



CEYLON ELECTRICITY BOARD SRI LANKA

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

(ADB LOAN NO: 3483/3484)

PACKAGE 8 - LOT A

Procurement of Plant

Design, Supply, and Installation

Single-Stage: Two-Envelope
Bidding Procedure

BIDDING DOCUMENT

for
Procurement
of

Augmentation of:

Aniyakanda 132/33kV Grid Substation

Chunnakam 132/33kV Grid Substation

Nadukuda 220/33kV 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 A

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

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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1. SCOPE OF WORKS

1.1. GENERAL DESCRIPTION OF THE PROJECT

1.1.1. AUGMENTATION OF ANIYAKANDA GRID SUBSTATION

The augmentation of Aniyakanda 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 Nos. 33kV, 800A, 30s Earthing Transformer.
4. Additions/Modifications of control, metering, monitoring and protection equipment.
5. Additions/Modification of Batteries, Battery Chargers, DC equipment, LVAC and Inverter equipment etc.
6. Additions/Modification of SCADA & Communication equipment.
7. Modification of Substation Automation System.
8. Modification of Energy Metering System.
9. Power and Control Cables including terminations.
10. Extension and modification of Substation Grounding System and Shield Earth Wire System.
11. Electrical, Civil and Mechanical works required for substation including control and other buildings.
12. Spare parts.

1.1.2. AUGMENTATION OF CHUNNAKAM GRID SUBSTATION

The augmentation of Chunnakam 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 Nos. 33kV, 800A, 30s Earthing Transformers.
4. 36 kV SF₆ gas insulated indoor switchgear with single bus bar arrangement comprising of
 - 01 No. 36kV Transformer bay
 - 03 Nos. 36kV Line feeder bays
 - 01 No. 36kV Generator feeder bays
 - 01 No. 36kV Bus Section bay
5. 04 Nos. of 36kV Outdoor line gantries including 36kV cable terminations.

6. Construction of Indoor Switchgear
7. Additions/Modifications of Control, Metering, Monitoring and Protection equipment.
8. Additions/Modification of Batteries, Battery Chargers, DC equipment, LVAC and Inverter equipment etc.
9. Additions/Modification of SCADA & Communication equipment.
10. Modification of Substation Automation System.
11. 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 and other buildings.
15. Spare parts.

1.1.3. AUGMENTATION OF NADUKUDA GRID SUBSTATION

Nadukuda 220/33kV Grid Substation shall consist of following main features.

1. 01 No. 220/33 kV, 63MVA Power Transformers.
2. 01 No. 33kV, 800A, 30s Earthing Transformer
3. Additions/Modification to Control, Metering, Monitoring and Protection equipment.
4. Additions/Modification to LVAC and DC distribution boards etc.
5. Additions/Modification to SCADA & Communication equipment.
6. Modification to Substation Automation System.
7. Power and Control cables including joints and terminations.
8. Extension and modification of Substation grounding system and lightning protection system.
9. Electrical, Civil and Mechanical works required for substation, control and other building.
10. Spare parts.

1.1.4. TERMINAL POINTS

A. ANIYAKANDA GRID SUBSTATION

The following shall be the contract terminal points: -

- (a) 145kV Outdoor Busbar/ Switchgear interfaces.
The existing 145kV busbar shall be extended to connect the new transformer bay and both shall be provided under Grid Substation Contract. This contract includes the connections and connectors from the existing 145kV busbar to new 145kV busbar.
- (b) 36kV Overhead Line/ Switchgear interfaces.
36kV overhead distribution lines terminate at the existing line bay gantry. This contract 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 Modification
This contract includes the modifications of existing control and protection system to include new bays where necessary.
- (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. Integration of IED into existing Substation Automation System is subjected to the employer's approval.

B. CHUNNAKAM GRID SUBSTATION

The following shall be the contract terminal points: -

- (a) 145kV Outdoor Busbar.
The existing 145kV busbar shall be extended to connect the new transformer bay and both shall be provided under Grid Substation Contract. This contract includes the connections and connectors from the existing 145kV busbar to new 145kV busbar.
- (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) 36kV Indoor Switchgear

The existing 36kV indoor switchgear shall be extended to connect the new 36kV transformer bay, 36kV line feeder bays and 36kV generator bay including bus section bay between the existing and new indoor switchgear panels. 36kV cables and terminations shall be

(d) Control and Protection Modification

This contract includes the modifications of existing control and protection system to include new bays where necessary.

(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 existing 132/33kV transformers. 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.

C. NADUKUDA GRID SUBSTATION

The following shall be the contract terminal points: -

(a) 245kV switchgear Interface.

245kV GIS feeder bay is available to connect the third transformer. 245kV cable and GIS termination shall be supply, install and commissioned by this contract.

(b) 36kV switchgear interface.

36kV GIS feeder bay is available to connect the third transformer. 36kV cable and GIS termination shall be supply, install and commissioned by this contract.

(c) Protection and Control.

Bay protection for transformer 245kV and 36kV is available with the 245kV and 36kV GIS. Transformer Voltage Regulation controls shall be provide under this contract.

(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 220/33kV 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 220kV 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.

