA	IB	IC	%UN	MW	Mvar	%PF	%THDi (B)	Date	Time	kV (BC)	IA	IB	IC	%UN	MW	Mvar	%PF	%THDi (B)
01/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	01/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	01/01/00	4.00	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X
02/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	02/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	02/01/00	4.30	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X
03/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	03/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	03/01/00	4.00	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X
04/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	04/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	04/01/00	5.00	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
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:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
31/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	31/01/00	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X	31/01/00	3.30	XX.X	XXX	XXX	XXX	X.X	X.X	X.X	XX	X.X

ANNEX 5.2

3) XXX kV Yearly Load Report

Substation Name

Year : XXXX

XXX kV Incoming No. XX																				
	Peak Load										Light Load									
Month	Day	Time	kV (BC)	IA	IB	IC	MW	Mvar	%PF	%THDv (BN)	Day	Time	kV (BC)	IA	IB	IC	MW	Mvar	%PF	%THDv (BN)
Jan	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X
Feb	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X
Mar	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X
Apr	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
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:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Dec	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X

ANNEX 5.2

3) XXX kV Yearly Load Report

Substation Name

Year : XXXX

XXX kV Outgoing No. XX																				
	Peak Load										Light Load									
Month	Day	Time	kV (BC)	IA	IB	IC	MW	Mvar	%PF	%THDi (B)	Day	Time	kV (BC)	IA	IB	IC	MW	Mvar	%PF	%THDi (B)
Jan	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X
Feb	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X
Mar	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X
Apr	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
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:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Dec	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X	XX	XX:XX	XX.X	XXX	XXX	XXX	X.X	X.X	XX	X.X

ANNEX 6 – IP ADDRESSING

Criteria for assigning the IP Address for control and protection system devices in a substation

A6.1 Background of IP Address (IPv4) in a substation

IP Address used for control and command operation in substation is in the format of private IP Address. Referring to IP Address Allocation Standard of the Internet Assigned Numbers Authority (IANA) which assigns the IP Address for private networks that can be used in general purposes. The details are in RFC 1918 documentations as follows:

RFC1918 name	IP address range	number of addresses	largest CIDR block (subnet mask)	host id size	mask bits	classful description[Note 1]
24-bit block	10.0.0.0 - 10.255.255.255	16,777,216	10.0.0.0/8 (255.0.0.0)	24 bits	8 bits	single class A network
20-bit block	172.16.0.0 - 172.31.255.255	1,048,576	172.16.0.0/12 (255.240.0.0)	20 bits	12 bits	16 contiguous class B networks
16-bit block	192.168.0.0 - 192.168.255.255	65,536	192.168.0.0/16 (255.255.0.0)	16 bits	16 bits	256 contiguous class C networks

Therefore, the IP Address in Table 1 should be used for the assignment of IP address for each device in a substation in order to comply with international standard.

A6.2 Objective for the assignment of IP address in substation

Objective for the assignment of IP address in a substation is to support the IEC 61850 substations that PEA plans to develop in the future. Since there are various devices in a substation, i.e., protection devices, control devices, etc., IP Address assignment will help identify the devices, provide the same direction of IP Address assignment for each substation, and provide more convenient working environemrnt the operators.

A6.3 Criteria for assigning the IP Address for control system in substation

In this documents, Private IP Address Class A, of which the IP Addresses are in the range of 10.0.0.0 to 10.255.255.255 and the subnet mask is 255.0.0.0, should be used. The assignment of IP Address, for control system in substation, will fixes the first two left-most groups of (decimal) number, and varies the other two groups of number according to functionality of a device. In the other words, the IP Address will be in the format of 10.0.aaa.xyz determined by the following criteria:

1) Criteria for assigning the third group of number of IP Address
   a. The third group of number (of IP Address), which is aaa, is used for differentiating different groups of devices. Details are as follows:
      - Assign aaa = 115 for main devices of a 115 kV system, i.e, bay protection devices, bay control devices, and MU.
      - Assign aaa = 116 for secondary devices or communication port of the 115 kV system.
      - Assign aaa = 22 or 33 for main devices of a 22 kV or 33 kV system respectively, i.e, bay protection devices, bay control devices and merging unit.
      - Assign aaa = 23 or 34 for secondary devices or communication port of the 22 kV or 33 kV system respectively.

- Assign aaa = 230 for tranformers such as TS.
- Assign aaa = 100 for necessary control devices, i.e., devices that are necessary for the operation of the system, such as SCPS Systems, HMI, Gateway, Common BCU, Printer and GIS. All other devices that are necessary for the operation of the system, but were not mentioned above will also be considered as devices of this group.
- Assign aaa = 200 for devices that are used for system management and recording of parameters, such as Relay Manager Station, Network Analyzer.
- Assign aaa = 0 for Network Switches, or Network Management System devices, such as Firewall, Router.
- Assign aaa = 50 for devices that will temporarily connect to the system such as a laptop of a system supervisor.
- Assign aaa = 99 for other devices that are not metioned above.

2) Criteria for assigning the last group of number of IP Address

2.1) For 115 kV system devices (IP Address 10.0.115.xyz)

a. x: in case of Bus Tie Bay (BTB), x = 2 and y= 0.

b. y: Bay Number, for example, Bay 2YB will get 10.0. 115.021.

c. z: device number, can be freely assigned from 0 to 9.

2.2) For 22 kV or 33 kV system devices (IP Address 10.0.22.xyz)

a. xy: determing by feeder number as followsL

- In case of outgoing, xy is assign by feeder number, for example, 05VB will get 10.0.22.05z or 10VB will get 10.0.22.10z.
- In case of incoming, assign x = 2 and y = incoming number, for example, 1BVB will get 10.0.22.21z.
- In case of Bus Tie, xy = 20.
- In case of Cap Bank, xy = 16 to 19.

b. Z: assigned according to device number in each feeder, can be freely assigned from 0 to 9.

Remark: In case when there are more than 10 units of the main devices of 115 kV or 22 kV systems, the assignment of the IP Address using above critetia will not have enough enough number. In this case, the second group of number of the IP Address will be changed from 0 to 1, for example, 10.1.22.101.

2.3) For main control devices (IP Address 10.0.100.xyz)

For main control system, xyz number can be assigned freely. However, for harmonization among substations, the IP Address of main devices will be assigned as follows:

a. SCPS Systems devices: xyz = 100 to 109

b. HMI devices: xyz = 110 to 119.

c. Gateway devices (connecting to Control Center): xyz = 150 to 159.

d. GPS: xyz = 160 to 169.

e. Printers: xyz = 170 to 179.

f. Common BCU devices: xyz = 0 to 9.

g. Other devices that are not metioned above: use xyz from 200 to 254.

2.4) For devices that are used for system management and recording of parameters (IP Address 10.0.200.xyz)

Since devices in this category can be different for each substation, xyz number can be assigned freely from 1 to 254.

2.5) For Network Switches or Network Management System devices (IP Address 10.0.0.xyz)

a. x assignment
- For Network devices in Station Bus, assign x = 0.
- For Network devices in Process Bus, assign x = 1.

b. y assignment
- y will be assigned freely according to the group of a device, such as group 1, group 2.

c. z assignment
- z will showredundancy of (network system) devices in the same group (i.e., under the same y).

Example: Switch 1A, which belongs to group 1, has a redundancy device that is Switch 1B. The IP Address will be 10.0.0.011 and 10.0.0.012 for 1A and 1B, repectively.

ANNEX 7 – CYBER SECURITY REQIUREMENTS

PREAMBLE

This section describes how cyber-security is to be implemented. The basis of this section is the ISO 27002 and the NERC Critical Infrastructure Protection (CIP) Standards. However, some CIP requirements from the NERC standard are not applicable to Substation Automation (particularly inside the substation), but have to be implemented by the customer directly in other areas of the business and therefore are not part of this document.

These are the following CIP standards that have relevance:

1) CIP-002 Identify Cyber Critical Assets
    a. We define the security perimeter and the cyber critical assets, which are in the scope of the project.
2) CIP-003 Security Management Controls
3) CIP-004 Personal Awareness
    a. The Contractor is responsible for the security training of the personnel according to the delivered system.
4) CIP-006 Physical Security
5) CIP-008 Incident Reporting, Documentation and Response Management
6) CIP-009 Recovery Plans for Cyber Critical Assets

In addition the Contractor shall devise plans and mechanisms for backup and storage of information required to restore critical cyber assets in the event it becomes necessary.

The recommended CIP annual reviews and process changes will be implemented by PEA to ensure integration into the corporate procedures. These requirements are also not part of this document.

Other cyber security related documents to be produced are:

1) Firewall Policy and Configuration
2) Cyber Security Audit Document
3) System Engineering
4) Master System Configuration

The described functionality here will be implemented according to the main contract. Additional described functions have to be covered by an appropriate maintenance contract or by PEA personnel.

