



CEYLON ELECTRICITY BOARD SRI LANKA

GREEN POWER DEVELOPMENT AND ENERGY EFFICIENCY IMPROVEMENT INVESTMENT PROGRAM (TRANCHE 2)

(ADB LOAN NO: 3483/3484)

PACKAGE 8 - LOT B

Procurement of Plant

Design, Supply, and Installation

Single-Stage: Two-Envelope
Bidding Procedure

BIDDING DOCUMENT
for
Procurement
of

Augmentation of:

Ambalangoda 132/33kV Grid Substation

Pannala 132/33kV Grid Substation

VOLUME 4 of 8

Part II- REQUIREMENTS

Section 6 - Employer's Requirements: Part A-Scope of Works

Issued on: 25 June 2020

Invitation for Bids No.: CEB/AGM/PRO/2019/IFB/GPDEEIP-T2-P8-LOT B

ICB No.: CEB/AGM/PRO/2019/ICB/GPDEEIP-T2-P8-LOT B

Employer: Ceylon Electricity Board

Country: Sri Lanka

Projects Division

Ceylon Electricity Board,
P.O. Box 540, Colombo 02
Sri Lanka

Document – Revision 1

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Preface

This Bidding Document for Procurement of Plant – Design, Supply, and Installation, has been prepared by Ceylon Electricity Board and is based on the Standard Bidding Document for Procurement of Plant – Design, Supply, and Installation (SBD Plant) issued by the Asian Development Bank dated December 2016.

ADB's SBD Plant has the structure and the provisions of the Master Procurement Document entitled "Procurement of Plant – Design, Supply, and Installation", prepared by multilateral development banks and other public international financial institutions except where ADB-specific considerations have required a change.

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This Section consists of provisions that are specific to each procurement and supplement the information or requirements included in Section 1 - Instructions to Bidders.

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1. SCOPE OF WORKS

1.1. GENERAL DESCRIPTION OF THE PROJECT

1.1.1. AUGMENTATION OF AMBALANGODA GRID SUBSTATION

The augmentation of Ambalangoda Grid Substation shall consist of following main features.

1. 145kV Outdoor air insulated switchgear with single bus bar arrangement comprising of 01 No. 145kV Transformer bay.
2. 01 No. 132/33 kV, 31.5MVA Power Transformer.
3. 01 No. 33kV, 800A, 30s Earthing Transformer.
4. 36 kV SF₆ gas insulated indoor switchgear with Single Bus bar arrangement comprising of
 - 01 No. 36kV Bus Section bay/ Expansion panel
 - 01 No. 36kV Transformer bay
 - 04 Nos. 36kV Line feeder bays
 - 01 No. 36kV Generator feeder bay
5. 04 Nos. of 36kV Outdoor line gantry including 36kV cable terminations.
6. Additions/Modifications of control, metering, monitoring and protection equipment.
7. Additions/ modifications of Batteries, Battery Chargers, DC Equipment, LVAC and Inverter Equipment etc.
8. Additions/Modifications of SCADA & Communication Equipment.
9. Modification of Substation Automation System.
10. Modification of Energy Metering System.
11. Power and Control Cables including terminations.
12. Extension and modification of Substation Grounding System and Shield Earth Wire System.
13. Electrical, Civil and Mechanical works required for substation including control and other buildings.
14. Spare parts.

1.1.2. AUGMENTATION OF PANNALA GRID SUBSTATION

The augmentation Pannala Grid Substation shall consist of following main features.

1. Extension to the 145kV Outdoor air insulated switchgear with Single Bus bar arrangement comprising of 1 No. 145kV Transformer bay.
2. 01 No. 132/33 kV, 31.5 MVA Power Transformer.

3. 02 Nos. 132/33 kV, 31.5 MVA Spare Power Transformers. (one spare transformer shall be delivered to Valachchena GSS and the other spare transformer shall be delivered to Deniyaya GSS)
4. 01 No. 33kV, 800A, 30s Earthing Transformer.
5. 36 kV SF₆ gas insulated indoor switchgear with Single Bus bar arrangement comprising of
 - 01 No. 36kV Bus Section bay
 - 02 Nos. 36kV Transformer bay
 - 04 Nos. 36kV Line feeder bays
 - 04 Nos. 36kV Generator feeder bay
6. 08 Nos. of 36kV Outdoor line gantry including 36kV cable terminations.
7. Additions/Modifications of control, metering, monitoring and protection equipment.
8. Additions/ modifications of Batteries, Battery Chargers, DC Equipment, LVAC and Inverter Equipment etc.
9. Additions/Modifications to SCADA & Communication equipment.
10. Modification of Substation Automation System.
11. Additions/Modification of Energy Metering System.
12. Power and Control cables including terminations.
13. Extension and modification of Substation Grounding System and Shield Earth Wire System.
14. Electrical, Civil and Mechanical works required for substation including control building.
15. Spare parts.

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1.1.3. TERMINAL POINTS

A. AMBALANGODA GRID SUBSTATION

The following shall be the contract terminal points: -

- (a) 145kV Outdoor Busbar/ Switchgear interfaces.
The existing 145 kV busbar terminates at busbar supports. The new 145kV transformer bay shall be provided under Grid Substation Contract and shall be connected to the existing 145kV busbar. This contract includes the connections and connectors from the existing 145kV outdoor busbar system to new 145kV transformer bay switchgears.
- (b) 36kV Overhead Line/ Switchgear interfaces
36kV overhead distribution lines terminate at the line bay gantries, which shall be provided at Grid Substation. This includes the connections and connectors from 36kV outdoor terminations to the 36kV line down droppers, which terminate at the line bay gantries.
- (c) Control and Protection interface
This contract includes the modifications of existing control and protection system to include new bays where necessary. This includes the inclusion of the new 145 kV transformer bay in to the existing busbar protection scheme.
- (d) Transformer AVR interface
This contract includes a new AVR for new transformer with both minimum circulating current method and master follower method for parallel operation with existing 132/33kV transformers. AVR shall be capable for correct operation of the voltage regulation described in the Chapter 10 of the specification.
- (e) Substation Automation System (SAS) interface
Proposed 132kV and 33kV system protection and control IEDs shall be covered under this project.

B. PANNALA GRID SUBSTATION

The following shall be the contract terminal points: -

- (a) 145kV Outdoor Busbar/ Switchgear interfaces
The existing 145 kV busbar terminates at busbar supports. The new 145kV transformer bay shall be provided under Grid Substation Contract and shall be connected to the existing 145kV busbar. This contract includes the connections and connectors from the existing 145kV outdoor busbar system to new 145kV transformer bay switchgears.

- (b) 36kV Overhead Line/ Switchgear interfaces
3rd transformer connection to existing GIS shall be removed and connected to the new 36kV GIS at new indoor switchgear room building which shall be constructed under this project.
- (c) 36kV Overhead Line/ Switchgear interfaces
36kV overhead distribution lines terminate at the line bay gantries, which shall be provided at Grid Substation. This includes the connections and connectors from 36kV outdoor terminations to the 36kV line down droppers, which terminate at the line bay gantries.
- (d) Control and Protection interface
This contract includes the modifications of existing control and protection system to include new bays where necessary. This includes the inclusion of the new 145 kV transformer bay in to the existing busbar protection scheme.
- (e) Transformer AVR interface
This contract includes a new AVR for new transformer with both minimum circulating current method and master follower method for parallel operation with 3rd 132/33kV transformer. AVR shall be capable for correct operation of the voltage regulation described in the Chapter 10 of the specification.
- (f) Substation Automation System (SAS) interface
Proposed 132kV and 33kV system protection and control IEDs shall be covered under this project. Integration of IED into existing Substation Automation System is subjected to the employer's approval.

1.1.4. SITE ENVIRONMENTAL CONDITIONS**Galle**

Altitude of site above sea level not exceeding	m	100
Maximum ambient air temperature	°C	36.4
Minimum ambient air temperature	°C	17.1
Average yearly temperature	°C	27.3
Relative humidity (24 hours)	%	84.3
Average annual rainfall	mm	2377.8
Maximum recorded rainfall for 24 hours	mm	282.8
Winds	As per wind zonal map of Sri Lanka	
Storms	Frequency of thunderstorms is high	
Average isokeraunic level	60 days per annum	
Atmospheric corrosive category (ISO 12944)	C4	
Pollution level for bushings and insulators	43.3mm/kV (USCD)	

Pannala

Altitude of site above sea level not exceeding	m	500
Maximum ambient air temperature	°C	38.4
Minimum ambient air temperature	°C	13.4
Average yearly temperature	°C	31.4
Relative humidity (24 hours)	%	87
Average annual rainfall	mm	2268
Maximum recorded rainfall for 24 hours	mm	321.3
Winds	As per wind zonal map of Sri Lanka	
Storms	Frequency of thunderstorms high	
Average isokeraunic level	90 days per annum	
Atmospheric Corrosivity Category	C4 (ISO 12944-2)	
Pollution level for bushings and insulators	43.3mm/kV (USCD)	

1.1.5. ELECTRICITY, WATER, GAS AND OTHER SERVICES

The Contractor shall at his expense, provide all electricity, water, gas and other services necessary to execute and complete the Works on site. Prevailing tariff and service connection procedure shall be applicable.

1.1.6. ADHERENCE TO THE ENVIRONMENTAL MITIGATION MEASURES

Bidders are requested to comply with the requirements stated in the Chapter 1, Clause 1.7 of Section 6 Part B -Technical Specifications and also to the environmental safeguard measures described in the following documents attached in the section 6 Employers requirement Part D- Supplementary Information.

The said documents prepared in accordance with the governing acts and/or guidelines, which are particularly relevant to this project may be inspected and a copy obtained free of charge from the office of the Project Director at the following address.

Address: Office of Project Director (GPD&EEIIP-T2)
Ceylon Electricity Board,
No.25/1,
Buthgamuwa Road,
Rajagiriya
Sri Lanka.

Telephone: 011 288 9650

Facsimile number: 011 288 9763

Electronic mail address: pdgpd2.prj@ceb.lk

1.2. PLANT & EQUIPMENT INCLUDING MANDATORY SPARE PARTS

1.2.1. AMBALANGODA GRID SUBSTATION

1.2.1.1. OUTDOOR SWITCHGEAR

1.2.1.1.1. 01 No. 145kV Transformer bay comprising:-

- 1 No. - 1250A, 145kV, 31.5kA three phase busbar disconnectors with hand and motor operating mechanism.
- 1 No. - 1250A, 145kV, 31.5kA three phase circuit breaker complete with operating mechanism etc.
- 3 Nos. - 145kV, 31.5kA current transformers with cores as follows:-
 - Class 5P20, ratio 400/200/1A for Main 1 protection and control IED
 - Class 5P20, ratio 400/200/1A for Main 2 protection and control IED
 - (Knee point Voltage and secondary burden of CT shall be adequate for the proper operation of REF)
 - Class 0.2, ratio 400/200/1A
 - Class 5P20, ratio 2000/1A for bus bar and breaker failure protection.
- 3 Nos. - 120kV, 10kA Class 2 single phase surge arresters with counters.
- 1 No. - Neutral current transformer with core as follows: -
 - Class 5P20 ratio 400/200/1A for Main 1 protection and control IED
 - Class 5P20 ratio 400/200/1A for Main 2 protection and control IED
 - (Knee point Voltage and secondary burden of CT shall be adequate for the proper operation of REF)
- 1 Lot - Set of connections, connectors, clamps, access ladders etc. including connections to 145kV busbar, transformer 132kV and neutral bushings.

1.2.1.1.2. 01 No. 36kV Transformer bay comprising:-

- 3 Nos. - 36 kV, 10 kA, Class 2 Single phase Surge arresters with counters.
- 1 Lot - Set of cable connection between main transformer and outdoor equipment (Surge arresters and cable termination for GIS) including set of connections, connectors, clamps, structures, access ladders, structure for surge arrester and cable supports, terminal arrangement suitable for

incoming 36 kV cables etc. to terminate the 36 kV cable and to connect in to the Earthing Transformer cables.

- 1 Lot - Set of cable connection between main transformer and indoor switchgear including set of connections, connectors, clamps, structures, access ladders, Cable sealing end or terminal arrangement suitable for incoming 36kV cables etc. to terminate the 36kV cable and connect to the Transformer.
- 1 Lot - Connections, connectors, clamps, access ladders etc. including connections to transformer 36kV and neutral bushings.

1.2.1.1.3. 03 No. 36kV Line feeder bay comprising:-

- 3 Nos. - 36kV, 10kA, Class 2 single phase surge arresters with counters.
- 1 Lot - Set of bay connections, connectors, and clamps, etc.
- 1 Lot - Set of cable connection between indoor switchgear and outdoor equipment including set of connections, connectors, clamps, structures, access ladders, cable terminating structure, sealing end or terminal arrangement suitable for incoming 36kV cables etc. to terminate the 36kV cable and connected to the 36kV take-off structure.

1.2.1.1.4. 01 Nos. of 36kV Generator Feeder bay comprising:-

- 3 Nos. - 36kV, 10kA, Class 2 single phase surge arresters with counters.
- 1 Lot - Set of bay connections, connectors, and clamps, etc.
- 1 Lot - Set of cable connection between indoor switchgear and outdoor equipment including set of connections, connectors, clamps, structures, access ladders, cable terminating structure, sealing end or terminal arrangement suitable for incoming 36kV cables etc. to terminate the 36kV cable and connected to the 36kV take-off structure.

Note: The current rating of generator feeders is 800A, and hence all connections, connectors and clamps shall be selected accordingly.

1.2.1.1.5. 01 No. 36kV, 800A/30s Earthing transformer bay comprising:-

- 1 No. - Neutral Current Transformer with cores as follows:
Class 5P20, ratio 800/1A for HV Main 1 protection and control IED
Class 5P20, ratio 800/1A for HV Main 2 protection and control IED

- 1 Lot - Set of cable connection between earthing transformer and outdoor bus bars of main transformer including set of connections, connectors, clamps, structures, connectors required for 36 kV bushing etc to terminate the 36 kV cable and to connect in to the Earthing Transformer and neutral current transformer.