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1.1.5. SITE ENVIRONMENTAL CONDITIONS

Colombo

Altitude of site above sea level not exceeding	m	100
Maximum ambient air temperature	°C	36.1
Minimum ambient air temperature	°C	18.2
Average yearly temperature	°C	30
Relative humidity (24 hours)	%	81
Average annual rainfall	mm	2424
Maximum recorded rainfall for 24 hours	mm	494
Winds	Maximum 1 to 3 second gusts at 145 km per hour. Mean speed 9 km per hour over 24 hours.	
Storms	Frequency of thunderstorms is high	
Average isokeraunic level	100 days per annum	
Atmospheric corrosive category (ISO 12944)	C4	
Pollution level for bushings and insulators	433 mm/kV (USCD)	

Jaffna

Altitude of site above sea level not exceeding	m	100
Maximum ambient air temperature	°C	35
Minimum ambient air temperature	°C	25
Average yearly temperature	°C	29
Relative humidity (24 hours)	%	74
Average annual rainfall	mm	112
Maximum recorded rainfall for 24 hours	mm	178
Storms	Frequency of thunderstorms is high	
Average isokeraunic level	30 days per annum	
Atmospheric corrosive category (ISO 12944)	C4	

Mannar

Altitude of site above sea level not exceeding	m	100
Maximum ambient air temperature	°C	38.5
Minimum ambient air temperature	°C	15.5
Average yearly temperature	°C	30
Relative humidity (24 hours)	%	81
Average annual rainfall	mm	963
Winds	Maximum 1 to 3 second gusts at 145 km per hour. Mean speed 6 km per hour over 24 hours.	
Storms	Frequency of thunderstorms high	
Average isokeraunic level	60 days per annum	
Pollution Condition	Very heavy saline pollution	
Pollution level for insulators and bushings (USCD)	53.7mm/kV for Nadukuda	
Atmospheric Corrosivity Category (ISO12944-2)	C5M for Nadukuda	

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1.1.6. 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.

1.1.7. 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: bdgpd2.prj@ceb.lk

1.2. PLANT & EQUIPMENT INCLUDING MANDATORY SPARE PARTS

1.2.1. ANIYAKANDA GRID SUBSTATION

1.2.1.1. OUTDOOR SWITCHGEAR

1.2.1.1.1. 145kV Single busbar system comprising:-

- 1 Set - 2000A, 31.5kA, 145kV three phase tubular bus bars with post insulators.
(The existing single busbar system shall be extended as per the drawings TD/CE/1/184/D/01/01)

1.2.1.1.2. 01 No. 145kV Transformer bay comprising:-

- 1 No. - 1250A, 145kV, 31.5kA three phase busbar disconnect 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
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.

1.2.1.1.3. 01 No. 36kV Transformer bay comprising:-

- 3 Nos. - 36kV, 10kA, 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 36 kV outgoing cables etc. to terminate the 36 kV cable and to connect in to the Earthing Transformer cables.

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

1.2.1.1.4. 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 - Outdoor equipment including set of connections, connectors, clamps, structures, access ladders etc. to connect 36kV outdoor busbars and neutral current transformers.

1.2.1.2. MODIFICATION OF SF₆ INSULATED INDOOR SWITCHGEAR

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

Generator Feeder No. 02 (H04) of the existing indoor switchgear shall be modified to accommodate incoming feeder from Transformer No.03 as follows:-

- 3 Nos. - 36kV Current Transformers with cores as follows:-
 Class 5P20, ratio 800/1A, 60VA for HV Main 1 protection and control IED
 Class 5P20, ratio 800/1A, 60VA for HV Main 2 protection and control IED, AVR and LV protection and control IED.
 Class 0.2 ratio 800/1A, 20VA 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 termination, complete with terminal arrangement suitable for incoming 36kV cables.
- 1 Lot - Complete set of miscellaneous items required for proposed modification

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

Panel No.1

Auxiliary Power for 145kV Transformer (No.03) bay switchgear

1.2.1.4. BATTERIES, CHARGERS, DISTRIBUTION BOARDS & INVERTER EQUIPMENT

Existing 110V DC system 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:-

Substation Automation System Unit of Control & Protection – Transmission, CEB will be undertaken integration work of new control & protection IEDs, Ethernet Switches, AVR and existing Capacitor controllers to existing Substation Automation Systems at Aniyakanda Grid Substation. However, if required the contractor shall undertake the integration work of new control and protection IEDs, Ethernet switches, AVR and existing Capacitor controller to existing SAS subjected to the approval of the 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 which will be supplied for Aniyakanda GSS shall be compatible with IEC 61850 protocol. The bidder shall submit IEC 61850 conformance certificate issued by an independent laboratory empowered by IEC International Users Group tested according to the IEC 61850-10 for the Control & Protection IEDs and AVR.

New control & protection IEDs and AVR 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 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.

1.2.1.5.2. 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. of 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 E05 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 a separate panel in the control building).

(a) 01 No. Ethernet Switch

This Ethernet Switch 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 Switch 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 	<ul style="list-style-type: none"> Existing Switch H11 MOXA EDS-508A-MM-SC Existing Switch SCS 3 MOXA EDS-508A-MM-SC

1.2.1.5.3.1 Modification of existing 01 No. 36kV generator feeder bay to accommodate 01 No. transformer bay comprising with:-

The existing protection and control system 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 5.12.1, 5.12.5 | - Directional and Non-directional Over current protection for LV side |
| Clause 5.12.1, 5.12.5 | - Directional and Non-directional Residual Earth fault protection for LV side |
| Clause 5.12.1, 5.8.2.3 | - BCU function for LV side |
| | - Synchronism Check function for the LV side |
| Clause 5.12.1 | - Monitoring of Lockout relay |
| Clause 5.19 | - Trip circuit supervision |
| Clause 5.8.5, 5.12.1 | - Synchrocheck & Synchronizing |
| Clause 5.6, 5.7, 5.8.2.3, 5.12.2.2 | - Control IED'S on 36kV level |

1.2.1.5.3.2 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. Modification of Energy Metering panels comprising with:-

The existing energy meter of the Generator feeder 02 shall be configured to use as the energy meter of the Transformer No. 03 as specified in Chapter 9 of Technical Specification - Grid Substation for 36kV feeders and transformer 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. : Optical interface module (2 x STM-1)
- 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 Aniyakanda Grid Substation

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. 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.