SOLUTIONS AND FEATURES

General Requirements and Housekeeping

General

Substation Automation is part of the overall physical mechanism to deliver electricity) control strategic physical assets via highly critical information systems and awareness in the vulnerability in this field has increased.

There is a need to manage the information and implement security controls for these systems and to create a Cyber Security Management System (CSMS) that fits into the overall enterprise cyber security systems. The Contractor shall design the appropriate cyber security systems such that the systems can work with PEA' Information Technology (IT) systems, and comply with PEA's Cyber Security Policies and Practices. The cyber security systems shall comply with NISTIR 7628 Guidelines for Smart Grid Cyber Security V 1.0- Aug 2010, or a newer version. PEA reserves the right to investigate and improve the cyber security systems, which are designed by the Contractor. The Contractor shall be responsible of the cost of the improvement, if any.

Specifically the Cyber Security Management System shall be designed specifically to be an integral part of the Integrated SCPS, to monitor and protect the physical control and delivery of electrical energy to PEA customers from a wide variety of external and internal cyber-security threats, ensuring a safe, highly reliable and productive supply environment.

The system is an integrated solution to include

1) A security perimeter for blocking potentially harmful traffic,
2) A security monitoring system to detect and manage potentially harmful events oto the Integrated SCPS, and
3) A complete set of services for planning and implementing security measures appropriate for the Integrated SCPS environment.

The CSMS shall provide the Integrated SCPS with IT security controls like

1) Perimeter and subsystem protection, Intrusion detection (IDS),
2) Intrusion prevention (IPS), Virus filtering,
3) Remote access authentication according to the risks and to prevent and
4) Detect threats.
5) Monitoring systems security and network security are essential parts of the CSMS.

Secure System Architecture

Security Perimeter

All connections between the secured zone and other networks have to be regulated with firewall and filtered with intrusion-detection technology. All network access needs control and all outbound connections need content filtering to avoid tunnelling and indirect access over outbound channels.

To reduce complexity and increase security, next generation firewall technology is used.

Within the substation there shall be no unknown protocols and ports which could be used for covered channels and for tunnelling or logically bypassing classical packet-inspection firewalls by some experienced attackers.

Next generation firewalls shall be used to inspect not only the TCP/IP header but also the payload. They are stacking the payloads to get application awareness. It is possible to monitor and block transfer of malicious code even it is encapsulated in normal application traffic (for example an exploit to an excel-embedded flash object). They are account-aware, so that misuse of remote access is minimized.

Packets are only one time inspected performing policy lookup, application identification and decoding, Active Directory user mapping, and content scanning (viruses, spyware, IPS) once on a given set of traffic. The software is tied directly to a parallel processing hardware platform that uses function specific processors for networking, security, threat prevention and management to maximize throughput and minimize latency.

Outside the substation perimeter administrators can view applications, could see, who is using them, any associated threats and they could respond by deploying shared or single device policies.

Host Security

The systems in the secured environment must be subject to an exact control. At all systems having external interfaces or could communicate contents (communications gateway) to an external source, there must be an antivirus-system installed. These systems will be treated as secure-clients or secure-servers.

There are systems within the perimeter which have special requirements with regard to latency where it is not possible to install and maintain cyber security. These systems have to be treated as “fixed function systems”.

Fixed-function-systems have fixed accepted applications and a fixed configuration which is not changeable. Every system where the configuration is not changing could be treated as fixed-function-system.

Security Event Monitoring

All systems are configured along standard auditing policies, so all necessary events are created and available. This auditing configuration is controlled with change-control at the systems.

Systems Health and Performance Monitoring

The monitoring tasks which are not typical security related like service availability, capacity monitoring (CPU, disk, memory, storage) will be installed on a dedicated secured Linux systems.

Minimum Privileges/Need-to-Know Principle

The operating systems and databases are set up using only personalized accounts. These accounts are set up with the standard tools of the operating system and/or database. Creating and supporting user and access rights are in the scope of the initial work by the Contractor. The operating system accounts can be set up in such a user name is displayed to the user console login. The users can be set up by the customer.

The typical users of the Integrated SCPS do not need access rights to the operating system or the database, as they access these standard components via the provided application system. Dialog boxes are available for defining these named accounts and access rights.

Defense-in-Depth Principle

Modern attacks are not performed by a one single action. CSMS hat also to protect against advanced persistent threats with multiple steps. The system represents a multi-layered approach for each attack.

The “defense-in-depth” model is used as reference to explain this multi-layered approach.

Redundancy Principle

The Contractor must fulfil redundancy requirements by implementing hardware redundancy and scalability and/or functional redundancy. This will be agreed with PEA and specified in the system documentation.

Patching and Patch Management

Patches are installed for correcting errors and small system expansions in an already operating system. New system versions or large system changes require a different method of deployment and commissioning.

After testing a patch in a separate test environment and subsequent release to the customer, the patch is installed first on standby components. After synchronization of the standby components, these components take over operations management, and the currently active components become standby components for step by step patch installation. In almost all cases, shutting down the primary systems is not needed.

As long as no project-specific additions were agreed upon, the patch management process shall cover the complete installation include:

1) Application systems,
2) Operating systems,
3) All other third-party software components, such as database.

The installation and deinstallation of patches with the before mentioned method is always based on close cooperation between the Contractor and customer's personnel. Patch installation is always authorized by the customer and normally completed by the customer. Automatic updates shall not be used.

Encryption of Sensitive Data during Storage and Transmission

The systems shall store and transmits passwords in encrypted form. For all other storage and transmission of sensitive data, encryption will be used, if technically possible.

A large amount of held within the Integrated SCPS is dynamic data which is stored in cyclical buffers which inherently overwrite themselves continuously. In order to comply with auditing requirements, data with long term storage requirements cannot be deleted..

Internal and External Software and Security Tests and Related Documentation

The Contractor will perform a detailed security and stress test on the perimeter of the system and certify that within the perimeter all systems act as "Fixed Function Systems" The test procedure for the security audit will be submitted for approval to the customer. The results of these tests and the respective documentation (software versions, test configuration, etc.) will be provided to the customer.

PEA is allowed to perform their own tests with internal personnel or external personnel. Use of external personnel from the Contractor' competitors will not be permitted for these tests. In addition, external personnel must receive approval from the Contractor. Furthermore, the Contractor will be given sufficient preparation time to organize these tests.

Secure Standard Configuration, Commissioning and Start-Up

After initial installation and start-up the system will be configured in a fail-safe manner. This defined base configuration will be documented. System services and daemons, data and functions, which are used during development or for system testing only, are verifiably removed or deactivated before the systems is commissioned for operations.

DOCUMENTATION

Design Documentation, Description of Security Relevant System Components and Implementation Characteristics

With the system documentation, the Contractor will provide the documents covering the high level design of the entire system. The documentation includes the description of the system concept and of the interaction of all system components. The documentation characterizes especially the details, interactions and dependencies of the system components which are security relevant or which deserve special protection. Furthermore the documentation lists and describes in brief the implementation details of security related functions (e. g. used cyber security standards).

Administrator and User Documentation

The Contractor will provide separate user and administrator documentation.

Documentation of Security Parameters and Security Messages

The document includes a description of all security parameters and their default values. Furthermore documentation is provided that includes all security events, warnings and important log messages the cyber security system generates, possible causes and the related administrative action that should be taken. This document is part of "Cyber Security Detailed Design"

Documentation of Requirements and Environment needed for Secure System Operation

This document provides a description of requirements relevant for secure systems operation (cyber policy). It provides also any exceptions of the cyber policies. This document also describes the remote access functionality. This document is part of "Cyber Security Detailed Design".

BASE SYSTEM

System Hardening

PEA requires computers with the latest operating system release which has been verified by the Contractor to work reliably. The operating system of all computers of the network control system will be hardened and updated to the current patch level during initial system delivery.

Only required users, programs, network protocols, and services are installed when creating and installing the operating system and database. Unneeded functions, protocols, and services shall be uninstalled and where they cannot be uninstalled they will be deactivated. Additionally, any development, analyzing and debugging tools will be deleted and also all extended user rights for development or debugging are to be erased.

After the new installation system functionality is verified and accepted via a system test. The verified standard configuration e.g. installed and activated software components, network protocols, services, and parameterization will be documented. Documentation is made for each computer type, e.g. operator workplace computers, interface computer systems.

All embedded defaults are to be deactivated or deleted.

Anti Virus Software

The Contractor will use virus scanner during system development, compiling and delivery process.

PEA preferred machines which are running Linux OS or Unix. Linux computing environments have the benefit of having considerably less harmful software in circulation in comparison to Windows based systems.

For the Integrated SCPS there may be additional several non-Linux computers which run the Microsoft Windows Operating System. These are PCs used only for consoles in the development system and the engineering area.

