CEYLON ELECTRICITY BOARD
SRI LANKA

MANNAR NADUKUDA EMBILIPITIYA GRID SUBSTATIONS AUGMENTATION PROJECT

(Funds: Savings from ADB Loan Nos.3585-SRI and 3147-SRI)

GRID SUBSTATIONS

Procurement of Plant

Design, Supply, and Installation

Single-Stage: Two-Envelope Bidding Procedure

BIDDING DOCUMENT FOR

Augmentation of:

Mannar 220/33 kV Grid Substation

Nadukuda 220/33 kV Grid Substation

Embilipitiya 132/33 kV Grid Substation

VOLUME 4 of 8

Part II- REQUIREMENTS

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

Issued on: 02 Sep 2021

Invitation for Bids No.: CEB/AGM/PRO/2021/IFB/MNEGSAP

OCB No.: CEB/AGM/PRO/2021/OCB/MNEGSAP

Employer: Ceylon Electricity Board

Country: Sri Lanka

Projects Division

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Sri Lanka

Document – Revision 1

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 June 2018.

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.

Savings of ADB Loan No. 3585-SRI is used for the Augmentation of Mannar Grid Substation and Nadukuda Grid Substation. Savings of ADB Loan No. 3147-SRI is used for the Augmentation of the Embilipitiya Grid Substation. In order to make the payment for the augmentation of Mannar Grid Substation and Nadukuda Grid Substation by ADB Loan No. 3585-SRI and augmentation of Embilipitiya Grid Substation by ADB Loan No. 3147-SRI, this procurement is separated into two lots as follows.

Lot A - Augmentation of Mannar 220/33kV Grid Substation and Nadukuda 220/33kV Grid Substation
Lot B - Augmentation of Embilipitiya 132/33kV Grid Substation

Separation of this procurement into two lots is only for the above mentioned purpose. It is mandatory for all Bidders to bid for both lots (Lot A and Lot B). Preparation of Bidding Document, evaluation, awarding etc. is carried out accordingly and a single contract that includes both lots will be signed with the successful Bidder.

Table of Contents - Summary Description

VOLUME 6 OF 8

PART II REQUIREMENTS

VOLUME 7 OF 8

PART II REQUIREMENTS

VOLUME 8 OF 8

PART III CONDITIONS OF CONTRACT AND CONTRACT FORMS

Section 6 - Employer's Requirements

Part A - Scope of Works

TABLE OF CONTENTS

LOT A

AUGMENTATION OF MANNAR 220/33 kV GRID SUBSTATION

AUGMENTATION OF NADUKUDA 220/33 kV GRID SUBSTATION

LOT A

1 SCOPE OF WORKS

1.1 GENERAL DESCRIPTION OF THE PROJECT

1.1.1 AUGMENTATION OF MANNAR GRID SUBSTATION

Augmentation of Mannar Grid Substation shall consist of following main features.

1. 245kV outdoor air insulated switchgear with extension to the existing double busbar arrangement comprising of 02 Nos. 245kV Transformer bays.
2. 02 Nos. 220/33 kV, 63MVA Power Transformers.
3. 02 Nos. 33kV, 800A Earthing Transformers.
4. 01 No. 33/0.4kV, 160kVA Auxiliary Transformers.
5. Extension to the 36kV indoor SF6 gas insulated switchgear with single busbar arrangement comprising of
   - 02 Nos. 36kV Transformer bays
   - 12 Nos. 36kV Generator feeder bays
   - 01 No. 36kV Bus Section bay
   - 01 No. 36kV Bus Section bay/ interfacing panel
6. 12 Nos. of 36kV Outdoor line gantries including 36kV cable terminations.
7. Additions / modifications on Control, Metering, Monitoring and Protection equipment.
8. Additions / modifications on Batteries and DC equipment, LVAC, Chargers and Inverter equipment etc.
9. Additions / modifications on SCADA & Communication equipment
10. Additions / Modification of Substation Automation System.
11. Additions / modifications of Energy Metering System.
12. Modifications to the Digital Disturbance Recorder.
13. Power and Control cables including terminations.
14. Additions / modifications on Substation grounding system and shield earth wire system.
15. Electrical, Civil and Mechanical works required for substation and control building.
16. Spare parts.

1.1.2 AUGMENTATION OF NADUKUDA GRID SUBSTATION

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

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

1.1.3 SCOPE OF WORKS RELATED TO FEEDING END GRID SUBSTATIONS

Not Applicable

1.1.4 TERMINAL POINTS

A. Mannar 220/33kV Grid Substation

The following shall be the contract terminal points:-

(a) 245kV Outdoor Busbar interface

The existing 245kV busbar shall be extended to connect the new transformer bays. This contract includes the connections and connectors from the existing 245kV busbar to new 245kV busbar.

(b) 36kV Overhead Line/ Switchgear interfaces

36kV overhead distribution lines terminate at the line bay gantries erect under this contract. 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 gas insulated switchgear shall be extended to connect the new 36kV transformer bays and 36kV generator bays including bus section bay/interfacing panel between the existing and new indoor switchgear panels. 36kV cables and terminations shall be provided under this contract.

(d) Control and Protection interface

This contract includes the modifications to the existing control and protection system with the addition of 220kV bus extension and two nos. of 220/33 kV power transformers including extension to the existing busbar protection scheme.