1.2.1.2. NEW SF₆ INSULATED INDOOR SWITCHGEAR AND MODIFICATION OF EXISTING SF₆ INSULATED INDOOR SWITCHGEAR

The new SF₆ insulated indoor switchgear shall be installed in the new switchgear room which shall be constructed under this contract. The Panel No. H14 of the existing indoor switchgear shall be used as the Bus Section Panel between existing 36kV Indoor switchgear and new 36kV indoor switchgear (as per the drawing no. TD/CE/1/185/D/00/01). The Feeder No.6 of the Ambalangoda GSS shall be shifted to new indoor switchgear with this modification.

1.2.1.2.1. 01 No. 36kV Transformer bay comprising:-

- 1 Set - 36kV, 2500A, 25kA, three phase bus bars.
- 1 No. - 1250A, 36kV, 25kA, 3-phase busbar disconnecter with earth switch and motor operating mechanism.
- 1 No. - 1250A, 36kV, 25kA, 3-phase circuit breaker complete with operating mechanism.
- 3 Nos. - 36kV Current Transformers with cores as follows:-
 Class 5P20, ratio 800/1A for HV Main 1 protection and control IED
 Class 5P20, ratio 800/1A for HV Main 2 protection and control IED, AVR and LV protection and control IED.
 Class 0.2 ratio 800/1A for metering.
- 3 Nos. - 36kV Single phase voltage transformers with cores as follows:-
 Class 3P ratio 33,000/√3V:110/√3V for HV Main 1 protection and control IED
 Class 3P ratio 33,000/√3V:110/√3V for HV Main 2 protection and control IED, AVR, and LV protection and control IED
 Class 0.2 ratio 33,000/√3V:110/√3V for Energy metering system
- 1 Lot - Cable terminating chamber, complete with cable box, sealing end or terminal arrangement suitable for incoming 36kV cables.
- 1 Lot - Complete set of miscellaneous items required for the safe and efficient operation of the switch gear, including cables, independently lockable shutters over busbar, cable and voltage transformer spouts (as appropriate), facility to enable busbar or cable to be earthed through circuit

breakers, terminal boxes for multi-core cables, busbar end covers or link to adjacent switch panel as appropriate etc.

1.2.1.2.2. 04 Nos. 36kV Feeder bays each comprising:-

- 1 Set - 36kV, 2500A, 25kA, three phase bus bars.
- 1 No. - 1250A, 36kV, 25kA, 3-phase busbar disconnecter with earth switch and motor operating mechanism.
- 1 No. - 1250A, 36kV, 25kA, 3-phase circuit breaker complete with operating mechanism.
- 3 Nos. - 36kV Current Transformers with cores as follows:-
Class 5P20, ratio 400/1A for over current and earth fault protection.
Class 0.2, ratio 400/1A for Energy metering system.
- 3 Nos. - 36kV Single phase voltage transformers with cores as follows: -
33,000/ $\sqrt{3}$ V:110/ $\sqrt{3}$ V:110/ $\sqrt{3}$ V Class 3P for protection and Class 0.2 for metering.
- 1 Lot - Cable terminating chamber, complete with cable box, sealing end or terminal arrangement suitable for incoming 36kV cables.
- 1 Lot - Complete set of miscellaneous items required for the safe and efficient operation of the switch gear, including cables, independently lockable shutters over busbar, cable and voltage transformer spouts (as appropriate), facility to enable busbar or cable to be earthed through circuit breakers, terminal boxes for multi-core cables, busbar end covers or link to adjacent switch panel as appropriate etc.

1.2.1.2.3. 01 No. 36kV Generator feeder bay each comprising:-

- 1 Set - 36kV, 2500A, 25kA, three phase bus bars.
- 1 No. - 1250A, 36kV, 25kA, 3-phase busbar disconnecter with earth switch and motor operating mechanism.
- 1 No. - 1250A, 36kV, 25kA, 3-phase circuit breaker complete with operating mechanism.
- 3 Nos. - 36kV Current Transformers with cores as follows:-
Class 5P20, ratio 800/400/1A for directional over current, directional earth fault, over current and earth fault protection.
Class 0.2, ratio 800/400/1A for Energy metering system.

- 3 Nos. - 36kV Single phase voltage transformers with cores as follows:-
33,000/ $\sqrt{3}$ V:110/ $\sqrt{3}$ V:110/ $\sqrt{3}$ V Class 3P for protection and Class 0.2 for metering.

(Note: These 36 kV Feeder bays require live-bus/Dead-line detecting system)

- 1 Lot - Cable terminating chamber, complete with cable box, sealing end or terminal arrangement suitable for incoming 36kV cables.
- 1 Lot - Complete set of miscellaneous items required for the safe and efficient operation of the switch gear, including cables, independently lockable shutters over busbar, cable and voltage transformer spouts (as appropriate), facility to enable busbar or cable to be earthed through circuit breakers, terminal boxes for multi-core cables, busbar end covers or link to adjacent switch panel as appropriate etc.

1.2.1.2.4. Modification of Panel No. H14 of Existing SF₆ Insulated Indoor Switchgear as 36kV Bus Section bay comprising.

- 1 Lot - Cable termination, complete with terminal arrangement suitable for incoming 36kV cables and existing SF₆ Insulated Indoor Switchgear panel.
- 3 Nos. - 36kV Current Transformers with cores as follows:-
Class 5P20, ratio 1600/1A for protection.
Class 0.2, ratio 1600/1A for Energy metering system.
- 1 Lot - Complete set of miscellaneous items required for proposed modification

1.2.1.2.5. 01 No. 36kV Bus Riser bay/ Expansion panel comprising:-

- 1 Set - 36kV, 2500A, 25kA, three phase bus bars.
- 1 No. - 1250A, 36kV, 25kA, 3-phase busbar disconnecter with earth switch and motor operating mechanism.
- 1 No. - 1250A, 36kV, 25kA, 3-phase circuit breaker complete with operating mechanism.
- 3 Nos. - 36kV Current Transformers with cores as follows:-
Class 5P20, ratio 1600/1A for protection.
Class 0.2, ratio 1600/1A for Energy metering system.
- 1 Lot - Cable terminating chamber, complete with cable box, sealing end or terminal arrangement suitable for incoming 36kV cables.

- 1 Lot - Complete set of miscellaneous items required for the safe and efficient operation of the switch gear, including cables, independently lockable shutters over busbar, cable and voltage transformer spouts (as appropriate), facility to enable busbar or cable to be earthed through circuit breakers, terminal boxes for multi-core cables, busbar end covers or link to adjacent switch panel as appropriate etc.

1.2.1.2.6. 01 No. 36kV GIS Voltage transformer comprising:-

- 3 Nos. - 36kV Single phase voltage transformers with cores as follows:-
33,000/ $\sqrt{3}$ V:110/ $\sqrt{3}$ V:110/ $\sqrt{3}$ V:110/ $\sqrt{3}$ V Class 3P for protection, Class 3P for protection and Class 0.2 for metering.

1.2.1.3. MODIFICATION OF LVAC SWITCH BOARDS

The existing 400V switchboards shall be modified to accommodate this augmentation scope.

1.2.1.3.1. 400V Distribution panel modification:

Additional MCBs for following distribution circuits (Number of Phases and rating shall be according to the load required)

Essential loads

Main transformer No. 3 OLTC & cooling fans

36kV new Indoor switchgear auxiliary power

Panel No.1

145kV Switchgear Auxiliary Power

36kV Switchgear Auxiliary Power

1.2.1.4. MODIFICATIONS OF BATTERIES, CHARGERS, DISTRIBUTION BOARDS & INVERTER EQUIPMENT

Existing 110V and 48V DC systems including the main switch board shall be modified to accommodate the load of proposed modifications.

1.2.1.5. PROTECTION, METERING, MONITORING AND CONTROL

1.2.1.5.1. Substation Automation System:-

The required modification and necessary upgrading shall be carried out in the existing Substation Automation System at Ambalangoda Grid Substation to integrate new and modified control and protection IEDs, Ethernet Switches, AVRs and existing Capacitor controllers.

Control & Protection IEDs and AVR's which will be supplied for Ambalangoda GSS shall be compatible with IEC 61850 protocol. The bidder shall submit IEC 61850 conformance certificate issued by an independent laboratory empowered by UCA International Users Group tested according to the IEC 61850-10 for the Control & Protection IEDs and AVR's.

New control & protection IEDs and AVR's should be connected to existing IEC 61850 SAS communication network using protected multimode fiber optic cables. IEC 61850 SAS communication network shall be extended using Ethernet Switches which support existing RSTP redundant protocol. Ethernet switches which will be supplied shall be compatible with SNMP V1, V2, V3 or IEC 61850. Configuration software and relevant files of Ethernet Switches shall be delivered to CEB.

Bidder should provide high quality ICD and CID files of new control & protection IEDs and AVR's along with the relevant IED software with license to CEB. Supplied AVR shall be IEC 61850 compatible and it shall be possible to integrate all its functions to IEC 61850 SAS.

1.2.1.5.2. 145kV Protection & Control facilities:-

All the control metering and protection panels shall be complied with requirements of Chapter 5 of the Technical Specifications. The trip circuit supervision scheme shall provide continuous supervision of all the trip coils and trip circuits with the circuit breaker in either the open or closed position for each 145kV bay as per clause 5.18.

1.2.1.5.2.1. For 01 No. 145kV Transformer comprising with:-

Protection and control panel and Mechanical protection and control panel shall be provided as per clauses 5.12 and 5.25 of Technical Specifications.

(a) Protection and Control panel with IEDs

Protection and control panel with HV main 1 and main 2 IEDs with functions listed in 5.12.1 of Technical Specifications and other required accessories as per Chapter 5 of Technical Specifications shall be provided.

Busbar and breaker failure protection bay IED shall also be provided on this protection and control panel.

(b) Mechanical Protection and Control Panel

Mechanical protection and control panel with relays, AVR's and accessories as per clauses 5.12 and 5.25 of Technical Specifications shall be provided.

(c) 01 No. Ethernet Switch

145 kV Transformer Control and Protection Panel shall consist of Ethernet Switch to connect followings through fiber optics.

1. Main 1 Protection and Bay Controlling IED
2. Main 2 Protection and Bay Controlling IED
3. AVR

4. IO Box for Transformer Mechanical Protection

Ethernet Switch shall be compatible with existing RSTP redundant protocol MOXA Turbo Ring and shall be connected to existing Ethernet Switches E07 MOXA EDS-508A-MM-SC and H12 MOXA EDS-508A-MM-SC using protected multimode fiber optics with SC type connectors to maintain IEC 61850 SAS communication network.

1.2.1.5.3. 36kV Protection & Control facilities:-

(Relays shall be installed in 36kV switchgear compartment).

(a) 02 Nos. Ethernet Switches

These Ethernet Switches shall be installed in 36kV switchgear compartment or separate wall mounted Patch Panel to connect new 36 kV Protection and Control IEDs through fiber optics.

Ethernet Switches shall be compatible with existing RSTP redundant protocol MOXA Turbo Ring and shall be connected to existing Ethernet Switches as tabulated below using protected multimode fiber optics with SC type connectors to maintain IEC 61850 SAS communication network.

Ethernet Switch No	IEDs to be connected	Ethernet Switches to be connected
1	<ul style="list-style-type: none"> No. Protection and Control IED for 36kV Transformer bay 01 No. Protection and Control IED for 36kV Bus section / Expansion bay 01 Nos. Protection and Control IED for 36kV Generator feeder 	<ul style="list-style-type: none"> Existing Switch H11 MOXA EDS-508A-MM-SC New 36 kV Ethernet Switch No. 2
2	<ul style="list-style-type: none"> 04 Nos. Protection and Control IEDs for 36kV feeders for outgoing lines 	<ul style="list-style-type: none"> New 36 kV Ethernet Switch No. 1 Existing Switch SCS 3 MOXA EDS-508A-MM-SC

1.2.1.5.3.1. For 04 Nos. 36kV feeders for outgoing lines each comprising with:-

IEDs shall be provided as per the requirements given in Chapter 5 of Technical Specification -Grid Substation for following functions.

- | | |
|--------------------------|---------------------------------|
| Clause 5.11.1.1, 5.11.4 | - 36kV Overhead Line Protection |
| Clause 5.11.4.5 | - 36kV Auto-Reclosing |
| Clause 5.19 | - Trip circuit supervision |
| Clause 5.6, 5.7, 5.8.2.3 | - Control IED'S on 36kV level |

1.2.1.5.3.2. For 01 No. 36kV Transformer bays each comprising with:-

IEDs shall be provided as per the requirements given in Chapter 5 of Technical Specification -Grid Substation for following functions.

- | | |
|--------------------------|---|
| Clause 5.12.1, 5.12.2.2 | - Directional and Non-directional Over current protection for LV side |
| | - Directional and Non-directional Residual Earth fault protection for LV side |
| | - BCU function for LV side |
| | - Synchronism Check function for the LV side |
| | - Monitoring of Lockout relay |
| Clause 5.19 | - Trip circuit supervision |
| Clause 5.8.5 | - Synchrocheck & Synchronizing |
| Clause 5.6, 5.7, 5.8.2.3 | - Control IED'S on 36kV level |

1.2.1.5.3.3. For 01 No. 36kV Generator feeder comprising with:-

IEDs shall be provided as per the requirements given in Chapter 5 of Technical Specification -Grid Substation for following functions.

- | | |
|------------------------------------|-------------------------------|
| Clause 5.11.1.1, 5.11.4 | 36kV Overhead Line Protection |
| Clause 5.11.4.5 | - 36kV Auto-Reclosing |
| Clause 5.19 | - Trip circuit supervision |
| Clause 5.6, 5.7, 5.8.2.3, 5.12.2.2 | - Control IED'S on 36kV level |

1.2.1.5.3.4. For 01 No. 36kV Bus section bay comprising with:-

The existing protection and control system of Panel No. H14 shall be modified (IEDs shall be provided if necessary) meet the requirement given in Chapter 5 of Technical Specification – Grid Substation for following functions.