At commissioning the virus scan software on computers within the perimeter will be removed because of reasons of performance. PEA therefore requires operation of the network control system computers within a physically isolated network or at least in a separately contained network segment.

To avoid inserting of dangerous software inside of the security perimeter all the necessary external USB/DVD/CD drive will be disabled for operator access.

Autonomous User Authentication

The different computers of the network control system, e.g. operator workstations, interface computer systems, servers, file servers, shall contain identification and authentication data. In Integrated SCPS, the user identification data and authentication data within the network control system are centrally managed by PEA.

NETWORKS / COMMUNICATION

Secure Network Design and Communication Standards

Deployed Communication Technologies and Network Protocols.

1) IP Addresses are agreed upon with the customer during system design. All IP addresses are saved on each individual computer in the network control system.
2) If applicable, firewall friendly protocols will be used: e. g. TCP instead of UDP if technically possible.
3) If shared network infrastructure components (e. g.. VLAN or MPLS technology) are used, the network with the highest protection level requirement determines the security requirements of the used hardware components and their configuration. Concurrent use of the network hardware for networks with different protection levels is permitted only if this concurrent use does not decrease the security level or the availability.

Secure Network Design

The Integrated SCPS shall meet the requirement for network segmentation. The network segments in the Integrated SCPS are:

1) Network Control System
2) Telecontrol Level

The Telecontrol Level is connected to the network control system with IP or serial connections. The IP connections are connected to the process LAN via the SCADA gateways. The inputs of gateways are secured with internal security parameters. Serial connections are made with telecontrol gateways in the process LAN. Security via firewalls is not technically possible for serial connections therefore the serial connections shall only be used when there is no alternative

PEA networks will be treated as the primary access point connecting to the Network Control System. The access to the Network Control System uses a firewall to block unauthorized access while permitting PEA authorized communications.

All firewalls will be configured with the white-list-principle. All dropped packets are logged.

Firewall rules will be documented in the functional design document for System Engineering.

Firewall

Firewall shall be designed to work as Next Generation Firewall or Next Generation Threat Prevention, which can be Logging via Syslog. Logs shall be stored in a Firewall device, and able to be exported to a Log Collector or an external equipment. In addition, the Firewall shall be able to detect and control at least, but not limited to, the following ICS/SCADA Protocols: DNP 3.0, IEC 60870-5-104, IEC 60870 – 6/TASE.2, IEC 61850, and OPC.

Documentation of Network Design and Configuration

The initial IT network setup and configuration in the scope of the project will be documented in system documentation by the Contractor.

Subsequently it is the primary responsibility of PEA to guarantee that network documentation is updated with network changes.

Because of system changes, the documentation shall be updated within 30 days after the system change. This process must be administered by PEA.

PEA shall review all documentations annually because of modifications.

Secure Maintenance Processes and Remote Access

Secure Remote Access

All access points to the secured environment will be secured and treated as perimeter. All remote access must be strongly authenticated. Every user with remote access has to follow strictly the remote access policy.

Direct dial-in access to devices is not allowed and not implemented.

Remote access will be (centrally) logged. All failed login attempts will result in a security event audit message.

All remote access possibilities and ports will be documented in the functional design document System Engineering Maintenance Processes.

For access via access gateways, personalized accounts will be set up and maintained. They are administered by PEA. The Contractor shall ensure that the list of authorized persons in the maintenance pool is always up to date (additions, removals) so that personalized accounts can be maintained by PEA, set up, or deleted. The Integrated SCPS shall not support automated remote access.

PEA shall review all documented users with their rights annually because of modifications. This review process must be implemented by the customer.

Contractor maintenance will normally be completed by the project personnel who originally set up the system.

The Contractor maintenance personnel used at PEA sites will be trained for the applicable cyber security guidelines.
On-call personnel will be equipped with mobile equipment with special safeguards.

The customer shall implement a process for physically inserting hardware directly in the security zone. All new hardware or temporarily needed hardware has to be tested at least for electrical integrity and malware on data media.

PEA shall also maintain a list with all persons who have direct access to the security zones.

Wireless Technologies: Assessment and Security Requirements
Wireless connections are not to be included

Firewall Security Policy

The Integrated SCPS firewall provides the first line of defense for the substation perimeter. The policy includes the following functions:

No direct connection from the Integrated SCPS networks to the Internet and vice versa.

The corporate networks do not have direct query or access capability to any data stores, such as maintained by the file exchange server, or processes within the Integrated SCPS (Network Control System). Corporate users access data through the SCADA gateway.

Well-defined rules outlining required and authorized traffic will be implemented at all access points. Management of access control devices is permitted only from a highly restricted subset of management devices.

All firewalls will be configured with the white-list-principle. This means that all needed connections have to be defined and all other connections are forbidden. All forbidden packets are dropped and the incident logged.

APPLICATIONS

User Account Management

Role-Based Access Model

With the user management system in Integrated SCPS, personalized user accounts can be set up with the following rights:

1) Data engineering observation
2) Operations observation
3) Data test observation
4) Edit data engineering
5) Authorized to control
6) System configuration
7) Accept Limit violations
8) System administration

Within the Integrated SCPS user roles can be composed from the defined user rights, e.g. the following user roles can be defined:

1) Administrator: system administration
2) Operator: edit data engineering, authorized to switch, edit archives, edit real-time data- base, Post Mortem, system configuration, limit violations
3) Data Display: data engineering observation, operations observation, data test observation

The Integrated SCPS will have a multi-client capability. Access control to data and resources will be implemented with user rights and responsibilities. The system will allow for a granular access control on data and resources. The default access permissions will conform to a secure system configuration. Security relevant system configuration data can only be read or changed by the administrator. For normal system use, the operator and data observation permissions will be sufficient.

User Authentication and Log-On Process

User login requires entering the user's name and the associated password. Passwords are represented by "*" and not displayed. Operational procedures must be set up by PEA so that the administrators cannot set up group accounts. Only users with system administration privileges can administer user accounts.

Entering a user name and password will be required to access any operating mode or other functionality.

After logging off from an operator workplace, a user must re-enter a password to use the operator workplace. Log off will occur automatically if there is no input activity for 15 mins.

Setup of passwords is carried out by system administrators. The quality of the passwords can be configured centrally. The default minimum password quality will be:

1) minimum length of 8 characters,
2) mandatory inclusion of alphabetic (upper and lower case), numeric and special (non-alphabetic) characters,
3) passwords cannot be the same as the user ID,
4) simple pattern changes will be prohibited,
5) previously used passwords cannot be reused,
6) any user is eligible to change their own password at any time,

A user can also manually lock the user session. After a configurable number of failed login attempts, an alarm will be generated.

All locally defined users on individual computer nodes will have the same UID on different computers for easy recognition.

All passwords will be maintained by PEA after the delivery.

User accounts, which are interactive and reachable over the network will have set passwords. i) The complete authentication process will be specified in the System Management user manual.

The usage of generic users (for example root) will be defined in the Functional Design document System Engineering.

Authorization of Activities on User and System Level

Before certain security relevant or security critical activities are performed, the Integrated SCPS will check the authorization of the requesting user or system. Relevant activities may be read access to process data or configuration parameters. User functions can be unlocked or locked based on user rights and roles. Therefore, users can only use functions for which they have rights to. With every attempt to use a function, it will be checked if the user has the right to use the function.

Application Protocols

Only standard application level protocols will be used. Protocols which protect the integrity of the transferred data and ensure correct authentication and authorization of the communication partners are required. Furthermore the used protocols should provide timestamps, secure sequence numbers or a connection via VPN to prevent re-injection of previously sent messages.

Integrity Checks of Relevant Data

Integrity check of relevant data shall be implemented in Integrated SCPS with the GIT-Tool.

Logging, Audit Trails, Timestamps, Alarm Concepts

All computers within the network control system are time-synchronized by a central time server.

In order to create an audit trail for later analysis, security relevant user actions, events and errors are logged in the available logs, e.g. operations log, event log, system log. Alarms are displayed in status lists.

The available histories of these logs can be set up individually for each substation. The recording capacity depends only on the size of the hard drives.

Event logging in Integrated SCPS consists of different logs, status lists, and log files. The contents of logs and status lists shall be dynamically configured by system administrators.

All events recorded in the logs have different event type. The event type can be used as filter criteria.

The central storage location of the log files shall be configurable.

A mechanism for automatic transfer of the log files to central location is available.
The log files will be protected against later modifications.

Within Integrated SCPS log files are not by default archived but use a circular buffer memory.

Log files on operator workplace computers are to be stored in a circular buffer memory. Therefore, operator workplace computers have no files that can grow in size indefinitely. Long term archives are only limited in size by the capacity of the storage medium. As such, no capacity monitoring is needed. Long term archives at the ADDC are configured to be saved for a time frame of 2 years.