(e) Substation Automation System (SAS) interface

Proposed 220kV and 33kV system protection and control IEDs shall be covered under this project. Connecting IEDs to network and field signal testing associated with commissioning shall be carried out by the contractor. Integration of new IEDs into existing Substation Automation System will be carried out by SAS unit of CEB.

(f) Communication interface

This Contract includes the modifications to the existing communication system up to the interface panel or RTU as per detailed scope of work to include the new bays.

B. Nadukuda 220/33kV Grid Substation

The following shall be the contract terminal points:-

(a) 245kV switchgear Interface

245kV GIS feeder bay is available to connect the fourth transformer. Connection of new 220/33 kV power transformer to the existing 245 kV GIS

with 245 kV underground power cable with terminations are included to this contract.

(b) 36kV switchgear interface

36kV GIS feeder bay is available to connect the fourth transformer. Connection of new 220/33 kV power transformer to the existing 36 kV GIS with 36 kV underground power cable with terminations are included to this contract.

(c) Control and Protection interface

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. Commissioning of the existing protection schemes of the transformer bay is also included in this contract.

(d) Transformer AVR interface

This contract includes the supply, installation and commissioning of a new AVR for new transformer with both minimum circulating current method and master follower method for parallel operation with existing 220/33 kV 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. Connecting IEDs to network and field signal testing associated with commissioning shall be carried out by the contractor. Integration of new IEDs into existing Substation Automation System will be carried out by SAS unit of CEB.

1.1.5 SITE ENVIRONMENTAL CONDITIONS

Mannar and Nadukuda

Altitude of site above sea level not exceeding	m	100
Maximum ambient air temperature	^{0}C	38.5
Minimum ambient air temperature	^{0}C	15.5
Average yearly temperature	^{0}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
Atmospheric Corrosivity Category (ISO12944-2)		C5M

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.

1.2 PLANT & EQUIPMENT INCLUDING MANDATORY SPARE PARTS

1.2.1 MANNAR GRID SUBSTATION

1.2.1.1 OUTDOOR SWITCHGEAR

Insulators of all outdoor 245kV switchgears and insulator strings shall be RTV silicone coated.

1.2.1.1.1 Extension to the existing 245kV double busbar system comprising:-

1 Set - 3000A, 245kV, 40kA three phase tubular double busbar with post insulators.

(The existing double busbar system shall be extended as per the drawing no.

TD/CE/1/201/D/00/01-A and TD/CE/1/201/D/01/01-A)

1.2.1.1.2 02 Nos. of 245kV Transformer bays each comprising:-

2 Nos. - 1250A, 245kV, 40kA three phase busbar disconnector with hand and motor operating mechanism.

1 No. - 1250A, 245kV, 40kA three phase circuit breaker complete with operating mechanism etc.

3 Nos. - 245kV, 40kA 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 3000/1A for bus bar and breaker failure protection.

3 Nos. - 192kV, 10kA Class 2 Surge arrestors with leakage current indicators and counters.

1No. - Neutral Current Transformer with core as follows:-
Class 5P20 ratio 400/1A for Main 1 protection and control IED

Class 5P20 ratio 400/1A for Main 2 protection and control IED

1 Lot - Set of connections, connectors, clamps, access ladders etc. including connections to transformer 220kV and neutral bushings.

1.2.1.1.3 02 Nos. of 36kV Transformer bays each comprising:-

3 Nos. - 36kV, 10kA, Class 2 Pluggable Surge arresters with counters

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 and DDR.

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

1.2.1.1.4 01 No. of 36kV Auxiliary transformer bay each comprising:-

1 Lot - Set of cable connections between Power transformer and Auxiliary transformer including set of connections, connectors, clamps, structures, access ladders, cable sealing end or terminal arrangement suitable for incoming 36kV cables etc. to terminate the 36kV cable and connect to the transformer.

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

1 Lot - Set of cable connection between indoor LVAC switchgear and LV cable box including set of connections, connectors, clamps, structures.

1.2.1.1.5 02 Nos. of 36kV Earthing transformer bays each comprising:-

1 Lot - Set of cable connections between Power transformer and Earthing transformer including set of connections, connectors, clamps, structures, access ladders, cable sealing end or terminal arrangement suitable for incoming 36kV cables etc. to terminate the 36kV cable and connect to the transformer.

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

1 Lot - Outdoor equipment including set of connections, connectors, clamps, structures, access ladders etc. to connect neutral current transformers.

1.2.1.1.6 12 Nos. of 36kV Generator 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.

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

1.2.1.2 SF_6 INSULATED INDOOR SWITCHGEAR

Panel design which allows removal of panel with lowest disturbance to adjacent panels is preferred.

1.2.1.2.1 02 Nos. 36kV Transformer bays each comprising:-

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

1 No - 2500A, 36kV, 25kA, three phase busbar disconnector with earth switch and motor operating mechanism.

1 No - 2500A, 36kV, 25kA, three phase circuit breaker complete with operating mechanism.

3 Nos. - 36kV current transformers with cores as follows:

Class 5P20, ratio 2000/1A for HV Main 1 protection and control IED

Class 5P20, ratio 2000/1A for HV Main 2 protection and control IED, DDR, AVR and LV protection and control IED.

Class 0.2 ratio 2000/1 for metering.

3 Nos. - Single phase voltage transformers with cores:

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, DDR and LV protection and control IED.