- | | |
|------------------------------------|---|
| Clause 5.15 | - 36kV Bus couple/ sectionalizer Over current, Earth fault Protection |
| Clause 5.19 | - Trip circuit supervision |
| Clause 5.8.5 | - Synchro-check & Synchronizing |
| Clause 5.6, 5.7, 5.8.2.3, 5.12.2.2 | - Control IED'S on 36kV level |

1.2.1.5.3.5. 36kV frequency & voltage relays to install in above Bus Section bay comprising with:-

- (a) Bus section bay IEDs shall be provided with following functions as per requirements given in chapter 5 of Technical Specification - Grid Substation.

Clause 5.15.3 - 02 sets of 36kV Bus section frequency & voltage relays to cover two busbar sections.

- Voltage selection scheme.

A Voltage selection scheme shall be provided to give correct Bus section Voltage to above voltage and frequency relays.

1.2.1.5.3.6. For 01 No. 36kV power cable between panel No. H14 of existing SF₆ insulated indoor switchgear to panel No. H15 of new SF₆ insulated indoor switchgear

IEDs shall be provided and installed in Panel No. H15 as per the requirements given in Chapter 5 of Technical Specification -Grid Substation for following functions.

- | | |
|------------------------------------|---|
| Clause 5.11 | - 36kV Bus sectionalizer Over current, Earth fault Protection |
| | - Cable Differential Protection (87L) |
| Clause 5.19 | - Trip circuit supervision |
| Clause 5.8.5 | - Synchro-check & Synchronizing |
| Clause 5.6, 5.7, 5.8.2.3, 5.12.2.2 | - Control IED'S on 36kV level |

1.2.1.5.3.7. Modification of Capacitor Bank Control & Protection

Necessary modifications/additions to the existing capacitor bank controlling/ protection scheme to incorporate addition of the 3rd power transformer.

1.2.1.5.4. Energy Metering panels comprising with:-

Energy Metering Panels with 09 nos. energy meters as specified in Chapter 9 of Technical Specification - Grid Substation for 36kV feeders and transformer feeders.

- 01 No. : Transformer Energy Measurement
- 04 No. : Transco Energy meters for 04 outgoing Feeders
- 04 No. : Disco Energy meters for 04 outgoing feeders

1.2.1.6. COMMUNICATION EQUIPMENT AND SCADA GATEWAYS/RTUs

1.2.1.6.1. Following modules shall be provided for existing fiber optic multiplexer of type FOX 515

- 01 No. : CPU module (with 32MB memory)
- 01 No. : Power supply module
- 01 No. : Module with 04 numbers of Data ports for SCADA (V.24, V.28) for IEC 101 SCADA
- 01 No. : Module with minimum 08 numbers of Ethernet ports with L2 Switching and VLAN facility (100/1000 Base T) and minimum 04 nos. GbE/10 GbE, SFP based ports
- 01 No. : Module with minimum 04 numbers of Ethernet ports with L2- switching, also configurable for VLAN and L3- routing facility (10/100 Mbps)
- 01 No. : Module SDH to PDH converter (2MB x 8)
- 01 No. : Module with 16 Nos. FXS ports

Installation and configuration of these modules to the existing fiber optic multiplexer will be carry out by CEB.

1.2.1.6.2. Required SCADA for Ambalangoda Grid Substation

SCADA integration of new and existing signals to National System Control Center (NSCC) shall be in IEC 60870-5-104 protocol.

Two separate redundant (1+1) Process and Communication modules each with two Ethernet interface modules for integration of new IEDs and SCADA communication through IEC60870-5-104 protocol with required license for the existing Gateway shall be provided along with necessary connecting boards by the contractor.

Required license upgrading, software and Hardware modifications shall be done by the contractor. Existing signals before the modification of the Gateway shall be available after the modification and they shall be tested and verified with the NSCC. Final configuration of Database and Project file (Gateway backup files) shall be provided (as CD/DVD or Portable external hard disk). If any Software up-gradation is required for the modification work, that software version shall be provided with the license (as CD/DVD or Portable external hard disk).

All new signals (Analog Measurements, Station Controls, Events and Alarms) shall be made available to the existing gateway according to the Annex A.

After the integration work, the integrated signals shall be tested from the field by the contractor.

The Gateway/RTU configuration parameters of signals are given in Annex B.

The Communication path configuration for Gateway is given in Annex C.

The point to point test SCADA commissioning signal list format is given in Annex D.

1.2.1.6.3. Integration of SCADA for Ambalangoda Grid Substation

The integration work of new control and protection IEDs to existing Gateway at Ambalangoda Grid Substation shall be carried out by the Contractor.

The on-site training as per the "1.3.4 of the Scope of Works" shall be arranged along with the above integration work.

1.2.1.7. MODIFICATION OF SUBSTATION EARTHING

The existing earth pit at the control building shall be relocated as per the drawing no. TD/CE/1/185/D/01/01. And the existing substation earthing system shall be modified to accommodate the augmentation works as per the requirements stated in Chapter 7 of the Technical Specification – Grid Substation. This shall include additional earth materials if required to reach the specified value of earth resistance.

1.2.1.8. MODIFICATION OF LIGHTNING PROTECTION SYSTEM COMPRISING:-

Design and erection of lightning protection system with earth wires in the area which covers the augmentation works.

1.2.1.9. MODIFICATION OF GROUNDING SYSTEM COMPRISING:-

Grounding system including connections of all steel structures and electrical apparatus which comes under this augmentation work to the existing earth mesh and grounding electrodes. New earth pit shall be constructed as shown in the drawing no. TD/CE/1/185/D/01/01.

1.2.1.10. POWER AND CONTROL CABLES

1.2.1.10.1. 36kV Power cables and terminations

The existing 36kV power cable from Panel no. H14 (Feeder No.06) to 33kV gantry shall be re-routed from Panel No. H17 of new indoor switchgear room to 33kV outdoor gantry. New 36kV power cables shall be provided and installed as follows.

- 1 Lot - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connection from Panel No.H14 of existing 36kV indoor switchgear to Panel No.H15 of new 36kV indoor switchgear and termination accessories. This cable shall be rated for 1250A.

- 1 Lot - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connections from Power transformer to new 36kV indoor switchgear and termination accessories.
- 3 Lots - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connections from switchgear panels to outdoor gantries for Line feeders and termination accessories.
- 1 Lot - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connections from switchgear panels to outdoor gantries for Generator feeders and termination accessories.
- 1 Lot - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connections from Power transformer to Earthing Transformer and termination accessories.

1.2.1.10.2. All low voltage AC power cables and terminations

1.2.1.10.3. All DC power and control cables and terminations

1.2.1.10.4. All cables required for protection, control, instrumentation, communication, SCADA and termination.

1.2.1.10.5. All cables required for station lighting, small power, fire protection, ventilation equipment.

The Contractor shall be responsible for the supply, installation, termination and testing of all cables for the execution of the works.

The Contractor is on a turnkey basis and the prices for Definite Works entered by the Bidder in Schedule of Rates & Prices shall only be varied if the Contract requirements are altered, up or down. For the purpose of such variations, the rates shall be those in Schedule of Prices & Rates.

The rates for supply and installation shall be those appropriate to order of drum lengths as appropriate to each type and rating of cable.

The cable installation rates shall include excavation, backfilling and reinstatement of the ground, installation in concrete trenches and ducts and fixing to cable tracks and supports as necessary.

Control and power cables shall be armoured and they shall be laid in concrete trenches, in the switchyard and within the buildings, they shall be cleated to cable trays. Cable trays and supports shall be supplied and installed in accordance with the Specification and included in the prices for Definite Work in Schedule of Prices & Rates.

1.2.1.11. TRANSFORMERS

Following transformers as specified in Chapter 10 of Technical Specification - Grid Substation.

Item	Description	Qty	Voltage	Rating	Cooling
1.	Power T/F	1	132/33kV	31.5MVA	ONAN/ONAF
2.	Earthing T/F	1	33kV	800A, 30s	ONAN

Note: 145kV & 36kV sides of Power transformers, 36kV sides of Earthing transformer shall be supplied with outdoor type bushings.

1.2.1.12. SUPPORTING STRUCTURES INCLUDING GANTRIES

All support structures necessary for the works and all terminating lines specified under the Employer's Requirements shall be provided by the Contractor. Materials used for the structures shall comply with the Technical Specification – Grid Substation.

1.2.1.13. MARSHALLING KIOSK

Marshalling kiosks shall be provided and wired where necessary. (i.e. shall be fabricated with higher grade of stainless steel or galvanized steel with protective coating).

1.2.1.14. SITE CLEARING AND HANDING OVER REMOVED ITEMS

After completing the project the site shall be cleaned and the removed items/equipment shall be handed over and delivered according to the instructions of the employer.

1.2.1.15. MISCELLANEOUS WORKS

Any work other than listed above.

1.2.1.16. SPARE PARTS

All necessary Spare parts.

1.2.1.17. TOOLS AND INSTRUMENTS

As per the price schedule.

1.2.2. PANNALA GRID SUBSTATION

1.2.2.1. OUTDOOR SWITCHGEAR

1.2.2.1.1. 01 No. 145kV Transformer bay comprising:-

- 1 No. - 1250A, 145kV, 31.5kA three phase busbar disconnector with hand and motor operating mechanism.
- 1 No. - 1250A, 145kV, 31.5kA three phase circuit breaker complete with operating mechanism etc.
- 3 Nos. - 145 kV, 31.5kA Current Transformers with cores as follows:-
 Class 5P20, ratio 400/200/1A for Main 1 protection and control IED
 Class 5P20, ratio 400/200/1A for Main 2 protection and control IED
 (Knee point Voltage and secondary burden of CT shall be adequate for the proper operation of REF)
 Class 0.2, ratio 400/200/1A
 Class 5P20, ratio 2000/1A for bus bar and breaker failure protection
- 3 Nos. - 120kV, 10kA Class 2 Surge arresters with counters.
- 1 No. - Neutral Current Transformer with core as follows: -
 Class 5P20 ratio 400/200/1A for Main 1 protection and control IED
 Class 5P20 ratio 400/200/1A for Main 2 protection and control IED
 (Knee point Voltage and secondary burden of CT shall be adequate for the proper operation of REF)
- 1 Lot - Set of connections, connectors, clamps, access ladders etc. including connections to 145kV busbar, transformer 132 kV and neutral bushings.

1.2.2.1.2. 01 No. 36kV Transformer bay comprising:-

- 3 Nos. - 36 kV, 10 kA, Class 2 Single phase Surge arresters with counters.
- 1 Lot - Set of cable connection between Main transformer and outdoor equipment (Surge arresters and cable termination for GIS) including set of connections, connectors, clamps, structures, access ladders, structure for surge arrester and cable supports, terminal arrangement suitable for incoming 36 kV cables etc. to terminate the 36 kV cable and to connect in to the Earthing Transformer cables.
- 1 Lot - Set of cable connection between indoor switchgear and outdoor equipment including set of connections, connectors, clamps, structures, access ladders, Cable sealing end or terminal arrangement suitable for

incoming 36kV cables etc. to terminate the 36kV cable and connect to the Transformer.

- 1 Lot - Connections, connectors, clamps, access ladders etc. including connections to transformer 36kV and neutral bushings.

1.2.2.1.3. 04 No. 36kV Line feeder bay comprising:-

- 3 Nos. - 36kV, 10kA, Class 2 single phase surge arresters with counters.
- 1 Lot - Set of bay connections, connectors, and clamps, etc.
- 1 Lot - Set of cable connection between indoor switchgear and outdoor equipment including set of connections, connectors, clamps, structures, access ladders, cable terminating structure, sealing end or terminal arrangement suitable for incoming 36kV cables etc. to terminate the 36kV cable and connected to the 36kV take-off structure.

1.2.2.1.4. 04 Nos. of 36kV Generator Feeder bay comprising:-

- 3 Nos. - 36kV, 10kA, Class 2 single phase surge arresters with counters.
- 1 Lot - Set of bay connections, connectors, and clamps, etc.
- 1 Lot - Set of cable connection between indoor switchgear and outdoor equipment including set of connections, connectors, clamps, structures, access ladders, cable terminating structure, sealing end or terminal arrangement suitable for incoming 36kV cables etc. to terminate the 36kV cable and connected to the 36kV take-off structure.

Note: The current rating of generator feeders is 800A, and hence all connections, connectors and clamps shall be selected accordingly.

1.2.2.1.5. 01 No. 36 kV, 800A/30s Earthing Transformer bay comprising:-

- 1 No. - Neutral Current Transformer with cores as follows:
 Class 5P20, ratio 800/1A for HV Main 1 protection and control IED
 Class 5P20, ratio 800/1A for HV Main 2 protection and control IED
- 1 Lot - Set of cable connection between earthing transformer and outdoor bus bars of main transformer including set of connections, connectors, clamps, structures, connectors required for 36 kV bushing etc to terminate the 36 kV cable and to connect in to the Earthing Transformer and neutral current transformer.