DEVELOPMENT, TEST AND ROLLOUT

Secure Development Standards, Quality Management and Release Processes

When creating and delivering the Integrated SCPS, the verification of its functionality shall be recorded in the test log book. The test log book is a compilation of test situations from the functional design.. This guarantees repeatability and traceability of the tests. Test results and quality states can be analysed with reports. Printed versions of the test log book are generated from a when required. Testing occurs with the customer's project team and not the development department. As such, the Contractor shall meet the required four-eye- principle for testing. The test log book is the basis for the internal PSI system test and all customer approvals.

The Contractor shall have a documented development security program that covers the physical, procedural and personnel security measures to protect the integrity and confidentiality of the system’s design and implementation.

System release and the release of updates and security patches will be managed and controlled through a well-defined and documented release process.

Secure Data Storage and Transmission

Sensitive customer data, which is used or produced during development and maintenance, will be transmitted encrypted if it is sent over public networks. If the data is stored on mobile devices it will be stored in encrypted form. Sensitive data may include, but is not limited to, internal customer information and documents, log files, error logs, and relevant system documentation. The amount of stored data and the storage time will be limited to the necessary minimum.

Secure Development, Test and Staging Systems, Integrity Checks

The Installation, Compilation and Patch (ICP) server ***shall be located and separated from the PEA network and the control room network by firewalls***. A test environment can be setup in the same location for testing software, updates, patches, processes and procedures.

Source code is stored on the ICP server. With this server, software can be installed and managed. The sources can also be compiled on the ICP server.

The process for patching and updating the system will be described in the System Management user manual.

Secure Update and Maintenance Processes

A description of maintenance processes will be available in the System Management user manual.

On the Contractor side, maintenance will be carried out by dedicated and trained personnel, using particularly secured systems.

Provision and installation of updates, enhancements and patches will be carried out in consultation with PEA according to a well-defined process.

Configuration and Change Management, Rollback

Development and change management in Integrated SCPS is administered with repositories. With GIT and periodic backups, there will be rollbacks available. Only the available hard disk space limits the number of rollbacks.

Each change of software will be described in the patch documentation.

Fixing Security Vulnerabilities

PEA will have a well-defined vulnerability management process to address security vulnerabilities. The process will allow all involved and external parties to report actual or potential vulnerabilities.

Furthermore PEA will obtain up-to-date information about security problems and vulnerabilities which might affect the system or its components. The vulnerability management process will define how a potential vulnerability is verified, classified, fixed and how recommended counter measures are reported to all involved. Furthermore the process will define timelines for each step in the vulnerability management process. The Contractor will early inform the customer about known security vulnerabilities, even if there is no patch available.

If a patch is available and verified the Integrated SCPS it should be installed within 30 days, otherwise the exception must be documented.

The Contractor also frequently checks third-party products for updates. If updates are available, they will be examined as described.

BACKUP, RECOVERY AND DISASTER RECOVERY

Backup: Concept, Method, Documentation, Test

All hardware components needed for operations shall have at least one redundant component. All online data is available and updated on each redundant component. Redundant components function in event-consistent parallel operation.

Data engineering databases are automatically backed up at least daily solid state drives. All configuration parameters are saved on an external hard drive.

All necessary data e.g.

1) Archives
2) Logs
3) System configuration files are automatically backed up at least daily on different devices. The backup process will be described in the System Management user manual. The backups in the Integrated SCPS are exact images of the original data and also contain any data encryption used in the original data.

All backup devices should be tested annually. This process has to be implemented by PEA.

Disaster Recovery

The Contractor will provide documented operational concepts and tested disaster recovery concepts and procedures for defined emergency and crisis scenarios.

The principle of disaster recovery is the base state recovery using a server without any installed software for the disaster recovery.

Therefore an Installation, Compilation and Patch (ICP) server ***<u>shall be used with</u>*** the ICP server, all server types can be recovered. This process will be described in the System Management user manual.

RELEASE AND PATCH MANAGEMENT

Purpose

For PCs based on Microsoft Windows the Contractor shall use the Microsoft Baseline Security Analyzer (MBSA) to check on the necessary vulnerability in windows system. MBSA provides a streamlined method to identify missing security updates and common security misconfiguration.

Testing and Checking of the Delivery State

The basis for the delivery is a tested and working software version which contains all files needed for on-site compilation and installation. In particular, this concerns the files which need to be adjusted on-site.

Check in of Revisions on Site

During the commissioning on-site, revisions on the software version are often needed. These revisions can be traced simply through a comparison with the repository. The changes made during the commission will be checked and tagged in the release repository on-site. This guarantees that these changes can be fed back into the Contractors' project release repository in a secure and traceable fashion.

Revision Feedback

Parallel to the delivery, a bundle will be created with all revisions since the delivery date. This bundle will be sent back to the Contractor and loaded into the project's release repository.

ORGANIZATION

In this section of this appendix, some general points will be noted.

Cyber Security Audit

After the completion of the project, a cyber-security audit with the following points will be done by PEA:

1) Random check about permissions and configurations to ensure that the deliverable configuration is accurately documented,
2) Random verification that unused services have been removed as described in the functional design document System Engineering,
3) Verification that all software has been updated with the latest security patches,
4) A random check that all generic and default accounts are removed,
5) Verification that all access authorization methods are properly configured,
6) Generating a full backup of software and databases,
7) Restore Test: A random check of the restore-process.

Asset-List

After completion, the customer will get a complete list with all used hardware components.

ANNEX 8 – TYPICAL LOGICAL NODE REQUIREMENTS

The Contractor shall refer to **IEC 61850-7-4 © IEC: 2010(E)** as shown below**:**

A8.1 Logical nodes for switchgear LN Group: X

1) Modelling remarks

The logical nodes of this group provide data which are needed to represent the related switchgear equipment in the automation system. There are only two logical nodes (XCBR, XSWI) since all not current breaking switches are modelled by XSWI. Each logical node has companion logical nodes in group S (like SCBR, SSWI) providing the detailed supervision information if needed.

2) LN: Circuit breaker Name: XCBR

This LN is used for modelling switches with short circuit breaking capability. Additional LNs, for example SIMS, etc. may be required to complete the logical modelling for the breaker being represented. The closing and opening commands shall be subscribed from CSWI or CPOW if applicable. If no "time activated control" service is available between CSWI or CPOW and XCBR, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).

XCBR class				
Data object name	**Common Data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O □
Status information				
EEHealth	ENS	External equipment health		O □
LocKey	SPS	Local or remote key (local means without substation automation communication, hardwired direct control)		O
Loc	SPS	Local control behaviour		M
OpCnt	INS	Operation counter		M
CBOpCap	ENS	Circuit breaker operating capability		O
POWCap	ENS	Point on wave switching capability		O
MaxOpCap	INS	Circuit breaker operating capability when fully charged		O
Dsc	SPS	Discrepancy		O
Measured and metered values				
SumSwARs	BCR	Sum of switched amperes, resettable		O
Controls				
LocSta	SPC	Switching authority at station level		O
Pos	DPC	Switch position		M

BlkOpn	SPC	Block opening		M
BlkCls	SPC	Block closing		M
ChaMotEna	SPC	Charger motor enabled		O
Setting				
CBTmms	ING	Closing time of breaker		O

3) LN: Circuit switch Name: XSWI

This LN is used for modelling switches without short circuit breaking capability, for example disconnectors, air break switches, earthing switches, etc. Additional LNs, SIMS, etc. may be required to complete the logical model for the switch being represented. The closing and opening commands shall be subscribed from CSWI. If no "time activated control" service is available between CSWI or CPOW and XSWI, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2)

XSWI class				
Data object name	**Common Data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O □
Status information				
EEHealth	ENS	External equipment health		O □
LocKey	SPS	Local-remote key		O
Loc	SPS	Local control behaviour		M
OpCnt	INS	Operation counter		M
SwTyp	ENS	Switch type		M
SwOpCap	ENS	Switch operating capability		O
MaxOpCap	INS	Switch operating capability when fully charged. Obsolete. Kept for backwards compatibility with Ed.1		O
Dsc	SPS	Discrepancy		O
Controls				
LocSta	SPC	Switching authority at station level		O
Pos	DPC	Switch position		M
BlkOpn	SPC	Block opening		M
BlkCls	SPC	Block closing		M
ChaMotEna	SPC	Charger motor enabled		O

ANNEX 9 – EXAMPLE OF A NETWORK DESIGN LIST

Please see the example the network design list which consists of:

1) Switch-Router List,
2) Physical Media List,
3) Factors as shown in the table below.