1.2.1.6.3. Integration of SCADA for Aniyakanda Grid Substation

The integration work of new control and protection IEDs to existing Gateway at Aniyakanda 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 AVR's to existing Gateway subjected to the approval of employer.

1.2.1.7. 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.

1.2.1.8. MODIFICATION OF LIGHTNING PROTECTION SYSTEM COMPRISING:-

Design and erection of lightning protection system with earth wires in the area which covers the augmentation works according to IEEE 998-2012 standard. The earth wire to ground the lightning rods shall be provided with suitable insulation level from building and installed not to be touched by a person easily.

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 earth mesh and grounding electrodes.

1.2.1.10. POWER AND CONTROL CABLES

1.2.1.10.1. 36kV Power cables and terminations

The existing 36kV power cables from indoor switchgear to existing outdoor 33kV gantry shall be reused. The existing two nos. of 36kV power cables from Panel no. H04 (existing Generator feeder No.02) to 33kV gantry shall be re-routed from Panel No. H10 to Generator feeder No.02 of the outdoor gantry. The existing 36kV power cable from Panel No. H10 to 33kV gantry shall be re-routed from Panel No.H12 to Line Feeder No.04 of the outdoor gantry. (As per the drawing no. TD/CE/1/184/D/01/01-A). New 36kV power cable shall be provided and installed as follows.

- 1 Lot - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connections between Power transformer and 36kV indoor switchgear and termination accessories.

- 1 Lot - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connections between Power transformer and 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. The power transformer shall be capable of parallel operation with the existing power transformer no. 02.

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

As per the price schedule.

1.2.1.17. TOOLS AND INSTRUMENTS

As per the price schedule.

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1.2.2. CHUNNAKAM GRID SUBSTATION

1.2.2.1. OUTDOOR SWITCHGEAR

1.2.2.1.1. 145kV Single busbar system comprising: -

- 1 Set - 2000A, 31.5kA, 145kV three phase tubular bus bars with post insulators.
(The existing single busbar system shall be extended as per the drawings TD/CE/1/184/D/01/02)

1.2.2.1.2. 01 No. 145kV Transformer bay comprising:-

- 1 No. - 1250A, 145kV, 31.5kA three phase busbar disconnecter 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
Class 0.2, ratio 400/200/1 A
Class 5P20, ratio 2000/1 A for bus bar and breaker failure protection.
- 3 Nos. - 120kV, 10kA Class 2 Surge arrestors with counters.
- 1No. - 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
- 1 Lot - Set of connections, connectors, clamps, access ladders etc. including connections to transformer 132kV and neutral bushings.

1.2.2.1.3. 01 No. 36kV Transformer bay comprising:-

- 3 Nos. - 36kV, 10kA, Class 2 single phase Surge Arresters with counters.
- 1 Lot - Set of cable connection between indoor switchgear and outdoor equipment including set of connections, connectors, clamps, structures, access ladders, post insulators, 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, and access ladders etc. including connections to transformer 36kV bushings.

1.2.2.1.4. 03 Nos. of 36kV Line Feeder bays each comprising: -

- 3 Nos. - 36kV, 10kA, Class 2 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.

1.2.2.1.5. 01 No. of 36kV Generator Feeder bay comprising: -

- 3 Nos. - 36kV, 10kA, Class 2 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.

1.2.2.1.6. 01 No. of 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 - Outdoor equipment including set of connections, connectors, clamps, structures, access ladders etc. to connect 33kV outdoor busbars and neutral current transformers.

1.2.2.2. SF₆ INSULATED INDOOR SWITCHGEAR

Panel design which allows removal of panel with lowest disturbance to adjacent panels is preferred. The existing model of the SF₆ insulated switchgear is Siemens 8DA. The existing 36kV SF₆ insulated GIS shall be extended as follows.

1.2.2.2.1. 01 No. 36kV Transformer bay each comprising: -

- 1 Set - 36kV, 2500A, 25kA, three phase bus bars.
- 1 No - 1250A, 36kV, 25kA, 3-phase busbar disconnector 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 800/1 for metering.
- 3 Nos. - Single phase voltage transformers with cores
 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, 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.

1.2.2.2.2. 03 Nos. of 36kV Feeder bays for outgoing lines each comprising: -

- 1 Set - 36kV, 2500A, 25kA three phase bus bars.
- 1 No. - 1250A, 36kV, 25kA three phase busbar disconnecter with earth switch and motor operating mechanism.
- 1 No. - 1250A, 36kV, 25kA three phase circuit breaker complete with operating mechanism.
- 3 Nos. - 36kV 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. - Single phase voltage transformers, ratio 33,000/ $\sqrt{3}$ V:110/ $\sqrt{3}$ V: 110/ $\sqrt{3}$ V
 Class 3P Protection and Class 0.2 for metering.
- 1 Lot - Set of cable terminating chamber, complete with cable box, sealing ends or terminal arrangement suitable for incoming 36 kV cables including all terminating accessories, cable lugs etc.

- 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.