1.2.2.2. 36kV INDOOR SWITCHGEARS

1.2.2.2.1. 02 Nos. 36kV Transformer Feeder bays each comprising:-

- 1 Set - 2500 A, 36 kV, 25 kA three phase busbars
- 1 No. - 1250 A, 36 kV, 25 kA three phase busbar disconnecter integral with earth switch complete with motor operating mechanism.
- 1 No. - 1250 A, 36 kV, 25 kA three phase circuit breaker complete with operating mechanism.
- 3 Nos. - 36 kV current transformers with cores as follows:-
 - Class 5P20, ratio 800/1A for HV Main 1 protection and control IED.
 - Class 5P20, ratio 800/1A for HV Main 2 protection and control IED, AVR and LV protection and control IED.
 - Class 0.2 ratio 800/1 A for metering.
- 3 Nos. - 36 kV single phase voltage transformers with cores as follows:-
 - Class 3P ratio 33,000/ $\sqrt{3}$ V:110/ $\sqrt{3}$ V for HV Main 1 protection and control IED
 - Class 3P ratio 33,000/ $\sqrt{3}$ V:110/ $\sqrt{3}$ V for HV Main 2 protection and control IED, AVR, and LV protection and control IED
 - Class 0.2 ratio 33,000/ $\sqrt{3}$ V:110/ $\sqrt{3}$ V for Energy metering system
- 1 Lot - Cable terminating chamber (cone) complete with cable box, sealing ends or terminal arrangement of 36 kV cables including dummy plugs and cable supports.
- 1 Lot - Complete set of miscellaneous items required for safe and efficient operation of the switchgear, facility to enable busbar or cable to be earthed through circuit breakers, terminal arrangements for multi-core cables, busbar end covers or link to adjacent switchgear panel as appropriate.

1.2.2.2.2. 04 Nos. of 36kV Generator Feeder bays each comprising:-

- 1 Set - 2500 A, 36 kV, 25 kA three phase busbars
- 1 No. - 1250 A, 36 kV, 25 kA three phase busbar disconnecter integral with earth switch complete with motor operating mechanism.
- 1 No. - 1250 A, 36 kV, 25 kA three phase circuit breaker complete with operating mechanism.
- 3 Nos. - 36 kV current transformers with cores as follows:-

Class 5P20, ratio 800/400/1A for directional over current, directional earth fault, over current and earth fault protection.

Class 0.2, ratio 800/400/1A for metering.

- 3 Nos. - 36 kV single phase voltage transformers with cores as follows:-
33,000/ $\sqrt{3}$ V: 110/ $\sqrt{3}$ V: 110/ $\sqrt{3}$ V Class 3P for Protection and Class 0.2 for Metering.
- 1 Lot - Cable terminating chamber complete with cable box, sealing ends or terminal arrangement of 36 kV cables including dummy plugs and cable supports.
- 1 Lot - Complete set of miscellaneous items required for safe and efficient operation of the switchgear, facility to enable busbar or cable to be earthed through circuit breakers, terminal arrangements for multi-core cables, busbar end covers or link to adjacent switchgear panel as appropriate.

1.2.2.2.3. 04 Nos. of 36kV Feeder bays each comprising:-

- 1 Set - 2500 A, 36 kV, 25 kA three phase busbars
- 1 No. - 1250 A, 36 kV, 25 kA three phase busbar disconnector integral with earth switch complete with motor operating mechanism.
- 1 No. - 1250 A, 36 kV, 25 kA three phase circuit breaker complete with operating mechanism
- 3 Nos. - 36 kV current transformers with cores as follows;
Class 5P20, 400/1A for over current and earth fault protection.
Class 0.2, 400/1A for Energy metering system.
- 3 Nos. - 36 kV single phase voltage transformers with cores as follows:-
33,000/ $\sqrt{3}$ V: 110/ $\sqrt{3}$ V: 110/ $\sqrt{3}$ V, Class 3P for Protection and Class 0.2 for Metering.
- 1 Lot - Cable terminating chamber (cone) complete with cable box, sealing ends or terminal arrangement of 36 kV cables including dummy plugs and cable supports.
- 1 Lot - Complete set of miscellaneous items required for safe and efficient operation of the switchgear, facility to enable busbar or cable to be earthed through circuit breakers, terminal arrangements for multi-core cables, busbar end covers or link to adjacent switchgear panel as appropriate.

1.2.2.2.4. 01 No. 36kV Bus Section Bay comprising:-

- 1 Set - 2500 A, 36 kV, 25 kA three phase busbars

- 2 Nos. - 2500 A, 36 kV, 25 kA three phase busbar disconnecter integral with earth switch complete with motor operating mechanism.
- 1 No. - 2500 A, 36 kV, 25 kA three phase circuit breaker complete with operating mechanism.
- 3 Nos. - 36kV Current Transformers with cores as follows:-
Class 5P20, ratio 2500/1A for over current and earth fault protection and for metering with interposing current transformer.
- 1 Lot - Complete set of miscellaneous items required for safe and efficient operation of the switchgear, facility to enable busbar or cable to be earthed through circuit breakers, busbar end covers or link to adjacent switchgear panel as appropriate.

1.2.2.2.5. 02 No. 36kV GIS Voltage transformer comprising:-

- 3 Nos. - 36 kV single phase voltage transformers with cores as follows:-
33,000/ $\sqrt{3}$ V:110/ $\sqrt{3}$ V:110/ $\sqrt{3}$: 110/ $\sqrt{3}$ V Class 3P for protection, Class 3P for protection and Class 0.2 for metering.

1.2.2.3. MODIFICATION OF LVAC SWITCHBOARDS

The existing 400V switchboards shall be modified to accommodate the requirements of the scope.

1.2.2.4. BATTERIES, CHARGERS, DISTRIBUTION BOARDS & INVERTER EQUIPMENT

Existing substation battery system complete with chargers shall be replaced with new battery banks and chargers to cater entire DC load of the Pannala Grid Substation. The main switchboard shall be modified to accommodate the load of the proposed modifications. The 110V DC system shall supply the following loads:-

- (i) 145kV and 36kV switchgear standing loads of control, protection and alarms as dictated by the equipment offered on other Chapters.
- (ii) SAS Inverter supply.
- (iii) Emergency building lighting of 1kW loading for 8 hours.
- (iv) SCADA and Communication system.
- (v) After supply of the above coincident loads for a period of 8 hours, the battery shall be capable of two closing and two tripping operations of each circuit breaker within the substation.
- (vi) 20% Design margin shall be kept for future loads

1.2.2.4.1. 110V Battery System comprising: -

- 2 Nos. - 110V Ni-Cd battery banks with the minimum capacity of 350Ah (For bidding purposes only. Actual capacity shall be calculated at detail design stage) in each.
- 2 Sets - Charging equipment with automatic switch-over function.
- 1 No. - Selector switch for Chargers 1 and 2.
- 1 Lot - Required modifications to the 110V DC distribution board.
- 1 Lot - Set of miscellaneous items.

Other circuits as may be required for the equipment.

1.2.2.4.2. Inverter System for Substation Automation System

- 2 Sets - Inverters with automatic load transfer facility by means of automatic transfer system, instrument and alarms described in Technical Specification. (20% of spare capacity shall be provided in each inverter system). (The existing inverter shall be replaced with this inverter panel)

1.2.2.4.3. Positive Grounded 48V DC System for SCADA and Communication Equipment Comprising

- 2 Nos. - Galvanically Isolated DC-DC converters (110V DC to 48V DC, 20A each)
- 1 Lot - Required modifications to 48V DC distribution board

1.2.2.5. PROTECTION, METERING, MONITORING AND CONTROL**1.2.2.5.1. Substation Automation System:-**

Substation Automation System Unit of Control & Protection – Transmission, CEB will carry out integration work of new control & protection IEDs, Ethernet Switches and AVR's to existing Substation Automation Systems at Pannala Grid Substation. However, if required, the Contractor shall undertake the integration work of new control and protection IEDs, Ethernet Switches and AVR's to existing SAS subjected to approval of employer.

After the integration work, the integrated signals shall be tested up to SAS from the field by the contractor.

Control & Protection IEDs and AVR's which will be supplied for Pannala GSS shall be compatible with IEC 61850 protocol. The bidder shall submit IEC 61850 conformance certificate issued by an independent laboratory empowered by UCA International Users Group tested according to the IEC 61850-10 for the Control & Protection IEDs and AVR's.

New control & protection IEDs and AVR's should be connected to existing IEC 61850 SAS communication network using protected multimode fiber optic cables. IEC 61850 SAS

communication network shall be extended using Ethernet Switches which support existing RSTP redundant protocol. Ethernet switches which will be supplied shall be compatible with SNMP V1, V2, V3 or IEC 61850. Configuration software and relevant files of Ethernet Switches shall be delivered to CEB.

Bidder should provide high quality ICD and CID files of new control & protection IEDs and AVRs along with the relevant IED software with license to CEB in advance to carry out SAS modification work. Supplied AVR shall be IEC 61850 compatible and it shall be possible to integrate all its functions to IEC 61850 SAS.

1.2.2.5.2. 145kV Protection & Control facilities:-

The new 145kV bay should be integrated to the existing busbar and breaker failure protection schemes by providing all necessary relays and protection modules. Protection and controls shall be provided in separate independent IEDs.

1.2.2.5.2.1. For 01 No. 145kV Transformer comprising with:-

Protection and control panel and Mechanical protection and control panel shall be provided as per clauses 5.12 and 5.25 of Technical Specifications.

(a) Protection and Control panel with IEDs

Protection and control panel with HV main 1 and main 2 IEDs with functions listed in 5.12.1 of Technical Specifications and other required accessories as per Chapter 5 of Technical Specifications shall be provided.

Busbar and breaker failure protection bay IED shall also be provided on this protection and control panel.

(b) Mechanical Protection and Control Panel

Mechanical protection and control panel with relays, AVRs and accessories as per clauses 5.12 and 5.25 of technical specifications shall be provided.

(c) 01 No. Ethernet Switch

145 kV Transformer Control and Protection Panel shall consist of Ethernet Switch to connect followings through fiber optics.

1. Main 1 Protection and Bay Controlling IED
2. Main 2 Protection and Bay Controlling IED
3. AVR
4. IO Box for Transformer Mechanical Protection

Ethernet Switch shall be compatible with existing RSTP redundant protocol MOXA Turbo Ring and shall be connected to existing Ethernet Switches E07 MOXA EDS-508A-MM-SC and H12 MOXA EDS-508A-MM-SC using protected multimode fiber optics with SC type connectors to maintain IEC 61850 SAS communication network.

1.2.2.5.3. 36kV Protection & Control facilities:-

(Relays shall be installed in 36kV switchgear compartment).

(a) 04 Nos. Ethernet Switches

These Ethernet Switches shall be installed in 36kV switchgear compartment or separate wall mounted Patch Panel to connect new 36 kV Protection and Control IEDs through fiber optics.

Ethernet Switches shall be compatible with existing RSTP redundant protocol MOXA Turbo Ring and shall be connected to existing Ethernet Switches as tabulated below using protected multimode fiber optics with SC type connectors to maintain IEC 61850 SAS communication network.

Ethernet Switch No	IEDs to be connected	Ethernet Switches to be connected
1	01 No. Protection and Control IED for 36kV Transformer bay 01 No. Protection and Control IED for 36kV Bus section bay 01 Nos. Protection and Control IED for 36kV Generator feeder	Existing Switch H09 MOXA EDS-508A-MM-SC New 36 kV Ethernet Switch No. 2
2	02 Nos. Protection and Control IEDs for 36kV feeders for outgoing lines 01 Nos. Protection and Control IED for 36kV Generator feeder	New 36 kV Ethernet Switch No. 1 New 36 kV Ethernet Switch No. 3
3	01 No. Protection and Control IED for 36kV Transformer bay 01 Nos. Protection and Control IED for 36kV Generator feeder	New 36 kV Ethernet Switch No. 2 New 36 kV Ethernet Switch No. 4
4	02 Nos. Protection and Control IEDs for 36kV feeders for outgoing lines 01 Nos. Protection and Control IED for 36kV Generator feeder	New 36 kV Ethernet Switch No. 3 Existing Switch SCS 3 MOXA EDS-508A-MM-SC

1.2.2.5.3.1. For 04 Nos. 36kV feeders for outgoing lines each comprising with:-

IEDs shall be provided as per the requirements given in Chapter 5 of Technical Specification -Grid Substation for following functions.

- | | |
|------------------------------------|---------------------------------|
| Clause 5.11.1.1, 5.11.4 | - 36kV Overhead Line Protection |
| Clause 5.11.4.5 | - 36kV Auto-Reclosing |
| Clause 5.19 | - Trip circuit supervision |
| Clause 5.6, 5.7, 5.8.2.3, 5.12.2.2 | - Control IED'S on 36kV level |

1.2.2.5.3.2. For 02 No. 36kV Transformer bays each comprising with:-

IEDs shall be provided as per the requirements given in Chapter 5 of Technical Specification -Grid Substation for following functions.

- | | |
|-------------------------------|---|
| Clause 5.12.2 | - Directional and Non-directional Over current protection for LV side |
| | - Directional and Non-directional Residual Earth fault protection for LV side |
| | - BCU function for LV side |
| | - Synchronism Check function for the LV side |
| | - Monitoring of Lockout relay |
| Clause 5.18 | - Trip circuit supervision |
| Clause 5.22.2 | - Synchrocheck & Synchronizing |
| Clause 5.8.1 and clause 5.8.2 | - Control IED'S on 36kV level |

1.2.2.5.3.3. For 04 Nos.36kV Generator feeder comprising with:-

IEDs shall be provided as per the requirements given in Chapter 5 of Technical Specification -Grid Substation for following functions.

- | | |
|------------------------------------|-------------------------------|
| .Clause 5.11.1.1, 5.11.4 | 36kV Overhead Line Protection |
| Clause 5.11.4.5 | - 36kV Auto-Reclosing |
| Clause 5.19 | - Trip circuit supervision |
| Clause 5.6, 5.7, 5.8.2.3, 5.12.2.2 | - Control IED'S on 36kV level |

1.2.2.5.3.4. For 01 No. 36kV Bus section bay comprising with:-

IEDs shall be provided as per the requirements given in Chapter 5 of Technical Specification -Grid Substation for following functions.