Switch / Router List - Network Design

Project	
Project Engineer	

Use	Location / Name	L2	L3	10G ports	1G ports	10/100 ports	PoE ports	PoE Watts	1588	IP-67	2x power	Redun nets	USB memory	(corrosive, moisture) Conformal Coating	Ethernet/IP	Profinet	Special Requirement	Model	Catalog Number	Accessories	Accesory Catalog Number

Physical Media List - Network Design

Project

Project Engineer

								Considerations							
Switch	Port #	Speed	Connector	Distance (meters)	To switch or device	To port #	Connector	Power over Ethernet (PoE)	Electro-mechanical Noise	Temp	Tigh Bend Radius	Hi Flex	Jacket Type (see chart)	Connector Premade or Field Install	Industrial Ethernet Cordset or Cable/Connectors
	1														
	2														
	3														
	4														
	5														
	6														
	7														
	8														

Copper								Fiber					Jacket									Connector / Cordset				
Stranded Alloy	Solid	Cat 5	Cat 5e / Cat 6	2 pair	4 pair	Shielded	Unshielded	Multi-mode	Single-mode	OM3/4	Always Tight Buffer	Always Plenum	UV	Armor	PUR Jacket	Expose Run	FEP Insulation & Jacket	TPE Insulation & Jacket	PE Jacket	CPE Jacket	LSZH Jacket	RJ-45	RJ-45 with Seal Overmold	M12	Field-installable Connectors	Premade Cordset
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓														
	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓														
								✓	✓		✓	✓														
									✓		✓	✓														
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓														
✓	✓		✓		✓	✓	✓	✓	✓		✓	✓														
									✓	✓	✓	✓														
✓	✓	✓	✓		✓	✓	✓																			
✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓														
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓														
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ANNEX 10 – DIGITAL FAULT RECORDER (DFR) SPECIFICATION

Digital Fault Recorder (DFR), shall be of a modular design; circuit cards and modules shall be easily replaceable without requiring the removal of the entire the recorder or other circuit cards or modules of the fault recorder from the rack.

Hardware specification of a recording unit shall comply with, but not limit to, the following requirements; a hardware with better specifications shall be acceptable:

No.	Item	Parameters
1	CPU	Embedded dual core CPU, main frequency 1.2 GHz.
2	RAM	4GB.
3	Hardware	Standard configuration 500GBx4; high configuration 1TBx4+ hard compression module, with storage capacity not less than 20T.

In case that there is a separated management unit, the management unit shall comply with, but not limit to, the following requirements; better specifications shall be acceptable:

No.	Item	Parameters
1	CPU	Low power consumption, main frequency 1.6GHz.
2	RAM	2GB.
3	Hardware	500GB or 1TB.
4	Operating system	Windows 10 or Linux.
5	Man-machine interface	17" LCD + keyboard + mouse (optional draw-out type KVM).

The DFR modular units shall be self – supporting and require no external supports of bracing, with:

Channels: expandable up to 128 analog and 512 digital input channels with complete time synchronization and without reducing the quality of recording. In case of analog inputs, for 115 kV systems DFR shall receive the inputs via MU, and for 22/33 kV systems DFR shall receive the inputs via IED (Relay). In case of 22/33 kV systems, DFR might be a software, or a set of software, installed at a server, and shall have a function for analyzing fault wave patterns.

Circuit boards and modules protection: all plug-in circuit boards and modules shall be equipped with card guides to prevent damage resulting from misalignment of connectors and sockets during insertion and removal of circuit boards and modules.

Analog inputs, with:

1) number of channels : to be specified
2) frequency response : 3 Hz to 2,000 Hz
3) CT nominal rating (In) : to be specified
4) over current shunt/auxiliary : 40 In for 1 second, and withstand 2 In continuous, or better
5) VT secondary rating (Vn) : 66.4 V AC and 115 V AC, selectable

6)	Signal isolators withstand	:	2 per unit over voltage for 5 second, or better
7)	Fast transient immunity	:	up to 2 kV, difference mode and common mode, according to IEC 61000-4-4, or equivalent
8)	Accuracy		
	a) current input	:	±3.5% of measured value ±0.5% of full scale ±30 mA, or better
	b) voltage input	:	±3.5% of measured value ±0.5% of full scale ±30 mV, or better
9)	Sampling rate		
	a) fast sampling rate	:	up to 6,000 Hz, selectable
	b) slow sampling rate	:	not more than 100 Hz
10)	Disturbance recording	:	not less than 25 minutes per each record, continuously, at 128 sample/ cycle
11)	Pre-fault recording interval	:	50 milliseconds to 2,500 milliseconds, selectable
12)	A/D conversion resolution	:	not less than 16 bits

Digital inputs, the digital channels shall be synchronized with the analog inputs and capable of initiating the recorder on a change of state which are normal- to- alarm and alarm-to-normal, either or both, all signals shall be recorded simultaneously, with:

1)	Number of channels	:	to be specified
2)	Type	:	dry contact, each channel shall be selectable Normally Open or Normally Close
3)	Maximum time resolution	:	0.167 ms (equivalent to the sampling rate of 600 Hz), or better
4)	Input voltage	:	24 V DC, 48 V DC, 125 V DC and 220 V DC, selectable
5)	Fast transient immunity	:	up to 2 kV, difference mode and common mode, according to IEC 61000-4-4, or equivalent
	Storage		
6)	Local storage	:	not less than 20 GB, shall be internal hard disk or Local Storage Unit (LSU) or Personal Computer (PC).
7)	Fault recording capacity	:	not less than 16 MB per Data Acquisition Unit (DAU)

Triggering and sensors, each sensor shall be provided with a LED target to indicate which sensor has operated. The fault recorded shall automatically trigger and record, and shall also automatically dial and transmit data to the Master station, the following type of sensors shall be supplied:

1)	Over current starting sensor, with:		
	a) nominal current rating (In)	:	to be specified
	b) setting range	:	10% to 300 % of In
	c) setting resolution	:	5% of In, or better

- d) accuracy : ±0.5% of measured value ±3% of full scale ±0.5 mA, or better
- e) response time : not more than 20 milliseconds
- f) over current withstand : 40 In for 1 second

2) Under voltage starting sensor, for sensing under voltage conditions of the buses or lines, with:
   - a) setting range : 50% to 100% of Vn
   - b) setting resolution : 5% of Vn, or better
   - c) accuracy : ±0.25% of measured value ±3% of full scale ±30 mV, or better
   - d) response time : not more than 20 milliseconds
3) Frequency starting sensor, for sensing abnormal frequency conditions, the sensor shall include a transducer output that can be recorded on one of the analog channels to provide accurate cycle-by-cycle plots of frequency versus time during the disturbance, the sensor shall trigger the recorder to operate at slow sampling rate, with:
   - a) setting range : 0 to 2 Hz over or under, the nominal frequency 50 Hz
   - b) setting resolution : not more than 0.1 Hz
   - c) accuracy : ±0.01 Hz, or better
4) Negative sequence voltage starting sensor, for sensing unbalance conditions, with:
   - a) setting range : 1 V r.m.s. to 20 V r.m.s., adjustable
   - b) setting resolution : 5% of Vn, or better
   - c) accuracy : ±0.25% of measured value ±3% of full scale ±30 mV, or better
   - d) response time : not more than 20 milliseconds
5) Zero sequence voltage starting sensor, for sensing earth – fault conditions, with:
   - a) setting range : 1 V r.m.s. to 20 V r.m.s., adjustable
   - b) setting resolution : 5% of Vn, or better
   - c) accuracy : ±0.25% of measured value ±3% of full scale ±30 mV, or better
   - d) response time : not more than 20 milliseconds
6) Power swing starting sensor, for detecting power swing conditions in transmission line, shall be operated at slow sampling rate.
7) External start, shall be provided for the fault recorder to connect with an external start signal.

Power quality recording, all of data can be exported to general program such as Microsoft Excel or Microsoft Word, etc., with:

1) Trending data (voltage variation), with :
   - a) sampling rate : 128 samples/cycle/channel, or better
2) Voltage sag/swell, each event with voltage and current waveform shall be recorded, with:
   - a) sampling rate : 128 samples/cycle/channel, or better

b) display : magnitude and duration with not less than 1 cycle pre – fault

3) Harmonics, with:
   a) harmonics orders : 0 to 50th orders, or better, at 50 Hz fundamental
   b) recording : fundamental with waveform, spectrum, amplitude, phase angle and/or harmonics direction for individual orders and Total Harmonics Distortion (THD) of voltage and current, or better

Clock, the DFR(s) shall be supplied with built – in calendar and clock to provide accurate date and time including month, day, year (or day, month, year), hour, minute, second and millisecond for each operation of the recorder; the clock synchronization precision shall be less than ±300ns. If the clock loses synchronous source after it is synchronized, the device itself shall have 24h timing precision error less than ±100ms. The linked fault recorded shall be time coordinated within 1 millisecond of each other. Recorded message time scale resolution shall be 0.167 ms (equivalent to the sampling rate of 600 Hz) or smaller. Maximum time scale deviation between multiple intelligent acquisition ports shall be 40 ns.