Class 0.2 ratio 33,000/√3V:110/√3V for Energy metering system.

1 Lot - Cable terminating chamber, complete with cable box, sealing end or terminal arrangement including cable termination suitable for incoming 36kV cables.

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

1.2.1.2.2 12 Nos. of 36kV Feeder bays for incoming generations each comprising:-

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

1 No. - 1250A, 36kV, 25kA three phase busbar disconnector 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/√3V:110/√3V:110/√3V Class 0.2 for energy metering of incoming generation and Class 3P for protection.

Note: These 36kV generator feeder bays require live-bus/dead-line detecting system.

1 Lot - Cable terminating chamber, complete with cable box, sealing end or terminal arrangement including cable termination suitable for incoming 36kV cables.

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

1.2.1.2.3 01 No. of 36kV Bus Section bay comprising:-

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

2 Nos. - 2500A, 36kV, 25kA three phase disconnector with earth switch and motor operating mechanism.

1 No - 2500A, 36kV, 25kA, three phase circuit breaker complete with operating mechanism.

3 Nos. - 36kV 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.

6 Nos. - Single phase voltage transformers with cores as follows:

Class 3P ratio 33,000/√3V:110/√3V for for Protection and control IED

Class 0.2 ratio 33,000/√3V:110/√3V 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.

1.2.1.2.4 Interconnection Arrangement and Bus Section bay between existing 36kV SF_6 insulated indoor switchgear and new 36kV SF_6 insulated indoor switchgear:-

The make of existing 36 kV GIS of Mannar 220/33 kV Grid Substation is LSIS South Korea and it is fed by existing 45 MVA transformer. In an event of a failure of the 45MVA transformer, the existing 36kV GIS needs to be fed from new 63 MVA transformers to be installed in Mannar GSS under this contract. Therefore the new 36 kV GIS procured under this contract shall be connected to existing 36 kV GIS by suitable interconnection arrangement with 36kV Bus section comprising with:-

1 Set	-	36kV, 2500A, 25kA three phase busbars.
2 Nos.	-	2500A, 36kV, 25kA three phase disconnector with earth switch and motor operating mechanism.
1 No	-	2500A, 36kV, 25kA, three phase circuit breaker complete with operating mechanism.
3 Nos.	-	36kV 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.
1 Lot	-	Accessories required for interconnection arrangement between existing 36kV GIS and new 36kV GIS.
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.

Please refer the drawing no. TD/CE/1/201/D/00/01-A, TD/CE/1/201/D/00/01-C and TD/CE/1/201/D/60/01-B. The bidder shall submit the details of interconnection arrangement with the bid.

1.2.1.3 ADDITIONS / MODIFICATIONS TO THE EXISTING LVAC SWITCH BOARDS

The existing 400V switchboards shall be modified to add new auxiliary transformer and change over operation.

1.2.1.3.1 Additions / modifications to the existing 400V Distribution panel comprising:-

MCB for following distribution Circuits (Number of Phases and rating shall be according to the load required.)

Essential loads

Main transformer No. 2 OLTC & cooling fans

Main transformer No. 3 OLTC & cooling fans

Others as necessary

Panel No.1

245kV Switchgear Auxiliary Power

36kV Switchgear Auxiliary Power

Cubicle lighting & space heater

Others as necessary

Panel No.2

245kV Switchgear Auxiliary Power

36kV Switchgear Auxiliary Power

Others as necessary

1.2.1.4 ADDITIONS / MODIFICATIONS TO THE DC DISTRIBUTION BOARDS

Addition of new DC distribution panel to the existing 220V DC system to accommodate the load of proposed augmentation works including modifications to the existing DC distribution board.

1.2.1.5 PROTECTION, METERING AND CONTROL

1.2.1.5.1 Additions / Modifications to the Substation Automation System:-

Following items shall be supplied as per the Clause: 5.24 of Chapter 5, Technical Specification - Grid Substation of bidding document and architecture drawing for SAS in Annexure 7.

1 No. - Engineering Workstation (EWS) with two 27' Monitors

1 No . - Industrial type layer 2 Manageable Gigabit Ethernet Switch and Ethernet connections. Operator Workstation 1 (HMI-1), Operator Workstation 2 (HMI-2), Engineering Workstation (EWS), and Firewall shall be connected to the switch.

1 No - Next Generation Firewall

4 Nos. - Industrial type layer 2 Manageable Ethernet Switch and connections for two power transformer bays and two 33 kV bus sections.

CEB will carry out integration work of new control & protection IEDs to existing Substation Automation Systems at Mannar Grid Substation.

The connecting IEDs to network and field signal testing associated with commissioning shall be carried out by the contractor as per the Site Acceptance Tests and Commissioning section of Clause: 5.24 of Chapter 5, Technical Specification - Grid Substation of bidding document.

1.2.1.5.2 Additions / Modification to the existing Digital Disturbance Recorder System:-

1 Lot - Existing Digital Disturbance Recorder (DDR) shall be expanded to include the new bays with 40 Analog Channels and 40 Digital Channels as per clause 5.21 of Technical Specifications.

1.2.1.5.3 245 kV 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 245kV bay as per clause 5.19.