1.2.2.2.3. 01 No. of 36kV Feeder bay for incoming generations comprising:-

- 1 Set - 36kV, 2500A, 25kA three phase bus bars.
- 1 No. - 1250A, 36kV, 25kA three phase busbar disconnecter with earth switch and motor operating mechanism.
- 1 No. - 1250A, 36kV, 25kA three phase circuit breaker complete with operating mechanism.
- 3 Nos. - 36kV current transformers with cores as follows:
Class 5P20, 800/400/1A for directional over current, directional earth fault, over current and earth fault protection.
Class 0.2, 800/400/1A for Energy metering system.
- 3 Nos. - Single phase voltage transformers, ratio 33,000/ $\sqrt{3}$ V:110/ $\sqrt{3}$ V: 110/ $\sqrt{3}$ V
Class 3P Protection and Class 0.2 for metering.

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

- 1 Lot - Set of cable terminating chamber, complete with cable box, sealing ends or terminal arrangement suitable for incoming 36 kV cables including all terminating accessories, cable lugs etc.
- 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.

1.2.2.2.4. 36kV Bus Section bay comprising:-

- 1 Set - 36kV, 2500A, 25kA three phase bus bars.
- 1 No - 2500A, 36kV, 25kA, three phase circuit breaker complete with operating mechanism.
- 2 Nos - 2500A, 36kV, 25kA three phase disconnectors with earth switches.
- 3 Nos. - Current transformers with core as follows:-
Class 5P20, ratio 2500/1A for over current and earth fault protection and for metering with interposing current transformer.

- 3 Nos. - Single phase voltage transformers with cores
- 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 functions of LV protection and control IED
- Class 0.2 ratio 33,000/ $\sqrt{3}$ V:110/ $\sqrt{3}$ V for Energy metering system
- 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.

1.2.2.3. MODIFICATION OF LVAC SWITCH BOARDS

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

1.2.2.3.1. 400V Distribution panel modification comprising:

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

Panel No.1

Auxiliary Power for 145kV Transformer (No.03) bay switchgear

1.2.2.4. BATTERIES, CHARGERS, DISTRIBUTION BOARDS & INVERTER EQUIPMENT

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

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 be undertaken integration work of new control & protection IEDs, Ethernet Switches and AVRs to existing Substation Automation Systems at Chunnakam Grid Substation. However, if required, the contractor shall undertake the integration work of new control and protection IEDs, Ethernet switches and AVR to existing SAS subjected to the approval of the employer.

Control & Protection IEDs and AVR's which will be supplied for Chunnakam 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 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: -

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.

1.2.2.5.2.1 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, AVR's and accessories as per clauses 5.12 and 5.25 of technical specifications shall be provided.

(c) 01 no. of 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 E05 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 may be installed in 36kV switchgear compartment).

- (b) 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	01 No. Protection and Control IED for 36kV Transformer bay	Existing Switch H11 MOXA EDS-508A-MM-SC New 36 kV Ethernet Switch No. 2
2	04 Nos. Protection and Control IEDs for 36kV Outdoor Compact Switchgear feeders for outgoing lines	New 36 kV Ethernet Switch No. 1 Existing Switch SCS 3 MOXA EDS-508A-MM-SC

1.2.2.5.3.1 For 03 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, 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 01 No. 36kV feeder for incoming generations 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, 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 |
| Clause 5.8.5 | - Synchro-check & Synchronizing |

1.2.2.5.3.3 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, 5.12.5 | - Directional and Non-directional Over current protection for LV side |
| Clause 5.12.1, 5.12.5 | - Directional and Non-directional Residual Earth fault protection for LV side |
| Clause 5.12.1, 5.8.2.3 | - RCD function for LV side |
| | - Synchronism Check function for the LV side |
| Clause 5.12.1 | - Monitoring of Lockout relay |
| Clause 5.19 | - Trip circuit supervision |
| Clause 5.8.5, 5.12.1 | - Synchrocheck & Synchronizing |
| Clause 5.6, 5.7, 5.8.2.3, 5.12.2.2 | - Control IED'S on 36kV level |

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

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

- | | |
|------------------------------------|---|
| Clause 5.16.1, 5.16.4 | - 36kV Bus Coupler/ Sectionalizer O/C & E/F Protection. |
| Clause 5.19 | - Trip circuit supervision |
| Clause 5.8.5, 5.16.1 | - 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 comprising with:-

Under frequency load shedding function shall be implemented in the feeder relay itself.

Clause 5.11.1, 5.11.4.3 - Under frequency load shedding

1.2.2.5.3.6 Auxiliary LVAC Control

IEDs shall be provided for indication in Automation System.

1.2.2.5.4. Energy Metering panel 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 nos. : Transformer Energy Measurement
- 04 nos. : Transco Energy meters for 04 outgoing Feeders
- 04 nos. : Disco Energy meters for 04 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. : 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 Chunnakam Grid Substation

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 Chunnakam Grid Substation

The integration work of new control and protection IEDs to existing Gateway at Chunnakam 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 AVR's 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 meet 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 according to IEEE 998-2012 standard. The earth wire to ground the lightning rods shall be provided with suitable insulation level from building and installed not to be touched by a person easily.

1.2.2.9. MODIFICATION OF GROUNDING SYSTEM COMPRISING: -

Grounding system including connections of all steel structures and electrical apparatus to earth mesh and grounding electrodes.

1.2.2.10. POWER AND CONTROL CABLES

1.2.2.10.1. 36kV Power cables and terminations

- 1 Lot - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connections between Power transformer and 36kV indoor switchgear and termination accessories.
- 3 Lots - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connections from indoor 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 indoor switchgear panels to outdoor gantries for Generator feeders 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	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. The power transformer shall be capable of parallel operation with the existing power transformers.