Synchronization, the DFR(s) shall be provided with the following time synchronizing features:
1) Synchronizing by using an external GPS clock, the GPS clock receiver and accessories shall be provided and completely installed in the cabinet per system, external antenna shall be provided and installed if necessary, power supply for GPS clock receiver shall be 125 V DC.
2) IEEE1588 or IRIG-B synchronizing shall be provided to permit synchronizing with remote station.
3) The synchronizing shall be within 1 millisecond.

Alarm, the DFR(s) shall detect, indicate and alarm by LED and dry contact for at least the following conditions:
1) Operation : fault recorded operate
2) Fault : including CPU auto reset
3) Failure : including CPU fail and power fail
4) Service : including memory overflow and clock synchronization loss

Recording Capability:
The DFR(s) shall have at least the following recording capability:
1) Transient-State Recording Capability
   a) Number of channels recording sampling value: not less than 512
   b) Number of channels judging whether to start sampling value: up to 128
   c) Number of channels recording on-off switch (GOOSE): not less than 1024
   d) Number of channels judging whether to start on-off switch (GOOSE): not less than 1024

2) Continuous Recording Capability (Optional)
   a) Optional steady-state recording function
   b) Sampling rate: 1000Hz (20 points/cycle)
   c) Number of channels recording sampling value: not less than 512
   d) Number of channels recording on-off switch (GOOSE): not less than 1024

Communications:

Between modules, fiber optic cables shall be provided for to communications with redundancy between the modules that installed at separated locations together in order to operate as one system and to eliminate any possible time skew. The communicated configuration shall be included complete time synchronization and initiation of all modules from any starting sensor by means of cross triggering. The signal for cross triggering function shall not be the digital channel. The design of the communications configuration shall be submitted to PEA for approval. Plastic and iron pipe shall be used for protection of indoor and outdoor fiber optic cables respectively.

Communications Between between DFR(s) and The Local controller unit/The Master station, shall be at least 100/1000 Mbps, and provided by a direct connect communication via a USB port(s). In addition to the USB port(s), the communications may be via Ethernet communication by TCP/IP protocol, via self-adaptive RJ–45 interface and/or SFP Ethernet interface (optional.)

Security:

The system shall have 3 levels of password access for user, each access level shall automatically determine the access rights of the lower levels.

Recorded information and printout, automatic range factors shall be printed on printout of the Master station's printer at the start of each analog axis. Autoranging function or equivalent feature is required to reduce peak-to-peak deflection of each analog channel. A horizontal dotted line crosses each channel of the fault record shall be printed to mark the end of pre-fault data and the beginning of the fault data. The printer shall print the maximum number of 16 channels per page, the following data shall be printed on the record:

1) Station identification, up to 32 alphanumeric characters
2) Day, month, year, hour, minute, second and millisecond
3) Sampling rate
4) Time marker
5) Operation number
6) All analog, digital channel waveform, sensor operation, time mark
7) Channel identification
8) Channel zero deflection line
9) Autoranging scale factor

10) Summary of computed data for instance, fault duration, relay time and breaker time, percentage of voltage dip, fault current, distance to fault, etc.

Status indicator: at least the following status indicator shall be shown at front panel:

1) Healthy
2) CPU failure
3) Operation
4) Transmit and receiving
5) Loss of clock synchronize
6) Loss of power, and
7) Others such as Recording, Storage, Backup, Fault etc.

Power supply, the DFR(s) shall be furnished with a DC-to-DC converter to provide transient surge isolation between the station battery and DFR(s), main On-Off AC switch and main DC circuit breaker shall be provided, with :

1) Power supply : nominal 125 V DC ungrounded stationary battery
2) Continuous operating voltage : 110 V DC to 250 V DC
3) Design and protection :
   a) power supply of each DC control circuits, AC power supply circuits and voltage transformer secondary supply circuits shall be completely separated and isolated and suitably protected by separate miniature circuit breakers.
   b) these circuits shall have separated bus wiring between the cabinets.
   c) the design of the power supplies and protection system shall ensure that any fault in modules or other devices which may block sequence logic interlocks and automatic control systems or other control systems, shall be restricted to the system in which the fault occurred.

Terminals and wiring, cabinet(s) and all equipment shall be completely wired, control cable shall be shielded from electromagnetic interference (EMI) and radio frequency interference, the terminal arrangement shall group all leads for each particular function to facilitate connection to the incoming and outgoing cables, with:

1) Internal cable
   a) type : stranded copper conductor, PVC insulation, 750 V
   b) minimum cross-section :
      i) 1.5 mm^2 for monitoring cables
      ii) 2.5 mm^2 for control cables
      iii) 2.5 mm^2 for VT cables
      iv) 2.5 mm^2 for CT and DC power supply cables
2) Incoming and outgoing cable
   a) Type : multi-core, double insulation, stranded copper conductor, PVC sheath, copper or brass shield, PVC insulation, 750 V

b) minimum cross-section : i) 2.5 mm^2 for monitoring and control cables
ii) 4.0 mm^2 for instrument transformer cables

3) Cable color
a) DC control circuit : gray
b) voltage and current bus wire: red, yellow and blue, corresponding to phase

4) Test switches : all current and voltage inputs of the DFR(s) shall be completely wired with test switches, shall be flexitest switch type FT-1 or MMLG.

5) Terminal block
a) insulation : not less than 600 V insulating barrier between terminals
b) type : i) spring loaded screw-on type for analog signal
ii) short and slide link type for CT
iii) slide link type for VT
iv) knife switch type for digital signal
c) spare : 15% of terminals shall be provided on each group of terminal block for future use.

6) Terminal lug : both ends of wires shall be terminated by compression ring type terminal lug.

7) Designation
a) every points of the terminal block and wire shall be assigned with identical designation on each corresponding terminal block and wire, as designated in approved schematic diagram.
b) all wiring shall be permanent designated at both ends by printing on designation sleeve, which resists oil, grease, acid, abrasion and chemicals, data on the designations shall be completed with the name or code of cabinet, equipment and terminal of the near terminal and far terminal in the first line and the second line respectively, color of letter shall be black and color of sleeve shall be white.
c) each designation on the terminal blocks shall be machine-lettered stamped or engraved with permanent ink on the removable marking strips, adhesive labels shall not be acceptable.
d) where a wire number changed, the termination shall has double designation sleeve to show both wire number.
e) 10% of wire designation sleeves shall be provided for spare.

8) Wiring design
a) maximum voltage drop on the cables shall not exceed 5% under worst load and temperature conditions.
b) internal wiring shall be installed in wiring duct, total cross section area of cables in duct shall not exceed 70% of cross section area of duct, and external wiring shall be

installed in wire way or cable trench, internal and external wiring shall be installed separately.

c) all cables shall run continuously without splices or taps.

d) connections between cubicles shall be via terminal blocks.

e) all switchgear auxiliary contacts, protection, control, signaling and measuring devices shall be wired to separate terminal blocks.

f) voltage and current circuits shall be wired to test blocks to enable for testing.

g) two or more wires shall not be connected in one terminal.

h) all incoming and outgoing cables shall be entered the cabinet through cable grands, one cable grand / one cable.

Cabinet(s), The DFR(s) shall be supplied as completely wiring and complete with all accessories mounted on a standard 19 – inch rack and enclosed in one or two cabinet(s), the cabinet(s) shall be furnished with channel base and designed without any permanent bottom braces, the bottom of the cabinet(s) can be opened, a floor under the channel base shall be covered by 3 mm – thick aluminium sheet and all incoming and outgoing cables shall be installed through the cover via cable grand, one cable grand / one cable, with:

1)	Size	:	600 mm – 800 mm depth x 800 mm – 900 mm width x 2,200 mm – 2,300 mm height plus a 30 mm – 50 mm channel base
2)	Color	:	gray (RAL 7032)
3)	Material	:	not less than 3 mm – thick steel sheet
4)	Wiring duct	:	each cabinet shall be equipped with plastic wiring ducts, size 100 mm x 100 mm, shall be installed in vertical position through the height of the cabinet(s).
5)	Grounding	:	6 mm x 25 mm copper ground bar shall be solidly bolted to the steel framework at the bottom of the cabinet(s), metallic case and grounding circuit shall be connected to the bar, solderless lugs and terminals shall be provided on the ground bar for terminating 95 mm2 copper ground cable from substation grounding system.
6)	Lamp and receptacle outlet	:	1 fluorescent lamp with door operated switch 1 receptacle outlet, single phase, 3 wire grounded type, 15 A, 250 V shall be furnished inside each cabinet with completely wiring for connection to 220 V AC, single phase, 50 Hz source.

Noise	:	the recorder shall not produce any signal, noise or impulse which greater than 300 mV peak-to-peak on the input DC supply leads.