1.2.1.5.3.1 For 02 Nos. of 245kV Transformer comprising with:-

Protection and control panel and Mechanical protection and control panel shall be provided as per clause 5.12 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.

b) Mechanical Protection and Control Panel

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

1.2.1.5.3.2 Extension to the 245kV Busbar protection and Bus Coupler bay protections and Control system comprising with:-

The 245kV new Transformer bays shall be integrated to the existing busbar and breaker failure protection scheme by providing all necessary relays, central unit interfacing modules, bay protection modules and software/ firmware upgrades if required. Protection/control and monitoring functions listed under clause 5.14 of Technical Specifications shall be included in respective IEDs.

1.2.1.5.4 36kV Protection & Control facilities:-

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

1.2.1.5.4.1 For 02 Nos. of 36kV Transformer bays each comprising with:-

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

Clause 5.12.2	- Directional and Non-directional Over current protection for LV side - Directional and Non-directional Residual Earth fault protection for LV side - BCU function for LV side - Synchronism Check function for the LV side - Monitoring of Lockout relay
Clause 5.19	- Trip circuit supervision
Clause 5.9.5.2	- Synchrocheck & Synchronizing
Clause 5.8.1 and clause 5.8.2	- Control IED'S on 36kV level

Operation counter auto-trip for circuit breaker.

Operation counter hand-trip for circuit breaker.

1.2.1.5.4.2 For 02 No. of 36kV Bus Section 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 5.16	- Bus Section Bay General requirements
Clause 5.16.4	- General Requirements for 33kV Bus Section Protection including directional Over current & Earth fault.
Clause 5.19	- Trip Circuit Supervision.

Clause 5.8.1 and clause 5.8.2 - Control IED'S on 36kV level

Operation counter auto-trip for circuit breaker.

Operation counter hand-trip for circuit breaker.

1.2.1.5.4.3 For 12 Nos. of 36kV Generator feeder 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 5.11.1	- General Requirements
Clause 5.11.4	- Protection/Control Functions Required in 11kV/33kV Feeder Protection (All the clauses under this shall be complied for TCS, BF protection etc.)
Clause 5.11.5	- Trip Matrix
Clause 5.11.6	- Interlocking
Clause 5.19	- Trip Circuit Supervision.

Clause 5.8.1 and clause 5.8.2 - Control IED'S on 36kV level

Clause 5.8.5 - Synchro-check & Synchronizing

Operation counter auto-trip for circuit-breaker.

Operation counter hand-trip for circuit breaker.

1.2.1.5.4.4 Gas Pressure Monitoring System

Gas Pressure Monitoring System shall be provided.

Clause 2.2.1.8.(e) - Gas Monitoring Device

1.2.1.5.4.5 Station Alarm and Annunciation

Modification of existing input modules and annunciator shall be provided as per Clause 5.20 of the Technical Specification - Grid Substation.

1.2.1.5.5 Energy Metering panels comprising with:-

The existing energy metering system shall be modified to incorporate new energy metering panels as per the chapter 9 of the Technical Specification-Grid Substation. Two separate sets of 36kV energy meter panels named as Transco and Disco are required where each set includes Energy meters for Transformers and feeders.

Transco Energy Metering panel set:

Energy meters with modems as specified in chapter 9 of the Technical Specification-Grid Substation for Transformers and 36kV feeders.

Disco Energy Metering panel set:

Energy meters with modems as specified in chapter 9 of the Technical Specification-Grid Substation for Transformers and 36kV feeders.

Ethernet Network Switch:

Ethernet switches for each set of Transco and Disco panels as specified in chapter 9 of the Technical Specification-Grid Substation.

1.2.1.6 ADDITIONS / MODIFICATIONS TO THE EXISTING COMMUNICATION EQUIPMENT AND SCADA GATEWAYS/RTUS

1.2.1.6.1 Fiber Optic Multiplexer at Mannar Grid Substation

The existing Fiber Optic Multiplexer (FO615 by ABB) shall be extended with following interfaces.

1 No.	-	Optical interface module of type SAMO5 with SFPs and patch cables for Nadukuda and New Anurafdhapura directions
2 Nos.	-	Optical patch cables
2 Nos.	-	Small Form-factor Pluggable (SFP) optical transceiver modules (with DDM support) of 1.25Gbit/s

The required extension modules shall be supplied as loose materials. The installation and commissioning work of the existing fibre optic multiplexer at Mannar GSS shall be carried out by CEB.

1.2.1.6.2 Required SCADA for Mannar Grid Substation

SCADA Gateway

The integration work of new control and protection IEDs to existing Gateway at Mannar Grid Substation will be undertaken by CEB.

Bidder 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.

The integrated SCADA signals shall be tested up to the NSCC by the contractor together with the CEB.

The SCADA signals shall be integrated as given in "Annex A1". Gateway communication path configuration parameters are given in "Annex B".

Configuration of NSCC SCADA Master Station for integration of the signals shall be done by the CEB. All the integrated signals shall be tested up to the NSCC by the contractor.

Required SCADA Signals and Commissioning of Mannar GS to proposed DCC

The integration work of all the signals relevant to the Mannar Grid Substation mentioned in the "Signal List for Mannar Substation- Annex A1" to existing Gateway at

Mannar Grid Substation will be undertaken by CEB to the Distribution Control Center (DCC) SCADA System through the gateways.

Bidder shall provide the required licenses for upgrading the gateway to CEB in order to carry out Gateway modification work

Configuration of DCC SCADA Master Station for integration of the signals shall be done by the CEB. The integrated signals shall be tested up to the DCC by the contractor.