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 as per the price schedule.

1.2.2.17. TOOLS AND INSTRUMENTS

As per the price schedule.

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1.2.3. NADUKUDA GRID SUBSTATION

1.2.3.1. OUTDOOR SWITCHGEAR

1.2.3.1.1. 01 No. 245kV Transformer bay comprising:-

- 3 Nos. - 192kV, 10kA Class 2 single phase surge arrestors with counters.
- 1 No. - Neutral current transformer with core as follows: -
 - Class 5P20 ratio 800/400/1A for Main 1 protection and control IED
 - Class 5P20 ratio 800/400/1A for Main 2 protection and control IED
- 1 Lot - Set of cable connection between indoor switchgear and power transformer outdoor equipment-including set of connections, connectors, clamps, structures, access ladders, cable sealing and or terminal arrangement suitable for incoming 245kV cables etc. to terminate the 245kV cable and connect to the Transformer.
- 1 Lot - Connections, connectors, clamps, and access ladders etc. including connections to transformer 245kV bushings.

1.2.3.1.2. 01 No. 36kV Transformer bay comprising:-

- 3 Nos. - 36kV, 10kA, Class 2 Surge Arresters with counters.
- 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 outgoing 36kV cables etc. to terminate the 36kV cable and connect to the transformer.
- 1 Lot - Connections, connectors, clamps, and access ladders etc. including connections to transformer 36kV bushings.

1.2.3.1.3. 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 - Outdoor equipment including set of connections, connectors, clamps, structures, access ladders etc. to connect 36kV outdoor busbars and neutral current transformers.

1.2.3.2. MODIFICATION OF LVAC SWITCH BOARDS

Existing 400V AC Main switchboard shall be modified to accommodate proposed modifications.

1.2.3.3. MODIFICATION OF BATTERIES, CHARGERS, DISTRIBUTION BOARDS AND INVERTER EQUIPMENT

Existing 220V DC Main switchboard shall be modified to accommodate proposed modifications.

1.2.3.4. PROTECTION, METERING, MONITORING AND CONTROL

1.2.3.4.1. Substation Automation System:-

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

AVR which will be supplied for Nadukuda GS shall be compatible with IEC 61850 protocol. The bidder shall submit IEC 61850 conformance certificate issued by an independent laboratory empowered by IEC International Users Group tested according to the IEC 61850-10 for the AVR.

New AVR should be connected to existing IEC 61850 SAS communication network using protected multimode fiber optic cables. Bidder should provide high quality ICD and CID files of new AVR along with the relevant 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.

1.2.3.4.2. 245 kV Protection & Control facilities:-

1.2.3.4.2.1. For 01 No. Transformer bay comprising with:-

- (a) AVR Panel

AVR shall be mounted on separate panel in the control building.

1.2.3.5. COMMUNICATION EQUIPMENT AND SCADA GATEWAYS/RTUs

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

- 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 with 16 Nos. FXS ports
- 01 No. : Module with 04 numbers of E1 ports for connecting voice trunks

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

1.2.3.5.2. Required SCADA for Nadukuda Grid Substation

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.

1.2.3.5.3. Integration of SCADA for Nadukuda Grid Substation

The integration work of new control and protection IEDs to existing Gateway at Nadukuda 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.

1.2.3.6. LIGHTNING PROTECTION SYSTEM COMPRISING: -

Design and erection of lightning protection system with earth wires in the area which covers the augmentation works according to IEEE 998-2012 standard. The earth wire to ground the lightning rods shall be provided with suitable insulation level from building and installed not to be touched by a person easily.

1.2.3.7. GROUNDING SYSTEM COMPRISING:-

Grounding system including connections of all steel structures and electrical apparatus to earth mesh and grounding electrodes.

1.2.3.8. POWER AND CONTROL CABLES

1.2.3.8.1. 245kV Power cables, joints and terminations

- 1 Lot - 245kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connections between Power transformer and 245kV indoor switchgear.
- 2 Lots - Cable termination for above mentioned cable circuits to be supplied and terminated at power transformer and 245kV GIS bays.

1.2.3.8.2. 36kV Power cables, joints and terminations

- 1 Lot - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connections between Power transformer and 36kV indoor switchgear and termination accessories.
- 1 Lot - 36kV, single core cables with Cu conductor, XLPE insulation, Aluminium sheath, HDPE jacket; for connections between Power transformer and Earthing transformer and termination accessories.

1.2.3.8.3. All low voltage AC power cables and terminations

1.2.3.8.4. All DC power and control cables and terminations

1.2.3.8.5. All cables required for Protection, Control, Instrumentation, Communication, SCADA and termination.

1.2.3.8.6. 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 (armored) and power cables 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.

1.2.3.9. TRANSFORMERS

Following transformers shall be provided.

Item	Description	Qty	Voltage	Rating	Cooling
1.	Power T/F	1	220/33 kV	63MVA	ONAN/ONAF
2	Earthing Transformer	1	33kV	800A, 30s	ONAN

Note: 220kV & 33kV sides of power transformer, 33kV side of earthing transformer and neutral of earthing transformer shall be supplied with outdoor type bushings. This transformer is used for the connection of wind farm to 220kV network. Estimated harmonic levels shall be considered during the designing of power transformer. The power transformer shall be capable of parallel operation with the existing power transformers.

1.2.3.10. SUPPORTING STRUCTURES

All support structures necessary for the works 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.

1.2.3.11. MARSHALLING KIOSK

N/A

1.2.3.12. 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.

1.2.3.13. MISCELLANEOUS WORKS

Any work other than listed above.