- | | |
|------------------------------------|---|
| Clause 5.15 | - 36kV Bus couple/ sectionalizer Over current, Earth fault Protection |
| Clause 5.19 | - Trip circuit supervision |
| Clause 5.8.5 | - Synchro-check & Synchronizing |
| Clause 5.6, 5.7, 5.8.2.3, 5.12.2.2 | - Control IED'S on 36kV level |

1.2.2.5.3.5. 36kV frequency & voltage relays to install in above Bus Section bay comprising with:-

- (a) Bus section bay IEDs shall be provided with following functions as per requirements given in chapter 5 of Technical Specification - Grid Substation.

Clause 5.15.3 - 02 sets of 36kV Bus section frequency & voltage relays to cover two busbar sections.

- Voltage selection scheme.

A Voltage selection scheme shall be provided to give correct Bus section Voltage to above voltage and frequency relays.

1.2.2.5.4. Energy Metering panels comprising with:-

Energy Metering Panels with 18 nos. energy meters as specified in Chapter 9 of Technical Specification - Grid Substation for 36kV feeders and transformer feeders.

- 02 Nos. : Transformer Energy Measurement
- 08 No. : Transco Energy meters for 08 outgoing Feeders
- 08 No. : Disco Energy meters for 08 outgoing feeders

1.2.2.6. COMMUNICATION EQUIPMENT AND SCADA GATEWAYS/RTUs

1.2.2.6.1. Following modules shall be provided for existing fiber optic multiplexer of type FOX 515

- 01 No. : CPU module (with 32MB memory)
- 01 No. : Power supply module
- 01 No. : Module with 04 numbers of Data ports for SCADA (V.24, V.28) for IEC 101 SCADA
- 01 No. : Module with minimum 08 numbers of Ethernet ports with L2 Switching and VLAN facility (100/1000 Base T) and minimum 04 nos. GbE/10 GbE, SFP based ports
- 01 No. : Module with minimum 04 numbers of Ethernet ports with L2- switching, also configurable for VLAN and L3- routing facility (10/100 Mbps)
- 01 No. : Module SDH to PDH converter (2MB x 8)
- 01 No. : Module with 16 Nos. FXS ports

Installation and configuration of these modules to the existing fiber optic multiplexer will be carry out by CEB.

1.2.2.6.2. Required SCADA for Pannala Grid Substation

Two separate Ethernet interface modules for IEC60870-5-104 protocol with required license for the existing Gateway shall be provided by the contractor. The Contractor shall provide high quality ICD and CID files of new control & protection IEDs and the relevant IED software with license and the required licenses for upgrading the gateway to CEB in order to carry out Gateway modification work.

All new signals (Analog Measurements, Station Controls, Events and Alarms) shall be made available to the existing gateway according to the Annex A.

After the integration work, the integrated signals shall be tested from the field by the contractor.

The Gateway/RTU configuration parameters of signals are given in Annex B.

The Communication path configuration for Gateway is given in Annex C.

The point to point test SCADA commissioning signal list format is given in Annex D.

1.2.2.6.3. Integration of SCADA for Pannala Grid Substation

The integration work of new control and protection IEDs to existing Gateway at Pannala Grid Substation will carry out by CEB. However, if required, the Contractor shall undertake the integration work of new control and protection IEDs, Ethernet Switches and AVRs to existing Gateway subjected to the approval of employer.

1.2.2.7. MODIFICATION OF SUBSTATION EARTHING

The existing substation earthing system shall be modified to accommodate the augmentation works as per the requirements stated in Chapter 7 of the Technical Specification – Grid Substation. This shall include additional earth materials if required to reach the specified value of earth resistance.

1.2.2.8. MODIFICATION OF LIGHTNING PROTECTION SYSTEM COMPRISING:-

Design and erection of lightning protection system with earth wires in the area which covers the augmentation works.

1.2.2.9. MODIFICATION OF GROUNDING SYSTEM COMPRISING:-

Grounding system including connections of all steel structures and electrical apparatus which comes under this augmentation work to earth mesh and grounding electrodes.

1.2.2.10. POWER AND CONTROL CABLES

1.2.2.10.1. 36kV Power cables and terminations

New 36kV power cables shall be provided and installed as follows.

- 01 Lot - The **existing** 36kV power cable from Power Transformer No. 03 to existing GIS panel shall be re-routed from Power Transformer No.03 to relevant GIS panel of the new 36kV indoor switchgear. Required cable termination and accessories shall be provided.
- 01 Lot - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connection from Power transformer No. 03 to new 36kV indoor switchgear and termination accessories. (Subjected to employer's approval)
- 01 Lot - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connection from Power transformer No. 04 to new 36kV indoor switchgear and termination accessories.
- 04 Lots - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connections from switchgear panels to outdoor gantries for Line feeders and termination accessories.
- 04 Lot - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connections from switchgear panels to outdoor gantries for Generator feeders and termination accessories.
- 01 Lot - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connections from Power transformer No. 04 to Earthing Transformer (ET 4) and termination accessories.

1.2.2.10.2. All low voltage AC power cables and terminations

1.2.2.10.3. All DC power and control cables and terminations

1.2.2.10.4. All cables required for protection, control, instrumentation, communication, SCADA and termination.

1.2.2.10.5. All cables required for station lighting, small power, fire protection, ventilation equipment.

The Contractor shall be responsible for the supply, installation, termination and testing of all cables for the execution of the works.

The Contractor is on a turnkey basis and the prices for Definite Works entered by the Bidder in Schedule of Rates & Prices shall only be varied if the Contract requirements are altered, up

or down. For the purpose of such variations, the rates shall be those in Schedule of Prices & Rates.

The rates for supply and installation shall be those appropriate to order of drum lengths as appropriate to each type and rating of cable.

The cable installation rates shall include excavation, backfilling and reinstatement of the ground, installation in concrete trenches and ducts and fixing to cable tracks and supports as necessary.

Control and power cables shall be armoured and they shall be laid in concrete trenches, in the switchyard and within the buildings, they shall be cleated to cable trays. Cable trays and supports shall be supplied and installed in accordance with the Specification and included in the prices for Definite Work in Schedule of Prices & Rates.

1.2.2.11. TRANSFORMERS

Following transformers as specified in Chapter 10 of Technical Specification - Grid Substation.

Item	Description	Qty	Voltage	Rating	Cooling
1.	Power T/F	3	132/33kV	31.5MVA	ONAN/ONAF
2.	Earthing T/F	1	33kV	800A, 30s	ONAN

Note:

- The above 132/33kV power transformer shall be capable of parallel operation with the existing power transformer no. 03.
- 145kV & 36kV sides of Power transformers, 36kV sides of Earthing transformer shall be supplied with outdoor type bushings.

1.2.2.12. SUPPORTING STRUCTURES INCLUDING GANTRIES

All support structures necessary for the works and all terminating lines specified under the Employer's Requirements shall be provided by the Contractor. Materials used for the structures shall comply with the Technical Specification – Grid Substation.

1.2.2.13. MARSHALLING KIOSK

Marshalling kiosks shall be provided and wired where necessary. (i.e. shall be fabricated with higher grade of stainless steel or galvanized steel with protective coating).

1.2.2.14. SITE CLEARING AND HANDING OVER REMOVED ITEMS

After completing the project the site shall be cleaned and the removed items/equipment shall be handed over and delivered according to the instructions of the employer.

1.2.2.15. MISCELLANEOUS WORKS

Any work other than listed above.

1.2.2.16. SPARE PARTS

All necessary Spare parts.

1.2.2.17. TOOLS AND INSTRUMENTS

As per the price schedule.

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1.3. CIVIL WORKS, INSTALLATION, OTHER SERVICES AND TRAINING

1.3.1. CIVIL WORKS

1.3.1.1. AMBALANGODA GRID SUBSTATION

1.3.1.1.1. Preliminary Works

(a) Site Survey

- As per chapter 13 of Technical Specification - Grid Substation.

(b) Sub Soil Investigations

- As per chapter 13 of Technical Specification - Grid Substation.

1.3.1.1.2. Site Clearing

- (a) Temporarily removing existing surface chipping where necessary and after completion of erection of structures the area shall be completely surface chipped.

- (b) Removing shrubs and boulders.

- (c) Removing existing chain link fence and drain to accommodate space for new indoor switchgear room and gate of the new approach road as shown in the drawing no. TD/CE/1/185/D/01/01.

1.3.1.1.3. Site formation and up keeping

(a) Surface Chipping

- Fill up the surface chipping where temporarily removed

(b) Anti-Termite soil treatment

- Anti termite treatment with more than 10 years guaranty shall be done for the new building area for 36kV switchgear room, passage between new and existing switchgear rooms and site office area.

1.3.1.1.4. Cable trenches & ducts

- Cable trench shall be constructed between two switchgear rooms and from new switchgear room to the new 33kV Gantry as shown in drawing no. TD/CE/1/185/D/01/02, as per chapter 13 of Technical Specification - Grid Substation.
- Provision shall be made for future cables.

1.3.1.1.5. Foundations

- (a) For take-off structures & switchgear
 - As required for all the equipment support structures.
- (a) For Main transformer and concrete firewall
 - 01 No. Power transformer and firewall
- (b) (Power transformer foundation shall be design and constructed to accommodate a 45MVA power transformer in future. The minimum weight of a 45MVA transformer with oil shall be considered as 110,000 kilograms and the minimum oil volume shall be considered as 30,000 litres.)
- (c) For Earthing transformers and NCT
 - 01 No. Earthing transformer.

1.3.1.1.6. Modification of lightning protection system

As per chapter 13 of Technical Specification - Grid Substation.

1.3.1.1.7. Water supply & drainage system

Modifications to existing surface water drainage system as required as per the specification and drawing no. TD/CE/1/185/D/01/01.

1.3.1.1.8. Maintenance of roads

Damaged access roads shall be repaired and re-surfaced as per the chapter 13 of Technical Specification - Grid Substation.

1.3.1.1.9. Fence, gates and boundary walls

- (a) Construction of chain link fence at new indoor switchgear room and connect to the existing chain link fence as per drawing no. TD/CE/1/185/D/01/01.
- For details of fence refer drawings for fence and gates (TD/CE/1/185/D/60/00-03).

- (b) Required modifications of Barbed wire fence at new indoor switchgear room.

1.3.1.1.10. Construction of control & other buildings

- (a) Construction of new building to accommodate new 36kV Indoor switchgear panels
- (b) Construction of sheltered passage between existing switchgear room and new switchgear room as shown in the layout drawing (drawing no.TD/CE/1/185/D/01/01).
- (c) Required modification to existing control building including new entrance to passage.
- (d) Site Office at Ambalangoda GSS
 - Temporary Building (Container Type)
- (e) Temporary Works (Stores, access, contractor's offices etc)

1.3.1.1.11. Construction of building Services

The following shall be constructed for new switchgear room.

- (a) Air conditioning & ventilation system
 - Refer chapter 13 of Technical Specification - Grid Substation.
- (b) Fire protection
 - Refer chapter 13 of Technical Specification - Grid Substation.
- (c) Internal Lighting & small power supply services.
 - Refer chapter 13 of Technical Specification - Grid Substation

1.3.1.1.12. Miscellaneous works

- Any work other than listed above.

1.3.1.2. PANNALA GRID SUBSTATION

1.3.1.2.1. Preliminary works

- (a) Site Survey
 - As per chapter 13 of Technical Specification - Grid Substation.
- (b) Sub Soil Investigations
 - As per chapter 13 of Technical Specification - Grid Substation.

1.3.1.2.2. Site clearing

- (a) Temporarily removing existing surface chipping where necessary and after completion of erection of structures the area shall be completely surface chipped.
- (b) Removing shrubs and boulders.
- (c) Relocating existing water tank at the existing site office and required modifications to the existing tube well. (The tube well shall be relocated if necessary.)
- (d) Removing the chain link fence to accommodate new gate

1.3.1.2.3. Site formation and up keeping

- (a) Cutting and filling earth.
 - Formation level shall be equal to the existing substation level.
- (b) Earth retaining structures
 - Earth retaining walls
 - Adequate erosion protection (retaining wall for the boundary)
 - All the embankments shall be protected as per specifications and drawings.
- (c) Rubble pitching work
- (d) Anti-Termite soil treatment
 - Anti termite treatment with more than 10 years guaranty shall be done for the control building area and site office area.
- (e) Surface Chipping
 - Area covered by the earth mat.

1.3.1.2.4. Cable Trenches & Ducts

- Cable trench shall be constructed between two switchgear rooms and from new switchgear room to the new 33kV Gantry as shown in drawing no. TD/CE/1/185/D/01/02, as per chapter 13 of Technical Specification - Grid Substation.

- Extension to cable trenches and ducts as required with necessary road modifications.
- Necessary modifications existing cable trenches to accommodate power cables from transformer no.04.
- Provision shall be made for future cables.
- Access Road loading shall be considered in designing cable trenches.

1.3.1.2.5. Foundations

(b) For take-off structures & switchgear

- As required for all the equipment support structures.

(c) For Main transformer and concrete firewall

- 01 No. Power transformer and firewall

(Power transformer foundation shall be design and constructed to accommodate a 45MVA power transformer in future. The minimum weight of a 45MVA transformer with oil shall be considered as 110,000 kilograms and the minimum oil volume shall be considered as 30,000 litres.)

(d) For Earthing transformers

- 01 No. Earthing transformers.

1.3.1.2.6. Lightning protection system

As per chapter 13 of Technical Specification- Grid Substation.

1.3.1.2.7. Water supply & drainage system

Modifications to existing surface water drainage system as required as per the specification and drawing no.TD/CE/1/185/D/01/02.

1.3.1.2.8. Construction & Maintenance of Roads

- (a) Access road to new GIS building as per the drawing, General Layout for Pannala GSS as per the chapter 13 of Technical Specification - Grid Substation.
- (b) Damaged access roads shall be repaired and re-surfaced as per the chapter 13 of Technical Specification - Grid Substation.
- (c) Construction of box culvert at the new gate.

1.3.1.2.9. Fence, Gates and Boundary Walls

- (a) Chain link fence

-For details refer drawing no. TD/CE/1/185/D/01/02. (TD/CE/1/185/D/60/00-01).