All the signals related to augmented bays of Mannar GSS as per Signal List given in "Annex A1-Mannar GS" shall be configured in the existing Gateway at Mannar GS as per the IEC 60870 – 5 – 104 protocol. Gateway configuration parameters are given in "Annex B". Finalized Signal List shall be submitted at least 02 weeks prior to the commissioning as per the format given in Annex D. Configuration of National System Control Center (NSCC) SCADA Master Station for integration of the signals shall be done by the CEB. The integrated signals shall be tested up to the NSCC by the contractor. Required license upgrading, software and hardware modifications shall be done by the contractor. The existing separate remote control level for NSCC operations and interlocking operations shall be activated for the new bays as well for the NSCC operations. Existing signals before the modification of the Gateway shall be available after the modification and all the control signals shall be tested and verified with the NSCC. Final configuration of Database and Project file (Gateway backup files) shall be provided. (As CD/DVD or Portable external hard disk). If any Software upgradation is required for the modification work, that software version shall be provided with the license. (As CD/DVD or Portable external hard disk)

1.2.1.6.3 Modifications required at New Anuradhapura Grid Substation

The existing Fiber Optic Multiplexer (FO615 by ABB) shall be extended with following interfaces.

1 No.	-	Optical interface module of type SAMO5
3 Nos.	-	Teleprotection interface modules of type TEPI1 (for the direction of Mannar GSS)
1 No.	-	Teleprotection interface modules of type OPIC1 (for the direction of Mannar GSS)
2 Nos.	-	Small Form-factor Pluggable (SFP) optical transceiver modules (U 1.2) and 02 nos. of patch cable 10m LC/PC-FC/PC
2 Nos.	-	Small Form-factor Pluggable (SFP) optical transceiver modules (with DDM support) of 1.25Gbit/s and 02 nos. Optical patch cables

The required extension modules shall be supplied as loose materials. The installation and commissioning work of the existing fibre optic multiplexer at New Anuradhapura GS shall be carried out by CEB.

1.2.1.7 ADDITIONS / MODIFICATIONS TO THE EXISTING SUBSTATION EARTHING SYSTEM:-

The existing substation earthing system shall be modified and extended to accommodate the augmentation works as per the requirements stated in Chapter 7 of the Technical Specification – Grid Substation. This shall include excavation, backfilling and reinstatement of the ground, driving the earth rods and making of the connections. This shall include additional earth materials to reach the specified value of earth resistance.

An earthing conductor of 95 mm^2 shall be installed into each borehole in order to connect with the substation earthing system later. This conductor shall be reached to the bottom most level of the borehole. The material of this earthing conductor shall be Copper commercial hard drawn and the surrounding space of this conductor shall be filled with electrically conductive aggregate material/earthing enhancement compound conforming to IEC 62561-7:2011 with the approval of the employer's representative. Locations of the boreholes are indicated in the substation layout drawing no. TD/CE/1/201/D/01/01-A. Advancing of boreholes shall be according to the clause 13 of the technical specification.

1.2.1.8 ADDITIONS / MODIFICATION TO THE EXISTING LIGHTNING PROTECTION SYSTEM COMPRISING:-

Additions and Modification of existing lightning protection system shall include design and erection of lightning protection system with shield earth wires to accommodate the augmentation works. 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 ADDITIONS / MODIFICATION TO THE EXISTING GROUNDING SYSTEM COMPRISING:-

The existing grounding system shall be extended to accommodate the augmentation work including connections of all steel structures and electrical apparatus to earth mesh and grounding electrodes.

1.2.1.10 POWER AND CONTROL CABLES

The Contractor shall be responsible for the supply, installation, termination and testing of all cables for the execution of this augmentation 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. However, any direct buried cables are not permitted in the substation. 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.

1.2.1.10.1 36kV Power Cables and Terminations

02 Lots	36kV, XLPE insulated, Cu wire or Tape screen, PVC sheathed, Armoured single core cables for connections between Power transformers and 36kV indoor switchgear.
01 Lot	36kV, XLPE insulated, Cu wire or Tape screen, PVC sheathed, Armoured single core cables for connections between Power transformer and Auxiliary Transformer.
02 Lots	36kV, XLPE insulated, Cu wire or Tape screen, PVC sheathed, Armoured single core cables for connections between Power transformer and Earthing Transformers.
12 Lots	36kV, XLPE insulated, Cu wire or Tape screen, PVC sheathed, Armoured single core cables for connections from switchgear panels to outdoor gantries for generator feeders.

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

1.2.1.11 TRANSFORMERS

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

Item	Description	Qty	Voltage	Rating	Cooling
1.	Three phase power transformer with ON-Load Tap Changers	2	220/33kV	63MVA	ONAN/ONAF
2.	Earthing T/F	2	33 kV	800A, 30s	ONAN
3.	Auxiliary T/F	1	33/0.4 kV	160kVA	ONAN

Note: 245kV, 36kV and neutral terminals of Power transformers and 36kV and 400V terminals of Auxiliary transformers shall be supplied with bushings as per the Technical Particulars and Guarantees in the Volume 7 of 8 of the bidding document. 36kV bushings of Earthing transformers shall be supplied with plug-in type bushings. These power transformers are used for the connection of wind power generation to 220kV network. Estimated harmonic levels shall be considered during the designing of power transformer. 245kV outdoor bushings shall be RTV silicone coated.