1.2.3.14. SPARE PARTS

All necessary Spare parts as per the price schedule.

1.2.3.15. TOOLS AND INSTRUMENTS

As per the price schedule.

Information Copy-Not for Bidding

1.3. CIVIL WORKS, INSTALLATION, OTHER SERVICES AND TRAINING

1.3.1. CIVIL WORKS

1.3.1.1. ANIYAKANDA GRID SUBSTATION

1.3.1.1.1. Preliminary Works

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

1.3.1.1.3. Site formation and up keeping

- (a) Surface Chipping
 - Fill up the surface chipping where temporarily removed

1.3.1.1.4. Cable trenches & ducts

- As per chapter 13 of Technical Specification - Grid Substation.
- Provision shall be made for all future cables.

1.3.1.1.5. Foundations

- (a) For take-off structures & switchgear
 - As required for all the equipment support structures.
- (b) For Main transformers and concrete firewall – 1 No.
 - (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 – 1 No.

1.3.1.1.6. Modification of Lightning protection system

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

1.3.1.1.7. Modification of Water supply & drainage system

- (a) Surface water drainage system
 - As per the specification

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. Construction of control & other buildings

- (a) Site Office at Aniyakanda GSS
 - Temporary Building (Container Type)
- (b) Temporary Works (Stores, access, contractor's offices etc)

1.3.1.1.10. Miscellaneous Works

- Any work other than listed above.

Information Copy-Not for Bidding

1.3.1.2. CHUNNAKAM GRID SUBSTATION

1.3.1.2.1. Preliminary Works

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

1.3.1.2.3. Site formation and up keeping

- a) Surface Chipping
 - Fill up the surface chipping where temporarily removed

1.3.1.2.4. Cable Trenches & Ducts

- As per chapter 13 of Technical Specification - Grid Substation.
- Provision shall be made for all future cables.

1.3.1.2.5. Foundations

- a) For take-off structures & switchgear
 - As required for all the equipment support structures.
- b) For Main transformers – 1 No.
 - (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 – 1 No.

1.3.1.2.6. Modification of Lightning Protection System

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

1.3.1.2.7. Modification of Water Supply & Drainage System

- a) Modification of existing surface water drainage system
 - As per the specification

1.3.1.2.8. Construction of Control & Other Buildings

- a) Site Office at Chunnakam

- Permanent Building with fence and gate (Please refer drawing no. TD/CE/1/184/D/60/02-B and TD/CE/1/184/D/60/00/02)

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

1.3.1.2.9. Maintenance of Roads

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

1.3.1.2.10. Miscellaneous Works

- Any work other than listed above.

Information Copy-Not for Bidding

1.3.1.3. NADUKUDA GRID SUBSTATION

1.3.1.3.1. Cable Trenches & Ducts

- As per chapter 13 of Technical Specification - Grid Substation.
- Provision shall be made for all future cables.

1.3.1.3.2. Foundations

- a) For take-off structures & switchgear
 - As required for all the equipment support structures.
- b) For Main transformer including concrete firewall
- c) Earthing transformers
 - 1 No Earthing transformer

1.3.1.3.3. Lightning protection system

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

1.3.1.3.4. Construction of Control & Other Buildings

- a) Control Building
 - Necessary modification as per chapter 13 of Technical Specification - Grid Substation
- b) Site Office at Nadukuda
 - Temporary Building at site (Container Type).
 - Rented building

1.3.1.3.5. Construction of Building Services

- a) Internal Lighting & small power supply services.
 - Refer chapter 13 of Technical Specification - Grid Substation

1.3.1.3.6. Maintenance of Roads

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

1.3.1.3.7. 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) Aniyakanda Grid Sub Station
- (b) Chunnakam Grid Substation
- (c) Nadukuda 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: 04 Nos.
(Mileage to be covered is 3000km 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) Aniyakanda 132/33kV Grid Substation
- (b) Chunnakam 132/33kV Grid Substation
- (c) Nadukuda 220/33kV 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;

A local training at site shall be provided to 10 Engineers and 10 Electrical Superintendents as per the clause **14.2.14: Operators Training**.

Annex A

Aniyakanda GSS	TYPE OF SIGNAL	VOLTAGE	132/33 kV T/F 3		33 kV			
		BAY No						
		BAY TYPE	132 kV side	33 kV side	F2-A	F2-B	F6-A	F6-B
CONTROLS		ACTION						
Circuit Breaker	DPC	Open/ Close	2	2	2	2	2	2
BB Isolator 1	DPC	Open/ Close	2	2	2	2	2	2
BB Isolator 2	DPC	Open/ Close						
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				
Protection Master relay Reset Command K86.2	SPC	Reset	1	1				
Protection Reset Command K96 (BB/BCF relay Reset)	SPC	Reset	1	1				
Load Shedding OFF	SPC	On/Off						
STATUS INDICATIONS		STATUS						
Circuit Breaker	DPI	Open/ Close	2	2	2	2	2	2
BB Isolator 1	DPI	Open/ Close	2	2	2	2	2	2
BB Isolator 2	DPI	Open/ Close						
Line Isolator	DPI	Open/ Close						
Capacitor Bay Isolator	DPI	Open/ Close						
Earthing Switch	DPI	Open/ Close		2	2	2	2	2
Bay Control	DPI	Local/Superv/Remote	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
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) - ***									
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
Earth Fault Protection Operated	SPI	Operated/ Normal			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
Trip Relay Operated/ Protection Relay K86.1 /Lockout Relay operated	SPI	Set/ Reset	1	1	1	1	1	1
Trip Relay Operated/Protection Relay K86.2	SPI	Set/ Reset	1					
Protection Relay K96	SPI	Set/ Reset						
Under Frequency Trip	SPI	Operated/ Normal			1	1	1	1
Over Frequency Trip	SPI	Operated/ Normal			1	1	1	1