(b) Gate for maintenance entrance

-The gate is only for entrance of maintenance vehicle, without man access.

-For details refer drawing no. TD/CE/1/185/D/01/02. (TD/CE/1/185/D/60/00-04).

1.3.1.2.10. Construction of control & other buildings

(a) New 33kV Indoor Switchgear room as indicated in drawing.

(b) Construction of sheltered passage between existing switchgear room and new switchgear room as shown in the layout drawing (drawing no. TD/CE/1/185/D/01/02).

(c) Required modification to existing control building including new entrance to passage.

(d) Site Office at Pannala GSS

- Temporary Building (Container Type)

(e) Temporary Works (Stores, access, contractor's offices etc.)

1.3.1.2.11. Construction of building services

The following shall be constructed for new switchgear room.

(a) Air conditioning & ventilation system

- Refer chapter 13 of Technical Specification - Grid Substation.

(b) Fire protection

- Refer chapter 13 of Technical Specification - Grid Substation.

(c) Internal Lighting & small power supply services.

- Refer chapter 13 of Technical Specification - Grid Substation

1.3.1.2.12. Miscellaneous Works

Any work other than listed above.

1.3.2. INSTALLATION

Erection, Installation and commissioning of structures Plant & Equipment specified in the clause 1.2 of Employer's Requirements.

- (a) Ambalangoda Grid Substation
- (b) Pannala Grid Substation

1.3.3. OTHER SERVICES

1.3.3.1. Transport

Transport for employer's representative should be provided as per Chapter 14 of Technical Specification – Grid Substation.

- (a) Four Wheel Drive Double Cabs: 03 Nos.
(Mileage to be covered is 2500km per month per vehicle.)

1.3.3.2. Engineers' Living Accommodation

Engineers living accommodation should be provided for the following sites as per clause 14.1.2 of Technical Specifications-Grid Substations.

- (a) Ambalangoda 132/33kV Grid Substation
- (b) Pannala 132/33kV Grid Substation

The contractor shall provide a fully furnished rented house/building with minimum 03 bed rooms with other facilities, located near sites of each substation from the contract commencement date.

Further the contractor has to maintain the premises including the caretaker facility until completion of the project and handover to CEB.

1.3.4. TRAINING

The contractor shall provide the following training modules as specified in clause 14.2 of Technical Specification – Grid Substation;

- One week training for 02 Electrical Engineers covering the Training Module given in 14.2.5: 33kV and 11kV GIS Indoor Switchgear.
- One week training for 02 Electrical Engineers covering the Training Module given in 14.2.15: Grid Substation Primary Equipment handling.
- A local training shall be provided to 10 Engineers and 10 Electrical Superintendents as per the clause 14.2.14: Operators Training, by a competent person.
- A local training of two weeks shall be provided to 12 Engineers covering the Training Module given in 14.2.6 Substation Automation and 14.2.12: Gateway/SAS

Interfacing for SCADA Transmission, by a competent person from OEM. However, the following items shall be covered under the training program.

SICAM RTUS & OPM II COMBI-TRAINING

- SICAM RTUs product family in an overview
- Features of AK 1703 ACP
- Operation - from data acquisition to data output
- Configuration and engineering based on pre-configured templates
- Communication with other components
- Addressing concept (IEC 60870)
- Automatic dataflow mapping
- Creation of process variables and preparation for usage in functional plans
- Parameterization of SICAM RTUs communication with other units or the control center 250 SCALA
- Diagnosis and test
- Possibilities for test and simulation with the TOOLBOX II
- Parameter administration with the TOOLBOX II: Import/Export/Backup
- OPM II feature list – overview
- signal-oriented engineering with the OPM II
- Working with predefined OPM II libraries
- Handling large amounts of data with the OPM II
- Reuse of existing project data with the OPM II
- Use of formulas and references
- Data import and export
- Creation of higher aggregated objects in the OPM II
- Overview Parameter of OPM II handling for control center systems
- Practical exercises with TOOLBOX II and OPM II on the example of an AK 1703 ACP

CAEX PLUS FOR SICAM RTUS

- Overview of the standard IEC 61131
- Handling of the functional component language CAEx plus
- Create and structuring of a control task
- Loading to the target system SICAM RTUs
- Application of the test options (OFFLINE, ONLINE oscilloscope)
- Create a documentation with CAEx plus
- Practical exercises

250 SCALA OPERATION & ENGINEERING

- Operation
- Creating pictures
- Creating process variables
- Object orientated parameterization of picture elements
- Alarms
- Reports and logs
- Graphs: function and operation
- Data security
- Interfacing with MS Excel
- Configurations
- Short overview of more complex functions
- Practical exercises

IEC 61850 Handling / Overview & Workflow

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Annex A

Ambalangoda GS		TYPE OF SIGNAL	VOLTAGE	132/33 kV T/F 3		33 kV						
			BAY No									
			BAY TYPE	132 kV side	33 kV side	F6	Gen F1	F7	F8	F9	BS	BB 3
CONTROLS			ACTION									
Circuit Breaker 01		DPC	Open/ Close	2	2	2	2	2	2	2	2	
Circuit Breaker 02											2	
BB Isolator 1		DPC	Open/ Close	2	2	2	2	2	2	2	2	
BB Isolator 2		DPC	Open/ Close								2	
Line Isolator		DPC	Open/ Close									
Capacitor Bay Isolators		DPC	Open/ Close									
Earth Switch		DPC	Open/ Close									
Tap Changer (AVR) Raise / Lower		DPC	Raise/ Lower	2								
Tap Changer (AVR) Auto / Manual		DPC	Auto /Manual	2								
AVR Operating mode (One of the 2 modes will be available)		DPC	Master/ Follower	2								
		DPC	Minimum Circulation Current									
AVR Independent / Parallel		SPC	Independent/ Parallel	1								
Protection Master Relay Reset /(Protection Reset Command K86.1) (/Lockout Relay Reset)		SPC	Reset	1	1						1	

Protection Master relay Reset Command K86.2		SPC	Reset	1	1							1	
Protection Reset Command K96 (BB/BCF relay Reset)		SPC	Reset	1	1							1	
Load Shedding OFF		SPC	On/Off										
STATUS INDICATIONS			STATUS										
Circuit Breaker		DPI	Open/ Close	2	2	2	2	2	2	2	2	2	
BB Isolator 1		DPI	Open/ Close	2	2	2	2	2	2	2	2	2	
BB Isolator 2		DPI	Open/ Close									2	
Line Isolator		DPI	Open/ Close										
Capacitor Bay Isolator		DPI	Open/ Close										
Earthing Switch		DPI	Open/ Close		2	2	2	2	2	2	2	4	
Bay Control		DPI	Local/ Superv/ Remote	2	2	2	2	2	2	2	2	2	
TRANSFORMER													
Tap Control		SPI	Local/ Superv	1									
T/F AVR Operating mode		SPI	Manual /Auto	1									
T/F AVR Operating mode (One of the 2 modes will be available)		SPI	Master/ Follower	1									
		SPI	Minimum Circulation Current										
AVR Parallel / Independent		SPI	Parallel/ Independent	1									
Capacitor Bank													
Capacitor Bank Operating Mode		SPI	Manual /Auto										
A L A R M INDICATIONS													
CIRCUIT BREAKER													

Breaker Fault (critical) - ***		SPI	Healthy/ Faulty	1	1	1	1	1	1	1	1	1	
a	SF6 Gas Pressure low. (2nd stage)												
b	Trip Circuit Supervision Fail 1 (Trip circuit faulty)												
c	Trip Circuit Supervision Fail 2 ((Trip circuit 2 faulty)												
d	Spring Not Charge (Spring Supervision)												
e	Hydraulic Pressure Low												
f	Pneumatic Pressure Low.												
g	CB Pole Discrepancy												
h	Trip Lockout/Close Lockout (SF6 Lock out)												
i	Control Voltage Failure (DC MCB trip)												
j	Internal Arc trip												
h	SF6 Gas Pressure low in Bus Bar Chamber												
Bay Fault (Non critical) - ***		SPI	Healthy/ Faulty	1	1	1	1	1	1	1	1	1	
a	SF6 Gas Pressure Low - First step												
b	PT Secondary MCB Trip (Protection VT MCB Failed/ Incoming Voltage MCB trip/ VT MCB trip)												
c	AC/DC Voltage Failure Indication (Auxiliary Fail)												
TRANSFORMER MECHANICAL PROTECTION													
Tap Changer Mechanism Fault (OLTC failure)		SPI	Healthy/ Faulty	1	1								
Tap out of step (TAP OUT ERROR)		SPI	Onset/ Reset	1	1								
Transf Buchholz Alarm - ***		SPI	Onset/ Reset	1	1								
a	Transf Buchholz Alarm												
b	OLTC Buchholz Alarm												

Transf Buchholz Trip		SPI	Operated/Normal	1	1														
OLTC Buchholz Trip (OLTC OIL Flow Relay Trip)		SPI	Operated/Normal	1	1														
ET Transf Buchholz Trip		SPI	Operated/Normal	1	1														
AT Transf Buchholz Trip		SPI	Operated/Normal	1	1														
Temperature Alarm - ***		SPI	Onset/ Reset	1	1														
a	Oil Temperature Alarm																		
b	Winding HV Temperature Alarm																		
c	Winding LV Temperature Alarm																		
Temperature trip - ***		SPI	Operated/Normal	1	1														
a	Oil Temperature trip																		
b	Winding HV Temperature trip																		
c	Winding LV Temperature trip																		
General Alarm - ***		SPI	Onset/ Reset	1	1														
a	Cooling Fan Fail (Group 1/Group 2)																		
b	Transformer Oil Level low																		
c	OLTC Oil level low																		
General Trip - ***		SPI	Operated/Normal	1	1														
a	OLTC Surge Trip																		
b	Main tank Pressure Release Valve (PRV) Trip																		
c	OLTC Pressure Release Valve																		
d	Transformer Oil Level low TRIP																		
e	OLTC Oil level low																		
PROTECTION SIGNALS																			
LINE PROTECTION																			

Main 1 - Differential protection operated		SPI	Operated /Normal										
Main 1 - Distance Zone 1 operated		SPI	Operated /Normal										
Main 1 - Distance Zone 2 operated		SPI	Operated /Normal										
Main 1 - Distance Zone 3 operated		SPI	Operated /Normal										
Main 1 - Distance Zone 4 operated		SPI	Operated /Normal										
Main 1 -Distance protection operated		SPI	Operated /Normal										
Main 1 - Directional Earth Fault operated		SPI	Operated /Normal										
Main 1 - Distance Protection Aided Trip		SPI	Operated /Normal										
Main 2- Differential protection operated		SPI	Operated /Normal										
Main 2 - Distance Zone 1 operated		SPI	Operated /Normal										
Main 2 - Distance Zone 2 operated		SPI	Operated /Normal										
Main 2 - Distance Zone 3 operated		SPI	Operated /Normal										
Main 2 - Distance Zone 4 operated		SPI	Operated /Normal										
Main 2 - Distance protection operated		SPI	Operated /Normal										
Main 2 - Directional Earth Fault operated		SPI	Operated /Normal										
Main 2 - Distance Protection Aided Trip		SPI	Operated /Normal										
Over Current Protection trip		SPI	Operated /Normal				1	1	1	1	1	1	

Earth Fault Protection Operated		SPI	Operated /Normal			1	1	1	1	1	1	
Pole Discrepancy Protection Operated		SPI	Operated /Normal									
Auto Recloser Operated / Success / Progress		SPI	Operated /Normal									
Direct Intertrip Send		SPI	Operated /Normal									
Direct Intertrip Received		SPI	Operated /Normal									
Permissive Intertrip Send (carrier send)		SPI	Operated /Normal									
Permissive Intertrip Received (carrier receive)		SPI	Operated /Normal									
DEF Protection carrier Send		SPI	Operated /Normal									
DEF Protection carrier Receive		SPI	Operated /Normal									
Distance Protection Block		SPI	Operated /Normal									
Communication Fail (Differential block)		SPI	Operated /Normal									
Switch On To Fault trip (SOTF trip)		SPI	Operated /Normal									
Over Voltage trip (OV)		SPI	Operated /Normal									
Breaker Failure Protection Operated		SPI	Operated /Normal	1	1	1	1	1	1	1	1	
Trip Relay Operated/ Protection Relay K86.1 /Lockout Relay operated		SPI	Set/Reset	1	1	1	1	1	1	1	1	
Trip Relay Operated/Protection Relay K86.2		SPI	Set/Reset	1							1	
Protection Relay K96		SPI	Set/Reset								1	
Under Frequency Trip		SPI	Operated /Normal			1	1	1	1	1		

Over Frequency Trip		SPI	Operated /Normal			1	1	1	1	1			
Main 1 Protection Relay Fail		SPI	Healthy/ Fail	1								1	
Main 2 Protection Relay Fail		SPI	Healthy/ Fail	1									
Back Up Protection Relay Fail		SPI	Healthy/ Fail	1								1	
Auto Relclose ON/OFF		SPI	ON / OFF										
33kV protection Operated		SPI	Operated /Normal			1	1	1	1	1			
BUSBAR PROTECTION													
Bus Bar Protection Operated		SPI	Operated /Normal	1								1	
TRANSFORMER PROTECTION													
Differential Protection Operated		SPI	Operated /Normal	1									
HV Restricted Earth Fault		SPI	Operated /Normal	1									
LV Restricted Earth Fault		SPI	Operated /Normal	1									
Transformer earth Fault Protection Operated		SPI	Operated /Normal	1	1								
Transformer Stand By EF Protection Operated		SPI	Operated /Normal	1	1								
Transformer Over Current Protection trip (OCProtection I>trip)		SPI	Operated /Normal	1	1								
Over Voltage Protection		SPI	Operated /Normal	1									
Over Fluxing Protection		SPI	Operated /Normal	1									
T/F Thermal Overload		SPI	Operated /Normal	1									