1.2.1.12 WATER SPRAY SYSTEM FOR TRANSFORMERS

The water spray system shall cover the existing 45MVA transformer, Variable Shunt Reactor along with the two nos. of 63MVA transformers which is mentioned in Clause No. 1.2.1.11 above and shall comply with the Technical Specification – Grid Substation.

1.2.1.13 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.

1.2.1.14 MARSHALLING KIOSKS

Marshalling kiosks shall be provided and wired where necessary.

1.2.1.15 MISCELLANEOUS WORKS

Any work other than listed above.

1.2.1.16 SPARE PARTS

All necessary Spare parts.

1.2.1.17 TOOLS AND INSTRUMENTS

As per the price schedule all the tools and equipment shall be provided. For the technical specification of the tools please refer Annex E of the volume 4 of 8 of the bidding document.

1.2.2 NADUKUDA GRID SUBSTATION

1.2.2.1 OUTDOOR SWITCHGEAR

Insulators of all outdoor 245kV switchgears and insulator strings shall be RTV silicone coated.

1.2.2.1.1 01 No. 245kV Transformer bay comprising:-

1 No. - Neutral current transformer with core as follows: -
Class 5P20 ratio 200/1A for Main 1 protection and control IED
Class 5P20 ratio 200/1A for Main 2 protection and control IED

1 Lot - Connections to the 245kV and neutral terminals of the power transformer including required connectors, clamps, termination accessories and access ladders etc.

1.2.2.1.2 01 No. 36kV Transformer bay comprising:-

3 Nos. - 36kV, 10kA, Class 2 Pluggable Surge Arresters with counters.

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

1 Lot - Set of cable connections between Power Transformer and Earthing Transformer including set of connections, connectors, clamps, structures, access ladders, cable sealing end or terminal arrangement suitable for incoming 36kV cables etc. to terminate the 36kV cable and connect to the Power Transformer.

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

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

1 Lot - Set of connections, connectors, clamps, structures, access ladders etc. to connect 36kV Earthing Transformer and Neutral Current Transformer.

1.2.2.2 MODIFICATION OF LVAC SWITCH BOARDS

Existing 400V AC Main switchboard and distribution panel shall be modified to accommodate the scope of works of this contract.

1.2.2.3 MODIFICATION OF DC DISTRIBUTION BOARDS

Existing 220V DC Main switchboard shall be modified to accommodate the scope of works of this contract.

1.2.2.4 PROTECTION, METERING, MONITORING AND CONTROL

1.2.2.4.1 Additions / Modification of Existing Substation Automation System:-

Following items shall be supplied as per the Clause: 5.24 of Chapter 5, Technical Specification - Grid Substation of bidding document and architecture drawing for SAS in Annexure 7.

1 No. - Industrial type layer 2 Manageable Gigabit Ethernet Switch and Ethernet connections. Operator Workstation 1 (HMI-1), Operator Workstation 2 (HMI-2), Engineering Workstation (EWS), Gateway 1, Gateway 2 and Firewall shall be connected to the switch.

1 No. - Next Generation Firewall

1 No. - Industrial type layer 2 Manageable Ethernet Switch and connections for power transformer bay.

CEB will carry out integration work of new control & protection IEDs to existing Substation Automation Systems at Nadukuda Grid Substation.

The connecting IEDs to network and field signal testing associated with commissioning shall be carried out by the contractor as per the Site Acceptance Tests and Commissioning section of Clause: 5.24 of Chapter 5, Technical Specification - Grid Substation of bidding document.

1.2.2.4.2 Protection & Control facilities:-

1.2.2.4.2.1 For 01 No. Transformer bay comprising with:-

(a) AVR Panel

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

(b) Protection and Control panel with IEDs

Control and Protection panels related to the scope of this project are available in the Nadukuda GSS. Required modification of wiring, testing and commissioning of existing Protection and control IEDs of **HV and MV** sides including primary injection and transformer stability testing shall be carried out by this contract.

1.2.2.5 COMMUNICATION EQUIPMENT AND SCADA GATEWAYS/RTUS

1.2.2.5.1 Fiber Optic Multiplexer at Nadukuda Grid Substation

The existing Fiber Optic Multiplexer (FO615 by ABB) shall be extended with following interfaces.

1 No.	-	Optical interface module of type SAMO5 with SFP and patch cable for Mannar GSS direction
1 No.	-	Ethernet Interface module with minimum 04 numbers of Ethernet ports with L2- switching, also configurable for VLAN and L3- routing facility (10/100 Mbps) of type EPSI1
1 No.	-	FXS interface module of type LESU1
2 Nos.	-	Small Form-factor Pluggable (SFP) optical transceiver modules (with DDM support) of 1.25Gbit/s and 02 nos. Optical patch cables

The required extension modules shall be supplied as loose materials. The installation and commissioning work of the existing fibre optic multiplexer at Nadukuda GS shall be carried out by CEB.

1.2.2.5.2 Required SCADA for Nadukuda Grid Substation

SCADA Gateway

The integration work of new control and protection IEDs to existing Gateway at Nadukuda Grid Substation will be undertaken by CEB.

Bidder 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.

The integrated SCADA signals shall be tested up to the NSCC by the contractor together with the CEB.

The SCADA signals shall be integrated as given in "Annex A2". Gateway communication path configuration parameters are given in "Annex B".