Main 1 Protection Relay Fail	SPI	Healthy/ Fail	1						
Main 2 Protection Relay Fail	SPI	Healthy/ Fail	1						
Back Up Protection Relay Fail	SPI	Healthy/ Fail	1						
Auto Relclose ON/OFF	SPI	ON / OFF							
33kV protection Operated	SPI	Operated/ Normal			1	1	1	1	
BUSBAR PROTECTION									
Bus Bar Protection Operated	SPI	Operated/ Normal	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 >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	
Bus Voltage Failure - ***									
a	Auxiliary 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) - ***									
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/ Superviosry						
ENERGY MEASUREMENTS									
Active Energy		AI	MWh			1	1	1	1
Re-Active Energy		AI	Mvarh			1	1	1	1
MEASUREMENTS			UNITS						
Voltage		AI	Volts	1	1	1	1	1	1
Frequency		AI	Hertz						
Active Power		AI	MW	1	1	1	1	1	1
Reactive Power		AI	MVar	1	1	1	1	1	1
Current		AI	Amperes	1	1	1	1	1	1
Transformer Tap Position		AI	Tap number	1					
GENERAL									
Air Condition Temprature		AI	Celcius						
Humidity		AI	RH %						

Chunnakam GS	TYPE OF SIGNAL	VOLTAGE	132/33kV T/F 3		33 kV					
		BAY No	132 kV side	33 kV side	F1	F2	F3	F4	BS	BB 1
		BAY TYPE								
CONTROLS		ACTION								
Circuit Breaker	DPC	Open/ Close	2	2	2	2	2	2	2	
BB Isolator 1	DPC	Open/ Close	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 K86 (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	
BB Isolator 1	DPI	Open/ Close	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	4	
Bay Control	DPI	Local/Superv/ Remote	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	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	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		
Earth Fault Protection Operated	SPI	Operated /Normal			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		
Trip Relay Operated/ Protection Relay K86.1 /Lockout Relay operated	SPI	Set/Reset	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			
Over Frequency Trip	SPI	Operated /Normal			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			
BUSBAR PROTECTION											
Bus Bar Protection Operated	SPI	Operated /Normal	1							1	

TRANSFORMER PROTECTION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
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ENERGY MEASUREMENTS													
Active Energy	AI	MWh			1	1	1	1					
Re-Active Energy	AI	Mvarh			1	1	1	1					
MEASUREMENTS													
Voltage	AI	Volts	1	1	1	1	1	1	1				1
Frequency	AI	Hertz											1
Active Power	AI	MW	1	1	1	1	1	1	1	1			
Reactive Power	AI	MVA _r	1	1	1	1	1	1	1	1			
Current	AI	Amperes	1	1	1	1	1	1	1	1			
Transformer Tap Position	AI	Tap number		1									
GENERAL													
Air Condition Temperature	AI	Celcius											
Humidity	AI	RH %											

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Nadukuda GSS	TYPE OF SIGNAL	VOLTAGE	220/ 33 kV T/F 3	
		BAY No		
		BAY TYPE	220 kV side	33 kV side
CONTROLS		ACTION		
Circuit Breaker	DPC	Open/ Close	2	2
BB Isolator 1	DPC	Open/ Close	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
Protection Master relay Reset Command K86.2	SPC	Reset	1	1
Protection Reset Command K96 (BB/BCF relay Reset)	SPC	Reset	1	1
Load Shedding OFF	SPC	On/Off		
STATUS INDICATIONS		STATUS		
Circuit Breaker	DPI	Open/ Close	2	2
BB Isolator 1	DPI	Open/ Close	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
Bay Control	DPI	Local/Superv/ Remote	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
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
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		
Earth Fault Protection Operated	SPI	Operated /Normal		
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
Trip Relay Operated/ Protection Relay K86.1/ Lockout Relay operated	SPI	Set/Reset	1	1
Trip Relay Operated/Protection Relay K86.2	SPI	Set/Reset	1	
Protection Relay K96	SPI	Set/Reset		
Under Frequency Trip	SPI	Operated /Normal		
Over Frequency Trip	SPI	Operated /Normal		
Main 1 Protection Relay Fail	SPI	Healthy/ Fail	1	
Main 2 Protection Relay Fail	SPI	Healthy/ Fail	1	
Back Up Protection Relay Fail	SPI	Healthy/ Fail	1	
Auto Relclose ON/OFF	SPI	ON / OFF		
33kV protection Operated	SPI	Operated /Normal		
BUSBAR PROTECTION				
Bus Bar Protection Operated	SPI	Operated /Normal	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		
Bus Voltage Failure - ***		SPI	Healthy/ Faulty		
a	Auxiliary 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		
Re-Active Energy		AI	Mvarh		
M E A S U R E M E N T S					
			UNITS		
Voltage		AI	Volts	1	1
Frequency		AI	Hertz		
Active Power		AI	MW	1	1
Reactive Power		AI	MVAr	1	1

Current	AI	Amperes	1	1
Transformer Tap Position	AI	Tap number	1	
GENERAL				
Air Condition Temperature	AI	Celsius		
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**