Operating temperature : up to 50°C

Relative humidity : up to 94%

Each DFR shall be complete with:

1) Local Modem, with :
   a) standard : according to CCITT or BELL, or equivalent
   b) type : internal or external industrial message Modem, V.90 (56k)
   c) data transfer rate : up to 56 kbps, or better
   d) functions : - automatic dial and auto answering functions
      - automatic fall back capability
   e) power supply : single phase, 220 V AC, 50 Hz

completed with internal speaker, volume controller, on-off switch, at least 8 status LED, software and user manual.

2) Accessories according to manufacturer's design and auxiliary equipment necessary to complete.

Commonly-Used Operations:

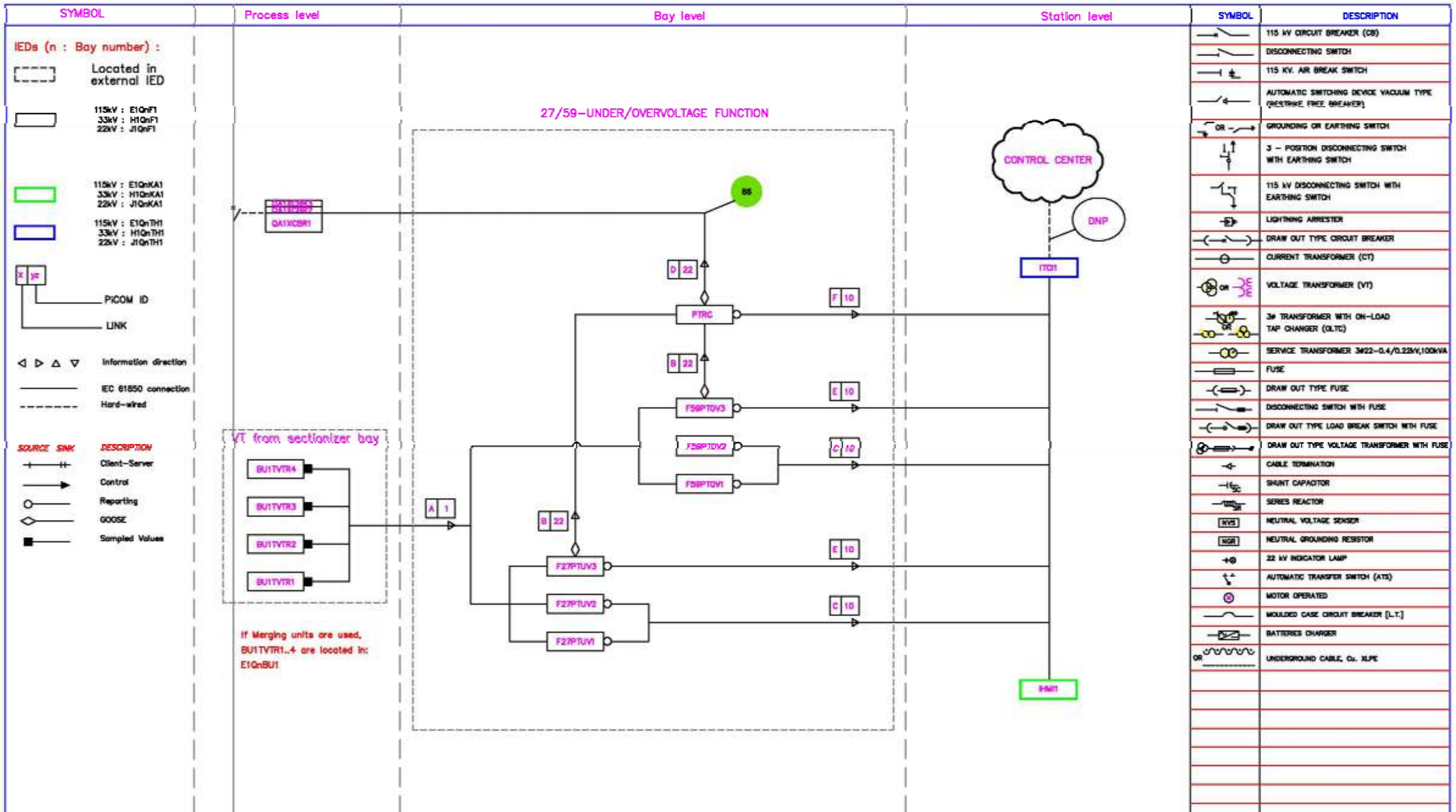
The DFR shall at least support, but not limit to, the following commonly-used operations:

1) Extract Message Recording Files including, but not limit to
   a) Extract via real-time event alarm information
   b) Extract via history event alarm information
   c) Extract via specified period of time
   d) Extract historical key message data
2) Extract Transient-State Record Data File including, but not limit to
   a) Call Record files in the new record screen
   b) Query record files by specified period of time
   c) Extract record files via historical record events
3) Real-Time Monitoring including, but not limit to
   a) Real-time Traffic
   b) Object Status
   c) RDU real-time waveform
      i. Waveform
      ii. Vector
      iii. Harmonic
      iv. Power
4) Message data analysis including, but not limit to
   a) SV waveform browsing
   b) SV harmonic analysis

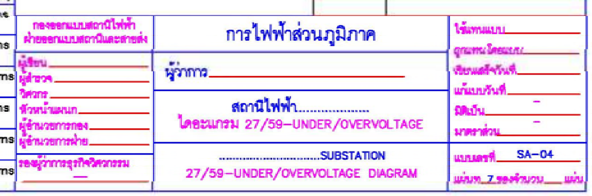
c) SV vector analysis
d) SV phase sequence analysis
e) SV power analysis
f) Statistic of SV double-AD inconsistency
g) SV Tx frequency jitter
h) SV sync characteristic analysis
i) GOOSE Event S/N Curve
j) Convert to COMTRADE format
    i. Convert a single SV data set
    ii. Convert several data sets and GOOSE data sets
k) Convert to PCAP format
l) Change Configuration
m) Undefined Object Statistic
n) Conflict Analysis
o) Address List
p) MMS Topography
q) Traffic Analysis
r) Brief Statistic Report
s) Other Shortcut Operations Regarding Offline Analysis
    i. Message Filtering
    ii. Save messages in the current list as "pcap" or "pkte" format
    iii. Switch GOOSE Time Resolution
    iv. Switch SV Time Resolution
    v. MMS Report Restructuring and Restoring
    vi. Simulation Tx Message

Extract File Data during MMS File Service

ANNEX 11 – TYPICAL SCPS FUNCTIONAL DECOMPOSITION DIAGRAM



Link	LN	Data Object	Description	Data Attribute	Message Type	Performance Class(PC)	Transfer Time(TT)
A	TVTR	VolSv	Voltage (sampled value)	instMag/q/t	4	P7	≤3 ms
B	PTOV PTUV	Op	Operate (Trip)	general/phsA/phsB/phsC/neut/q/t	1	P1	≤3 ms
C	PTOV PTUV	Str Op	Start Operate(Alarm)	general/dirGeneral/phsA/dirPhsA/phsB/dirPhsB/phsC/disPhsC/neut/dirNeut/q/t general/phsA/phsB/phsC/neut/q/t	3	P6	≤1000ms
D	PTRC	Op	Operate(Trip)	general/phsA/phsB/phsC/neut/q/t	1	P1	≤3 ms
E	PTOV PTUV	Str Op	Start Operate(Trip)	general/dirGeneral/phsA/dirPhsA/phsB/dirPhsB/phsC/disPhsC/neut/dirNeut/q/t general/phsA/phsB/phsC/neut/q/t	3	P6	≤1000ms
F	PTRC	Op	Operate(Trip)	general/phsA/phsB/phsC/neut/q/t	3	P6	≤1000ms



BoQ of PEA-AIS Substation

CONVENTIONAL TYPE

PART A,B : SUBSTATION EQUIPMENT
SCHEDULE 20 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A Equipment (Baht)		PART B Local Transportation (Baht)		PART B Installation (Baht)		Total
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
20	IEC 61850 Based SCPS										
20.1	SCPS System										
	- SCPS Server 1	Set									
	- SCPS Server 2	Set									
20.2	Human Machine Interface (HMI) or Engineering Work Station (EWS)										
	- Personal computer, rack-mounted industrial type	Set									
	- Logging printer, A4, Colour laser printer	Set									
20.3	Engineering Tool Notebook	Set									
20.4	Time Data Server (TDS) or Time Reference Unit (TRU)	Set									
20.5	Communication Gateway (CGW) with Firewall	Set									
20.6	Digital Fault Recorder (DFR)	**Set**									
	(continue)										