Configuration of NSCC SCADA Master Station for integration of the signals shall be done by the CEB. All the integrated signals shall be tested up to the NSCC by the contractor.

Required SCADA Signals and Commissioning of Nadukuda GS to proposed DCC

The integration work of all the signals relevant to the Nadukuda Substation mentioned in the "Signal List for Nadukuda Substation- Annex A2" to existing Gateway at Nadukuda Grid Substation will be undertaken by CEB to the Distribution Control Center (DCC) SCADA System through the gateways.

Bidder shall provide the required licenses for upgrading the gateway to CEB in order to carry out Gateway modification work

Configuration of DCC SCADA Master Station for integration of the signals shall be done by the CEB. The integrated signals shall be tested up to the DCC by the contractor.

All the signals related to augmented transformer bay of Nadukuda GS as per Signal List given in "Annex A2-Nadukuda GS" shall be configured in the existing Gateway at Nadukuda GS as per the IEC 60870 – 5 – 104 protocol. Gateway configuration parameters are given in "Annex B". Finalized Signal List shall be submitted at least 02 weeks prior to the commissioning as per the format given in Annex D. Configuration of NSCC SCADA Master Station for integration of the signals shall be done by the CEB.

The integrated signals shall be tested up to the NSCC by the contractor. Required license upgrading, software and hardware modifications shall be done by the contractor. The existing separate remote control level for NSCC operations and interlocking operations shall be activated for the new bays as well for the NSCC operations.

Existing signals before the modification of the Gateway shall be available after the modification and all the control signals shall be tested and verified with the NSCC. Final configuration of Database and Project file (Gateway backup files) shall be provided. (As CD/DVD or Portable external hard disk). If any Software upgradation is required for the modification work, that software version shall be provided with the license. (As CD/DVD or Portable external hard disk)

1.2.2.6 SUBSTATION EARTHING SYSTEM COMPRISING:-

The existing substation earthing system shall be modified to accommodate the scope of works as per the requirements stated in Chapter 7 of the Technical Specification – Grid Substation

1.2.2.7 LIGHTNING PROTECTION SYSTEM COMPRISING: -

Additions and Modification of existing lightning protection system shall include design and erection of lightning protection system with shield earth wires to accommodate the augmentation works. 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.

1.2.2.8 GROUNDING SYSTEM COMPRISING:-

The existing grounding system shall be extended to accommodate the augmentation work including connections of all steel structures and electrical apparatus to earth mesh and grounding electrodes.

1.2.2.9 POWER AND CONTROL CABLES

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. However, any direct buried cables are not permitted in the substation. 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.

1.2.2.9.1 245kV Power Cables and Terminations

1 Lot - 245kV, single core cables with Cu conductor, XLPE insulated, Cu wire screened, Lead alloy sheath, HDPE sheathed single core cables as necessary for connections between Power transformer and 245kV indoor switchgear.

1 Lot - Cable terminations/ sealing ends for above mentioned cable circuits to be supplied and terminated at power transformer and 245kV GIS bays.

1.2.2.9.2 36kV Power Cables and Terminations

1 Lot - 36kV, XLPE insulated, Cu wire or Tape screen, PVC sheathed, Armoured single core cables for connections between Power transformer and 36kV indoor switchgear including cable termination/sealing end and required accessories.

1 Lot - 36kV, XLPE insulated, Cu wire or Tape screen, PVC sheathed, Armoured single core cables for connections between Power transformer and Earthing transformer including cable termination/sealing end and required accessories.

1.2.2.9.3 All low voltage AC power cables and terminations

1.2.2.9.4 All DC power and control cables and terminations

1.2.2.9.5 All cables required for Protection, Control, Instrumentation,

1.2.2.9.6 Communication, SCADA and termination.

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

1.2.2.10 TRANSFORMERS

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

Item	Description	Qty	Voltage	Rating	Cooling
1.	Three phase power transformer with ON-Load Tap Changers	1	220/33 kV	63MVA	ONAN/ONAF
2	Earthing Transformer	1	33kV	800A, 30s	ONAN

Note: 245kV, 36kV and neutral terminals of Power transformers shall be supplied with bushings as per the Technical Particulars and Guarantees in the Volume 7 of 8 of the bidding document and as per the drawing no. TD/CE/1/201/D/03/02. 36kV terminal of Earthing transformers shall be supplied with plug-in type bushings. These power transformers are used for the connection of wind power generation to 220kV network. Estimated harmonic levels shall be considered during the designing of power transformer. The power transformers shall be capable of parallel operation with the existing power transformers.

1.2.2.11 WATER SPRAY SYSTEM FOR TRANSFORMERS

The water spray system shall cover two nos. of existing 63MVA transformers, one no. of 63MVA transformer proposed under a different contract, one no. of 63MVA transformer which is mentioned in Clause No. 1.2.2.10 above and shall comply with the Technical Specification – Grid Substation.

1.2.2.12 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.

1.2.2.13 MISCELLANEOUS WORKS

Any work other than listed above.

1.2.2.14 SPARE PARTS

All necessary Spare parts as per the price schedule.

1.2.2.15 TOOLS AND INSTRUMENTS

As per the price schedule.

1.3 CIVIL WORKS, INSTALLATION, OTHER SERVICES AND TRAINING

1.3.1 CIVIL WORKS

1.3.1.1 MANNAR GRID SUBSTATION

1.3.1.1.1 Preliminary Works

a) Site Survey

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

b) Sub Soil Investigations

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

1.3.1.1.2 Site Clearing

a) Cutting and removing trees & shrubs.