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Annex B

Gateway/RTU Configuration Parameters of Signals

Signal Description	Type e Of Sign al	Signal Type Description				User Data of Class
		For IEC 60870 - 5 - 101		For IEC 60870 - 5 - 104		
		Type ID No.	Description	Type ID No.	Descriptio n	
<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
<u>Status Indications</u>						
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
<u>Alarm Indications:</u>						
CIRCUIT BREAKER						
Breaker Fault (critical) -**	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
SF6 Gas Pressure low (2nd stage)						
Trip Circuit Supervision Fail 1 (Trip circuit faulty)						
Trip Circuit Supervision Fail 2 ((Trip circuit 2 faulty)						
Spring Not Charge (Spring Supervision)						
Hydraulic Pressure Low						
Pneumatic Pressure Low.						
CB Pole Discrepancy						
Trip Lockout/Close Lockout (SF6 Lock out)						
Control Voltage Failure (DC MCB trip)						

Internal Arc trip						
SF6 Gas Pressure low in Bus Bar Chamber						
Bay Fault (Non critical)-***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
SF6 Gas Pressure Low - First step						
PT Secondary MCB Trip(Protection VT MCB Failed/ Incoming Voltage MCB trip/ VT MCB trip)						
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
Transf Buchholz Alarm						
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	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Oil Temperature Alarm						
Winding HV Temperature Alarm						
Winding LV Temperature Alarm						
Temperature trip - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Oil Temperature trip						
Winding HV Temperature trip						
Winding LV Temperature trip						

General Alarm- ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Cooling Fan Fail (Group 1/Group 2)						
Transformer Oil Level low						
OLTC Oil level low						
General Trip- ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
OLTC Surge Trip						
Main tank Pressure Release Valve (PRV) Trip						
OLTC Pressure Release Valve						
Transformer Oil Level low TRIP						
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	2	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
Auxiliary Supply Voltage						

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 Malfuntion)	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
48V Battery Charger 2 Fail						
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
220 V Battery Charger 2 Fail /(Rectifier 1 Fault)						
220 V Battery Charger 1 Fail (Rectifier 2Fault)						
Station Urgent Fault - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Fox Faulty Urgent Alarm						
Station Non Urgent Fault - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
Diesel Generator Alarm						
Fox Faulty Non Urgent Alarm						
Station Control Remote/Supervisory	LPI	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
<u>Measurements</u>						
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

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	<u>ASDU</u>
	<u>Type ID</u>
DPI - Double Point Indication	C_DC_NA_1 :- Double Command
SPI - Single Point Indication	C_SC_NA_1 :- Single Command
DPC - Double Point Command	M_DP_TA_1 :- Double Point Information with time tag

SPC - Single Pont Command	M_SP_TA_1 :- Single Point Information with time tag
BCP - Binary Coaded Measurement	M_ME_NC_1 :- Measured Value, short floating point number
AI - Analog Input	M_DP_TB_1 :- Double Point Information with time tag CP56Time2a
AO - Analog Out Put	M_SP_TB_1 :- Single Point Information with timw tag CP56Time2a
TC -Tap Controller	M_IT_NA_1 :- Integrated Totals
	C_SE_NC_1:- Set Point Command,Short Floating point
	C_SC_TA_1 :- Single point Command with Timetag CP56Time2a
	C_DC_TA_1:- Double point Command with Timetag CP56Time2a

**** For Grouped 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
	Tap Changer	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	Protection Reset	SPC	45	C_SC_NA_1	45	C_SC_NA_1	Class 1
	<u>Status Indications</u>						
	Circuit Breaker	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	Transformer Isolator	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 2
	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
	Line Isolator	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 2
	Shunt 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						
	Tap Control	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	T/F AVR Operating mode	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	T/F AVR Operating mode	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Tap Position Binary	BCI	15	M_IT_NA_1	15	M_IT_NA_1	Class 2
	<u>Alarm Indications</u>						
	CIRCUIT BREAKER						
	Breaker Fault (critical)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	SF6 Gas Pressure low (2nd stage)						
b	Trip Circuit Supervision Fail						
c	Spring Charge Fail						
d	Hydraulic Pressure Low						
e	Pneumatic Pressure Low.						
f	CB Pole Discrepancy						
g	Trip Lockout/Close Lockout						
h	Control Voltage Failure						
	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						
c	Voltage Failure Indication						
	TRANSFORMER						
	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	Tank						
b	OLTC						
	Transf Buchholz Trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Tank						
b	OLTC						
	Temperature Alarm	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Oil						
b	Winding						
	Temperature trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Oil						
b	Winding						
	General Alarm	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Cooling Fan Fail						
b	Transformer Oil Level						
	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						
	PROTECTION SIGNALS						
	LINE PROTECTION						
	Main Protection 1 Trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main Protection 2 Trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Back-Up Protection Trip	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	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	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Permissive Intertrip Received	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
	Protection Relay Reset	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
	BUSBAR PROTECTION						
	Bus Bar Protection Operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	TRANSFORMER PROTECTION						
	Transformer Protection Operated(Diff, Restricted Earth Fault)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Transformer Backup Protection Operated(Overcurrent/Earth Fault)	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
	Auxiliary Supply Voltage	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	DC Voltage Failure	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	RTU Alarm	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Communication Alarm	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
	Battery Charger Failure (Station)	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Station Urgent Fault	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Station Non Urgent Fault	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Station Control Disabled	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	ENERGY MEASUREMENTS						
	Active Energy (Pulse Outputs) from Meters	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Re-Active Energy (Pulse Outputs)- from Meters	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	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
	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 Point 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)

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.

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

<div>(Name of GSS) NSCC SIGNAL LIST - SINGLE POINT INDICATIONS</div>											
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				

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

Information Copy-Not for Bidding