CAPACITOR BANK																	
Phase OverVoltage Operated		SPI	Operated /Normal														
STATION ALARMS																	
Under Frequency Load Shedding Operated		SPI	Operated/Normal			1	1	1	1	1							
Bus Voltage Failure - ***		SPI	Healthy/ Faulty														
a	Auxialary Supply Voltage	SPI	Healthy/ Faulty														
b	DC Voltage Failure (110V DC MCB Trip)	SPI	Healthy/ Faulty														
Gateway Alarm(Running A/Running B)		SPI	Healthy/ Faulty														
Communication Alarm (Communication Malfuntion)		SPI	Healthy/ Faulty														
Battery Charger Failure (Communication) - ***		SPI	Healthy/ Faulty														
a	48V Battery Charger 2 Fail																
b	48V Battery Charger 1 Fail. /(Rectifier 1 Fault)																
Battery Charger Failure (Station)/		SPI	Healthy/ Faulty														
a	220 V Battery Charger 2 Fail /(Rectifier 1 Fault)																
b	220 V Battery Charger 1 Fail (Rectifier 2 Fault)																
Station Urgent Fault - ***		SPI	Operated /Normal														
a	Fox Faulty Urgent Alarm																
Station Non Urgent Fault - ***		SPI	Operated/Normal														
a	Diesel Generator Alarm																
b	Fox Faulty Non Urgent Alarm																
Station Control Remote/Supervisory		DPI	Remote/Supervisory														
ENERGY MEASUREMENTS																	
Active Energy		AI	MWh			1	1	1	1	1							

Re-Active Energy		AI	Mvarh				1	1	1	1	1		
MEASUREMENTS			UNITS										
Voltage		AI	Volts	1	1	1	1	1	1	1	1		1
Frequency		AI	Hertz										1
Active Power		AI	MW	1	1	1	1	1	1	1	1	1	
Reactive Power		AI	MVAr	1	1	1	1	1	1	1	1	1	
Current		AI	Ampere	1	1	1	1	1	1	1	1	1	
Transformer Tap Position		AI	Tap number		1								
GENERAL													
Air Condition Temperature		AI	Celcius										
Humidity		AI	RH %										

Pannala GS		TYPE OF SIGNAL	VOLTAGE	132/33 kV T/F 3		132/33 kV T/F 4		33 kV								
			BAY No													
			BAY TYPE	132 kV side	33 kV side	132 kV side	33 kV side	F6	F7	F8	F9	Gen F3	Gen F4	Gen F5	Gen F6	BS
CONTROLS			ACTION													
Circuit Breaker		DPC	Open/ Close	2	2	2	2	2	2	2	2	2	2	2	2	
BB Isolator 1		DPC	Open/ Close	2	2	2	2	2	2	2	2	2	2	2	2	
BB Isolator 2		DPC	Open/ Close												2	

Line Isolator		DPC	Open/ Close		2		2											
Capacitor Bay Isolators		DPC	Open/ Close															
Earth Switch		DPC	Open/ Close															
Tap Changer (AVR) Raise / Lower		DPC	Raise/ Lower	2		2												
Tap Changer (AVR) Auto / Manual		DPC	Auto /Manual	1		2												
AVR Operating mode (One of the 2 modes will be available)		DPC	Master/ Follower															
		DPC	Minimum Circulation Current	2		2												
AVR Independent / Parallel		SPC	Independ ent/Parall el	1		1												
Protection Master Relay Reset /(Protection Reset Command K86.1) (/Lockout Relay Reset)		SPC	Reset	1	1	1	1										1	
Protection Master relay Reset Command K86.2		SPC	Reset	1	1	1	1										1	
Protection Reset Command K96 (BB/BCF relay Reset)		SPC	Reset	1	1	1	1										1	
Load Shedding OFF		SPC	On/Off															
STATUS INDICATIONS			STATUS															
Circuit Breaker		DPI	Open/ Close	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
BB Isolator 1		DPI	Open/ Close	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
BB Isolator 2		DPI	Open/ Close														2	
Line Isolator		DPI	Open/ Close		2		2											

Capacitor Bay Isolator		DPI	Open/ Close															
Earthing Switch		DPI	Open/ Close		2		2	2	2	2	2	2	2	2	2	2	4	
Bay Control		DPI	Local/ Superv/ Remote	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
TRANSFORMER																		
Tap Control		SPI	Local/ Superv/ Manual	1		1												
T/F AVR Operating mode		SPI	Auto	1		1												
T/F AVR Operating mode (One of the 2 modes will be available)		SPI	Master/Fo llower	1		1												
		SPI	Minimum Circulatio n Current															
AVR Parallel / Indipendent		SPI	Parallel/ Independ ent	1		1												
Capacitor Bank																		
Capacitor Bank Operating Mode		SPI	Manual /Auto															
A L A R M INDICATIONS																		
CIRCUIT BREAKER																		
Breaker Fault (critical) - ***		SPI	Healthy/ Faulty	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
a	SF6 Gas Presure low. (2nd stage)																	
b	Trip Circuit Supervision Fail 1 (Trip circuit faulty)																	

c	Trip Circuit Supervision Fail 2 ((Trip circuit 2 faulty)																	
d	Spring Not Charge (Spring Supervision)																	
e	Hydraulic Pressure Low																	
f	Pneumatic Pressure Low.																	
g	CB Pole Discrepancy																	
h	Trip Lockout/Close Lockout (SF6 Lock out)																	
i	Control Voltage Failure (DC MCB trip)																	
j	Internal Arc trip																	
h	SF6 Gas Pressure low in Bus Bar Chamber																	
Bay Fault (Non critical) - ***																		
		SPI	Healthy/ Faulty	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
a	SF6 Gas Pressure Low - First step																	
b	PT Secondary MCB Trip (Protection VT MCB Failed/ Incoming Voltage MCB trip/ VT MCB trip)																	
c	AC/DC Voltage Failure Indication (Auxiliary Fail)																	
TRANSFORMER MECHANICAL PROTECTION																		
Tap Changer Mechanism Fault (OLTC failure)		SPI	Healthy/ Faulty	1	1	1	1											
Tap out of step (TAP OUT ERROR)		SPI	Onset/ Reset	1	1	1	1											
Transf Buchholz Alarm - ***		SPI	Onset/ Reset	1	1	1	1											
a	Transf Buchholz Alarm																	
b	OLTC Buchholz Alarm																	
Transf Buchholz Trip		SPI	Operated/ Normal	1	1	1	1											

OLTC Buchholz Trip (OLTC OIL Flow Relay Trip)		SPI	Operated/Normal	1	1	1	1											
ET Transf Buchholz Trip		SPI	Operated/Normal	1	1	1	1											
AT Transf Buchholz Trip		SPI	Operated/Normal	1	1	1	1											
Temperature Alarm - ***		SPI	Onset/Reset	1	1	1	1											
a	Oil Temperature Alarm																	
b	Winding HV Temperature Alarm																	
c	Winding LV Temperature Alarm																	
Temperature trip - ***		SPI	Operated/Normal	1	1	1	1											
a	Oil Temperature trip																	
b	Winding HV Temperature trip																	
c	Winding LV Temperature trip																	
General Alarm - ***		SPI	Onset/Reset	1	1	1	1											
a	Cooling Fan Fail (Group 1/Group 2)																	
b	Transformer Oil Level low																	
c	OLTC Oil level low																	
General Trip - ***		SPI	Operated/Normal	1	1	1	1											
a	OLTC Surge Trip																	
b	Main tank Pressure Release Valve (PRV) Trip																	
c	OLTC Pressure Release Valve																	
d	Transformer Oil Level low TRIP																	
e	OLTC Oil level low																	
PROTECTION SIGNALS																		
LINE PROTECTION																		

Main 1 - Differential protection operated		SPI	Operated /Normal																
Main 1 - Distance Zone 1 operated		SPI	Operated /Normal																
Main 1 - Distance Zone 2 operated		SPI	Operated /Normal																
Main 1 - Distance Zone 3 operated		SPI	Operated /Normal																
Main 1 - Distance Zone 4 operated		SPI	Operated /Normal																
Main 1 -Distance protection operated		SPI	Operated /Normal																
Main 1 - Directional Earth Fault operated		SPI	Operated /Normal																
Main 1 - Distance Protection Aided Trip		SPI	Operated /Normal																
Main 2- Differential protection operated		SPI	Operated /Normal																
Main 2 - Distance Zone 1 operated		SPI	Operated /Normal																
Main 2 - Distance Zone 2 operated		SPI	Operated /Normal																
Main 2 - Distance Zone 3 operated		SPI	Operated /Normal																
Main 2 - Distance Zone 4 operated		SPI	Operated /Normal																
Main 2 - Distance protection operated		SPI	Operated /Normal																
Main 2 - Directional Earth Fault operated		SPI	Operated /Normal																
Main 2 - Distance Protection Aided Trip		SPI	Operated /Normal																

Over Current Protection trip		SPI	Operated /Normal					1	1	1	1	1	1	1	1	1	
Earth Fault Protection Operated		SPI	Operated /Normal					1	1	1	1	1	1	1	1	1	
Pole Discrepancy Protection Operated		SPI	Operated /Normal														
Auto Recloser Operated / Success / Progress		SPI	Operated /Normal														
Direct Intertrip Send		SPI	Operated /Normal														
Direct Intertrip Received		SPI	Operated /Normal														
Permissive Intertrip Send (carrier send)		SPI	Operated /Normal														
Permissive Intertrip Received (carrier receive)		SPI	Operated /Normal														
DEF Protection carrier Send		SPI	Operated /Normal														
DEF Protection carrier Receive		SPI	Operated /Normal														
Distance Protection Block		SPI	Operated /Normal														
Communication Fail (Differential block)		SPI	Operated /Normal														
Switch On To Fault trip (SOTF trip)		SPI	Operated /Normal														
Over Voltage trip (OV)		SPI	Operated /Normal														
Breaker Failure Protection Operated		SPI	Operated /Normal	1	1	1	1	1	1	1	1	1	1	1	1	1	
Trip Relay Operated/ Protection Relay K86.1 /Lockout Relay operated		SPI	Set/Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	
Trip Relay Operated/Protection Relay K86.2		SPI	Set/Reset	1		1											1
Protection Relay K96		SPI	Set/Reset														1

Under Frequency Trip		SPI	Operated /Normal					1	1	1	1	1	1	1	1				
Over Frequency Trip		SPI	Operated /Normal					1	1	1	1	1	1	1	1				
Main 1 Protection Relay Fail		SPI	Healthy/ Fail			1												1	
Main 2 Protection Relay Fail		SPI	Healthy/ Fail	1		1													
Back Up Protection Relay Fail		SPI	Healthy/ Fail	1		1												1	
Auto Relclose ON/OFF		SPI	ON / OFF																
33kV protection Operated		SPI	Operated /Normal					1	1	1	1	1	1	1	1				
BUSBAR PROTECTION																			
Bus Bar Protection Operated		SPI	Operated /Normal	1		1												1	
TRANSFORMER PROTECTION																			
Differential Protection Operated		SPI	Operated /Normal	1		1													
HV Restricted Earth Fault		SPI	Operated /Normal	1		1													
LV Restricted Earth Fault		SPI	Operated /Normal	1		1													
Transformer earth Fault Protection Operated		SPI	Operated /Normal	1	1	1	1												
Transformer Stand By EF Protection Operated		SPI	Operated /Normal	1	1	1	1												

Transformer Over Current Protection trip (OCProtection I>trip)		SPI	Operated /Normal	1	1	1	1											
Over Voltage Protection		SPI	Operated /Normal	1		1												
Over Fluxing Protection		SPI	Operated /Normal	1		1												
T/F Thermal Overload		SPI	Operated /Normal	1														
CAPACITOR BANK																		
Phase OverVoltage Operated		SPI	Operated /Normal															
STATION ALARMS																		
Under Frequency Load Shedding Operated		SPI	Operated/ Normal					1	1	1	1	1	1	1	1			
Bus Voltage Failure - ***		SPI	Healthy/ Faulty															
a	Auxialary Supply Voltage	SPI	Healthy/ Faulty															
b	DC Voltage Failure (110V DC MCB Trip)	SPI	Healthy/ Faulty															
Gateway Alarm(Running A/Running B)		SPI	Healthy/ Faulty															
Communication Alarm (Communication Malfuntion)		SPI	Healthy/ Faulty															
Battery Charger Failure (Communication) - ***		SPI	Healthy/ Faulty															
a	48V Battery Charger 2 Fail																	
b	48V Battery Charger 1 Fail /(Rectifier 1 Fault)																	
Battery Charger Failure (Station)/		SPI	Healthy/ Faulty															
a	220 V Battery Charger 2 Fail /(Rectifier 1 Fault)																	
b	220 V Battery Charger 1 Fail (Rectifier 2Fault)																	

Station Urgent Fault - ***		SPI	Operated /Normal															
a	Fox Faulty Urgent Alarm																	
Station Non Urgent Fault - ***		SPI	Operated/ Normal															
a	Diesel Generator Alarm																	
b	Fox Faulty Non Urgent Alarm																	
Station Control Remote/Supervisory		DPI	Remote/Supervisory															
ENERGY MEASUREMENTS																		
Active Energy		AI	MWh					1	1	1	1	1	1	1	1	1		
Re-Active Energy		AI	MVarh					1	1	1	1	1	1	1	1	1		
MEASUREMENTS			UNITS															
Voltage		AI	Volts	1	1	1	1	1	1	1	1	1	1	1	1	1		1
Frequency		AI	Hertz															1
Active Power		AI	MW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Reactive Power		AI	MVAr	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Current		AI	Amperes	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Transformer Tap Position		AI	Tap number		1		1											
GENERAL																		
Air Condition Temperature		AI	Celcius															
Humidity		AI	RH %															