CONVENTIONAL TYPE

PART A,B : SUBSTATION EQUIPMENT
SCHEDULE 20 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A		PART B				Total
					Equipment (Baht)		Local Transportation (Baht)		Installation (Baht)		
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
20.7	Network Management System	Set									
20.8	IED Bay Control Unit (BCU) and IED Protective Relay, give itemized price										
	- BCU1	Set									
	- BCU2	Set									
	- BCU3	Set									
	- BCU4	Set									
	- Main 1 Line Protection Relay (115kV)	Set									
	- Main 2 Line Protection Relay (115kV)	Set									
	- Bus Protection Relay (115kV)	Set									
	- Main 1 Transformer Protection Relay (115kV)	Set									
	- Main 2 Transformer Protection Relay (115kV)	Set									
	- Transformer Differential Protection Relay (115/22kV)	Set									
	- Main Protection Relay (22kV)	Set									
(continue)											

CONVENTIONAL TYPE

PART A,B : SUBSTATION EQUIPMENT

SCHEDULE 20 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A Equipment (Baht)		PART B Local Transportation (Baht)		PART B Installation (Baht)		Total
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
20.9	Industrial Ethernet Switch (IES), provide itemized price										
	- IES1	Set									
	- IES2	Set									
	- IES3	Set									
20.10	Merging Unit (MU), provide itemized price										
	- MU1	Set									
	- MU2	Set									
	- MU3	Set									
20.11	Smart I/O, provide itemized price										
	- Smart I/O1	Set									
	- Smart I/O2	Set									
	- Smart I/O3	Set									
	(continue)										

CONVENTIONAL TYPE

PART A,B : SUBSTATION EQUIPMENT, TRANSPORTATION AND INSTALLATION
SCHEDULE 20 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A		PART B				Total
					Equipment (Baht)		Local Transportation (Baht)		Installation (Baht)		
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
20.12	Marshalling control cubicle and accessories	Set									
20.13	Operator console furniture with chair	Lot									
20.14	SCPS software and licenses	Lot									
	(continue)										

CONVENTIONAL TYPE

PART A,B : SUBSTATION EQUIPMENT
SCHEDULE 20 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A		PART B				Total
					Equipment (Baht)		Local Transportation (Baht)		Installation (Baht)		
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
20.15	Other Equipment Cabinet Enclosures										
	1) Indoor enclosures	Lot									
	2) Outdoor enclosures	Lot									
20.16	Interconnecting Cables and Wiring										
	1) Fiber Optic cables and accessories	Lot									
	2) Metallic cables and accessories	Lot									
	3) CAT6, Control cable and accessories	Lot									
	(continue)										

CONVENTIONAL TYPE

PART A,B : SUBSTATION EQUIPMENT
SCHEDULE 20 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A		PART B				Total
					Equipment (Baht)		Local Transportation (Baht)		Installation (Baht)		
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
	4) Terminal blocks	Lot									
20.17	Conduit and Raceway	Lot									
20.18	Power Supply System										
	1) Power Supply	Set									
(continue)											

CONVENTIONAL TYPE

PART A,B : SUBSTATION EQUIPMENT
SCHEDULE 20 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A		PART B				Total
					Equipment (Baht)		Local Transportation (Baht)		Installation (Baht)		
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
	2) Inverter	Set									
	3) Converter	Set									
	4) UPS	Set									
20.19	Power Distribution System	Lot									
	(continue)										

CONVENTIONAL TYPE

PART A,B : SUBSTATION EQUIPMENT, TRANSPORTATION AND INSTALLATION
SCHEDULE 20 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A		PART B				Total
					Equipment (Baht)		Local Transportation (Baht)		Installation (Baht)		
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
20.20	Operation and Maintenance and Supports										
	- Engineering tool and erection accessories	Lot									
	- Testing, commissioning and engineering cost.	Lot									
	- Special tools	Lot									
	- Recommended Spare parts	Lot									
	- Complete documentation with operation and maintenance manuals	Lot									
	- Training, including factory-based training for special equipment and on-site during construction and commissioning	Lot									
20.21	Other (If necessary)										
	....										
	....										
	....										
	Total Price for Schedule 20										

BoQ of PEA-GIS Substation

GIS TYPE

PART A,B : SUBSTATION EQUIPMENT
SCHEDULE 17 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A Equipment (Baht)		PART B Local Transportation (Baht)		PART B Installation (Baht)		Total
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
17	IEC 61850 Based SCPS										
17.1	SCPS System										
	- SCPS Server 1	Set									
	- SCPS Server 2	Set									
17.2	Human Machine Interface (HMI) or Engineering Work Station (EWS)										
	- Personal computer, rack-mounted industrial type	Set									
	- Logging printer, A4, Colour laser printer	Set									
17.3	Engineering Tool Notebook	Set									
17.4	Time Data Server (TDS) or Time Reference Unit (TRU)	Set									
17.5	Communication Gateway (CGW) with Firewall	Set									
17.6	Digital Fault Recorder (DFR)	Set									
	(continue)										

GIS TYPE

PART A,B : SUBSTATION EQUIPMENT

SCHEDULE 17 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A Equipment (Baht)		PART B Local Transportation (Baht)		PART B Installation (Baht)		Total
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
17.7	Network Management System	Set									
17.8	IED Bay Control Unit (BCU) and IED Protective Relay, give itemized price										
	- BCU1	Set									
	- BCU2	Set									
	- BCU3	Set									
	- BCU4	Set									
	- Main 1 Line Protection Relay (115kV)	Set									
	- Main 2 Line Protection Relay (115kV)	Set									
	- Bus Protection Relay (115kV)	Set									
	- Main 1 Transformer Protection Relay (115kV)	Set									
	- Main 2 Transformer Protection Relay (115kV)	Set									
	- Transformer Differential Protection Relay (115/22kV)	Set									
	- Main Protection Relay (22kV)	Set									
	(continue)										

GIS TYPE

PART A,B : SUBSTATION EQUIPMENT
SCHEDULE 17 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A Equipment (Baht)		PART B Local Transportation (Baht)		PART B Installation (Baht)		Total
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
17.9	Industrial Ethernet Switch (IES), provide itemized price										
	- IES1	Set									
	- IES2	Set									
	- IES3	Set									
17.10	Merging Unit (MU), provide itemized price										
	- MU1	Set									
	- MU2	Set									
	- MU3	Set									
17.11	Smart I/O, provide itemized price										
	- Smart I/O1	Set									
	- Smart I/O2	Set									
	- Smart I/O3	Set									
	(continue)										

GIS TYPE

PART A,B : SUBSTATION EQUIPMENT, TRANSPORTATION AND INSTALLATION
SCHEDULE 17 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A Equipment (Baht)		PART B Local Transportation (Baht)		PART B Installation (Baht)		Total
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
17.12	Marshalling control cubicle and accessories	Set									
17.13	Operator console furniture with chair	Lot									
17.14	SCPS software and licenses	Lot									
	(continue)										

GIS TYPE

PART A,B : SUBSTATION EQUIPMENT

SCHEDULE 17 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A		PART B				Total
					Equipment (Baht)		Local Transportation (Baht)		Installation (Baht)		
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
17.15	Other Equipment Cabinet Enclosures										
	1) Indoor enclosures	Lot									
	2) Outdoor enclosures	Lot									
17.16	Interconnecting Cables and Wiring										
	1) Fiber Optic cables and accessories	Lot									
	2) Metallic cables and accessories	Lot									
	3) CAT6, Control cable and accessories	Lot									
(continue)											

GIS TYPE

PART A,B : SUBSTATION EQUIPMENT
SCHEDULE 17 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A Equipment (Baht)		PART B Local Transportation (Baht)		PART B Installation (Baht)		Total
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
	4) Terminal blocks	Lot									
17.17	Conduit and Raceway	Lot									
17.18	Power Supply System										
	1) Power Supply	Set									
(continue)											

GIS TYPE

PART A,B : SUBSTATION EQUIPMENT

SCHEDULE 17 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A Equipment (Baht)		PART B Local Transportation (Baht)		PART B Installation (Baht)		Total
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
	2) Inverter	Set									
	3) Converter	Set									
	4) UPS	Set									
20.19	Power Distribution System	Lot									
(continue)											

GIS TYPE

PART A,B : SUBSTATION EQUIPMENT, TRANSPORTATION AND INSTALLATION

SCHEDULE 17 : IEC 61850 BASED SUBSTATION CONTROL AND PROTECTION SYSTEM (SCPS)

Item	Description	Unit	Quantity of Each Substation	TOTAL QTY'S	PART A		PART B				Total
					Equipment (Baht)		Local Transportation (Baht)		Installation (Baht)		
			WWW		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	
17.20	Operation and Maintenance and Supports										
	- Engineering tool and erection accessories	Lot									
	- Testing, commissioning and engineering cost.	Lot									
	- Special tools	Lot									
	- Recommended Spare parts	Lot									
	- Complete documentation with operation and maintenance manuals	Lot									
	- Training, including factory-based training for special equipment and on-site during construction and commissioning	Lot									
17.21	Other (If necessary)										
	....										
	....										
	....										
	Total Price for Schedule 17										