Legend

BC = BusCoupler T/F = Transformer G = Generator C = Capacitor F = Feeder BB= Bus Bar BS= Bus Section MH= Mini Hydro D= Dendro Power
GF=Generator Feeder BSC= Capacitor Bank

TYPE OF SIGNAL

DPC : Double Point Control Command

SPC : Single Point Control Command

DPI : Double point indication input

SPI : Single point indication input

AI : Analogue Measurement

AO : Analogue Output

Double points are counted individually

*** :- Grouped Alarms

Information Copy - Not for Bidding

Annex B

Gateway/RTU Configuration Parameters of Signals

	Signal Description	Type Of Signal	Signal Type Description				User Data of Class
			For IEC 60870 - 5 - 101		For IEC 60870 - 5 - 104		
			Type ID No.	Description	Type ID No.	Description	
	<u>Control Command</u>						
	Circuit Breaker	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	BB Isolator 1	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	BB Isolator 2	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	Line Isolator	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	Capacitor Bay Isolators	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	Earth Switch	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	TRANSFORMER AVR/TC						
	Tap Changer(Raise/Lower)	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	Tap Changer (AVR) Auto / Manual	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	AVR Operating mode (One of the 2 modes will be available)						
	Master/Follower	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	Minimum Circulation Current	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	AVR Independent / Parallel	SPC	45	C_SC_NA_1	45	C_SC_NA_1	Class 1
	VARIABLE REACTOR TAP CONTROL						
	Tap Changer(Raise/Lower)	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	Tap Changer (AVR) Auto / Manual	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	GENERATOR CONTROLS						
	MW Setpoint	AO	50	C_SE_NC_1	50	C_SE_NC_1	Class 1

MVAr Setpoint	AO	50	C_SE_NC_1	50	C_SE_NC_1	Class 1
MW Control	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
MVAr Control	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
Protection Master Relay Reset /(Protection Reset Command K86.1) (/Lockout Relay Reset)	SPC	45	C_SC_NA_1	45	C_SC_NA_1	Class 1
Protection Master relay Reset Command K86.2	SPC	45	C_SC_NA_1	45	C_SC_NA_1	Class 1
Protection Reset Command K96 (BB/BCF relay Reset)	SPC	45	C_SC_NA_1	45	C_SC_NA_1	Class 1
Load Shedding OFF	SPC	45	C_SC_NA_1	45	C_SC_NA_1	Class 1
Status Indications						
Circuit Breaker	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
BB Isolator 1	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 2
BB Isolator 2	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 2
Capacitor Bay Isolators	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 2
Line Isolator	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 2
Earthing Switch	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 2
Bay Control	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 2
TRANSFORMER AVR/TC						
Tap Control (Local/Remote)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Tap Changer (AVR) Auto / Manual	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
AVR Operating mode (One of the 2 modes will be available)						
Master/Follower	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Minimum Circulation Current	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
AVR Independent / Parallel	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
VARIABLE REACTOR TAP CONTROL						
Tap Changer(Raise/Lower)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Tap Changer (AVR) Auto / Manual	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
CAPACITOR BANK/REACTOR BAY						

	Capacitor Bank Operating Mode	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Reactor Operating Mode	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	GENERATOR STATUS INDICATIONS						
	Oper. mode of Governor	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	Oper. mode of Gen. AVR	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	Gen ready to Start	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	Generator Status	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	Generator Control	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	Setpoint Validation	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Raise /Lower Enable	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Alarm Indications						
	CIRCUIT BREAKER						
	Breaker Fault (critical) -***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	SF6 Gas Presure low. (2nd stage)						
b	Trip Circuit Supervision Fail 1 (Trip circuit faulty)						
c	Trip Circuit Supervision Fail 2 ((Trip circuit 2 faulty)						
d	Spring Not Charge (Spring Supervision)						
e	Hydraulic Pressure Low						
f	Pneumatic Pressure Low.						
g	CB Pole Discrepancy						
h	Trip Lockout/Close Lockout (SF6 Lock out)						
i	Control Voltage Failure (DC MCB trip)						
j	Internal Arc trip						
k	SF6 Gas Presure low in Bus Bar Chamber						
	Bay Fault (Non critical)-***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	SF6 Gas Pressure Low - First step						
b	PT Secondary MCB Trip(Protection VT MCB Failed/ Incoming Voltage MCB trip/ VT MCB trip)						
c	AC/DC Voltage Failure Indication (Auxiliary Fail)						

	TRANSFORMER MECHANICAL PROTECTION						
	Tap Changer Mechanism Fault	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Tap out of step	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Transf Buchholz Alarm - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Transf Buchholz Alarm						
b	OLTC Buchholz Alarm						
	Transf Buchholz Trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	OLTC Buchholz Trip (OLTC OIL Flow Relay Trip)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	ET Transf Buchholz Trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	AT Transf Buchholz Trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Temperature Alarm - ***	SPI		M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Oil Temperature Alarm						
b	Winding HV Temperature Alarm						
c	Winding LV Temperature Alarm						
	Temperature trip - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Oil Temperature trip						
b	Winding HV Temperature trip						
c	Winding LV Temperature trip						
	General Alarm- ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Cooling Fan Fail (Group 1/Group 2)						
b	Transformer Oil Level low						
c	OLTC Oil level low						
	General Trip- ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	OLTC Surge Trip						
b	Main tank Pressure Release Valve (PRV) Trip						
c	OLTC Pressure Release Valve						
d	Transformer Oil Level low TRIP						

e	OLTC Oil level low						
	PROTECTION SIGNALS/ALARMS						
	Main 1 - Differential protection operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 1 - Distance Zone 1 operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 1 - Distance Zone 2 operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 1 - Distance Zone 3 operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 1 - Distance Zone 4 operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 1 -Distance protection operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 1 - Directional Earth Fault operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 1 - Distance Protection Aided Trip	SPI		M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 2- Differential protection operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 2 - Distance Zone 1 operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 2 - Distance Zone 2 operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 2 - Distance Zone 3 operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 2 - Distance Zone 4 operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 2 - Distance protection operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 2 - Directional Earth Fault operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 2 - Distance Protection Aided Trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Over Current Protection trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Earth Fault Protection Operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Pole Discrepancy Protection Operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Auto Recloser Operated / Success / Progress	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Direct Intertrip Send	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Direct Intertrip Received	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1

Permissive Intertrip Send (carrier send)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Permissive Intertrip Received (carrier receive)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
DEF Protection carrier Send	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
DEF Protection carrier Receive	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Distance Protection Block	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Communication Fail (Differential block)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Switch On To Fault trip (SOTF trip)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Over Voltage trip (OV)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Breaker Failure Protection Operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Trip Relay Operated/ Protection Relay K86.1 /Lockout Relay operated(if any)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Trip Relay Operated/Protection Relay K86.2(if any)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Protection Relay K96	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Under Voltage Trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Under Frequency Trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Over Frequency Trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Restricted Earth Fault Protection Operated(Main 2)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Main 1 Protection Relay Fail	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Main 2 Protection Relay Fail	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Back Up Protection Relay Fail	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Auto Relclose ON/OFF	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
33kV protection Operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
GENERATOR PROTECTION INDICATIONS						
Gen. Prot. Operated (critical)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Gen. Prot. Operated (non critical)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Over /Under voltage protection operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Over /Under Frequency protection operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Over speed protection operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1

	BUSBAR PROTECTION						
	Bus Bar Protection Operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	TRANSFORMER PROTECTION						
	Differential Protection Operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	HV Restricted Earth Fault	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	LV Restricted Earth Fault	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Transformer earth Fault Protection Operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Transformer Stand By EF Protection Operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Transformer Over Current Protection trip (OCProtection I>trip)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Over Voltage Protection	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Over Fluxing Protection	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	T/F Thermal Overload	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	STATION ALARMS						
	Under Frequency Load Shedding Operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Bus Voltage Failure - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Auxiliary Supply Voltage						
b	DC Voltage Failure (110V DC MCB Trip)						
	RTU Alarm	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Communication Alarm (Communication Malfunction)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Battery Charger Failure (Communication) - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	48V Battery Charger 2 Fail						
b	48V Battery Charger 1 Fail /(Rectifier 1 Fault)						
	Battery Charger Failure (Station) - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	220 V Battery Charger 2 Fail /(Rectifier 1 Fault)						
b	220 V Battery Charger 1 Fail (Rectifier 2 Fault)						
	Station Urgent Fault - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Fox Faulty Urgent Alarm						

	Station Non Urgent Fault - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Diesel Generator Alarm						
b	Fox Faulty Non Urgent Alarm						
	Station Control Remote/Supervisory	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	ENERGY MEASUREMENTS						
	Active Energy	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Re-Active Energy	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Measurements						
	Voltage	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Frequency	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Active Power	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Reactive Power	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Current	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Transformer Tap Position	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	GENERATOR MEASUREMENTS						
	Unit Generation	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Active Power (included above)	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Reactive Power (included above)	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Active Energy	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Reactive Energy	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Droop Setting - Hand dressed	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	GENERAL						
	Air Condition Temperature	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Humidity	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2

LEGEND

DPI - Double Point Indication
SPI - Single Point Indication
DPC - Double Point Command
SPC - Single Pont Command
BCP - Binary Coded
Measurement

C_DC_NA_1 :- Double Command
C_SC_NA_1 :- Single Command
M_DP_TA_1 :- Double Point Information with time tag
M_SP_TA_1 :- Single Point Information with time tag

M_ME_NC_1 :- Measured Value, short floating point number
M_DP_TB_1 :- Double Point Information with time tag CP56Time2a
M_SP_TB_1 :- Single Point Information with time tag CP56Time2a
M_IT_NA_1 :- Integrated Totals

Note :

There are two types defined for Transformer Tap position. Providing the tap position through the Type ID 13 as a Analog Input (Measurement) is better than Type ID 15(Binary Coded Pulse signal)

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Annex C**Communication Path Configurations for Gateway****a) SCADA Protocol -IEC 60870-5-104**

- Speed of the TCP/IP connection : 10/100Mbps
- Gateway IP address : will be provided at commissioning period.
- IP address of the Master Station : 10.3.1.8 & 10.3.1.9
- Subnet Mask : 255.255.255.240

➤ Application Layer

Fixed lengths are defined in the protocol as below.

- Common Address of ASDU : 2 octets
- Information object address : 3 octets
- Cause of transmission : 2 octets
- Length of APDU : Maximum length of APDU per system (253)

b) SCADA Protocol -IEC 60870-5-101

SCADA communication link is Serial, Asynchronous, Unbalanced (Master Slave) and Multipoint Party Line System.

➤ Physical Layer

The transmission speed should be 9600 bits per seconds.

➤ Link Layer

Link transmission procedure : Unbalanced transmission

➤ **Application Layer**

- Link Address (Polling Address) : will be provided at commissioning period.
- Station Address (Common address of Application Service Data Unit): will be provided at commissioning period.
- Length of Link address :1 byte(1 Octet)
- Length of ASDU : 1 byte(1 Octet)
- Length of IOA(Information Object Address) : 2 bytes(2 Octets)
- Length of Cause of Transmission : 1 byte(1 Octet)

Note: There should have a facility to change Length of Link address, Length of ASDU & Length of Cause of Transmission as Octet 1 or 2.

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Annex D**The point to point test SCADA commissioning signal list format**

a) Indications

<u>(Name of GSS) NSCC SIGNAL LIST - SINGLE POINT INDICATIONS</u>											
Bay No.	Bay Name	Signal Description	Type Of Signal	Signal Type Description				User Data of Class	Information Object Address	Remarks	Test Results (OK/Alarm)
				For IEC 60870 - 5 - 104		For IEC 60870 - 5 - 104					
				Type ID No.	Description	Type ID No.	Description				

T/F AVR Operating mode (Manual/Auto) – High (1) = Low (0) =.....

Tap Control (Local/Remote) – High (1) =..... Low (0) =.....

T/F AVR Operating mode (Master/Follower; Minimum Circulation) - High (1) =..... Low (0) =.....

AVR Parallel / Independent- High (1) =..... Low (0) =.....

b) Controls

<u>(Name of GSS) NSCC SIGNAL LIST – CONTROL AND DOUBLE POINT INDICATIONS</u>											
Bay No.	Bay Name	Signal Description	Type Of Signal	Signal Type Description				User Data of Class	Information Object Address	Remarks	Test Results (OK/Alarm)
				For IEC 60870 - 5 - 101		For IEC 60870 - 5 - 104					
				Type ID No.	Description	Type ID No.	Description				

86/96 reset command -

High(1)=.....command; Low(0)=.....command

Tap Position Command(DPC) –

High(10)=.....command; Low(01)=.....command

T/F AVR Operating mode(Auto/Manual) (DPC) –

High(10)=.....command; Low(01)=.....command

T/F AVR Operating mode (Master/Follower; Minimum Circulation) (DPC) -

High(10)=.....command; Low(01)=.....command

AVR Parallel / Independent (SPC)-

High(1)=..... Low (0)=.....

c) Measurement

<u>(Name of GSS) NSCC SIGNAL LIST – CONTROL AND DOUBLE POINT INDICATIONS</u>											
Bay No.	Bay Name	Signal Description	Type Of Signal	Signal Type Description				User Data of Class	Information Object Address	Remarks	Test Results (OK/Alarm)
				For IEC 60870 - 5 - 101		For IEC 60870 - 5 - 104					
				Type ID No.	Description	Type ID No.	Description				

Tested By

Name:

Signature:

Date:

(Name of the Contractor):

(Project Name):

Checked By

Name:

Signature:

Date:

CEB

(Project Name):

d) Signal Grouping

(Name of the Substations) NSCC SIGNALS - SIGNAL GROUPING DETAILS

E01 Bay Fault - Non critical:	E02 Bay Fault - Non critical:	E03 Bay Fault - Non critical:	E04 Bay Fault - Non critical:
CB Heater Fault	CB Heater Fault	CB Heater Fault	CB Heater Fault

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