- Big trees, shrubs and boulders.

b) Demolishing existing constructions as required.

1.3.1.1.3 Site formation and up keeping

a) Cutting and filling earth.

- Formation level shall be same as the formation level of the existing Mannar Grid Substation

b) Rock excavation

- If rock excavation is required during earth works, payment shall be made for actual quantities of rock volume based on the volume ranges mentioned in the price schedule 4 of Volume 2.

c) Earth retaining structures

- Earth retaining walls
- All the embankments shall be protected as per specifications and drawings.
- Rubble pitching work

d) Landscaping

- As required for the layout.

e) Surface Chipping

- Area covered by the earth mat.

1.3.1.1.4 Cable Trenches & Ducts

- As per chapter 13 of Technical Specification - Grid Substation.
- Extensions to cable trenches and ducts as required
- 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

- 2 Nos. of Main power transformers with concrete firewalls.

c) Auxiliary & Earthing transformers

- 1 Nos. Auxiliary transformers
- 2 Nos. Earthing transformers

1.3.1.1.6 Lightning protection system

- Extensions and modifications to lightning protection system as required as per chapter 13 of Technical Specification - Grid Substation.

1.3.1.1.7 Water supply & drainage system

a) Surface water drainage system

- Extension to the existing surface water drainage system as per the specification

1.3.1.1.8 Construction & Maintenance of Roads

a) Access road and structures

- Extension to the existing access road as indicated in the drawings and as per chapter 13 of Technical Specification - Grid Substation.

1.3.1.1.9 Fence, Gates and Boundary Walls

a) Chain link fence

- The existing chain link fence shall be extended. For details refer drawings for fence and gates.

1.3.1.1.10 External Lighting & small power supply services

- Shall include all necessary extensions and modifications to Switchyard Street and security lighting.

1.3.1.1.11 Construction of Control & Other Buildings

a) Required modifications to the Control building when erecting 36 kV GIS panels, control and protection panels come under this procurement.

b) Site Office at Mannar

- Temporary building at site (Converted Container type Office).

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

1.3.1.1.12 Miscellaneous Works

- Any work other than listed above.

1.3.1.2 NADUKUDA GRID SUBSTATION

1.3.1.2.1 Cable Trenches & Ducts

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

1.3.1.2.2 Foundations

a) For take-off structures & switchgear

- As required for all the equipment support structures.

b) For Main power transformer including concrete firewall

c) Earthing transformers

-1 No Earthing transformer

1.3.1.2.3 Lightning protection system

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

1.3.1.2.4 Construction of Control & Other Buildings

a) Control Building

- Necessary modifications to the existing control building as per chapter 13 of Technical Specification - Grid Substation

b) Site Office at Nadukuda

-Temporary Building at site (Converted Container type Office).

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

1.3.1.2.5 External Lighting & small power supply services

- Shall include all necessary extensions and modifications to Switchyard lighting.

1.3.1.2.6 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) Mannar 220/33kV Grid Sub Station
(b) Nadukuda 220/33kV Grid Substation

1.3.3 OTHER SERVICES

1.3.3.1 TRANSPORT

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

a) Four Wheel Drive SUV: 02 No.

Mileage to be covered is 3500km per month per vehicle including running and maintenance.

b) Four Wheel Drive Double Cabs: 03 Nos.

Mileage to be covered is 3000km per month per vehicle including running and maintenance.

In case the contractor fails to provide above vehicles as per the stipulated requirement of the tender document due to unavoidable reasons beyond the control of the contractor, the contractor is to provide transport facility for the above requirement.

1.3.3.2 ENGINEERS' LIVING ACCOMMODATION

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

a) Mannar 220/33 kV Grid Substation

The contractor shall provide a fully furnished rented house/building 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

- N/A

LOT B

AUGMENTATION OF EMBILIPITIYA 132/33 kV GRID SUBSTATION

LOT B

2. SCOPE OF WORKS

2.1 GENERAL DESCRIPTION OF THE PROJECT

2.1.1 EMBILIPITIYA GRID SUBSTATION

Augmentation of Embilipitiya Grid Substation shall consist of following main features.

1. 36kV SF_6 gas insulated indoor switchgear with Single Bus bar arrangement comprising of
   - 02 Nos. 36kV Transformer bays
   - 08 Nos. 36kV Line feeder bays
   - 02 Nos. 36kV Generator feeder bays
   - 01 No. 36kV Bus Section bay
2. 4 Nos. of 36kV Outdoor line gantries including 36kV cable terminations
3. Control, Metering, Monitoring and Protection of 36kV equipment
4. Addition/Modification to DC distribution to accommodate the scope of work of this contract and LVAC.
5. 50kW Roof-Top Solar PV System
6. SCADA & Addition/Modification to Communication equipment
7. Substation Automation System
8. Power and Control cables including terminations
9. Addition/Modification to existing Substation grounding system and shield earth wire system
10. 40kVA Diesel Generator
11. Electrical, Civil and Mechanical works required for substation including control building and extension of control buildings
12. Spare parts

2.1.2 SCOPE OF WORKS RELATED TO FEEDING END GRID SUBSTATIONS

Not Applicable

2.1.3 TERMINAL POINTS

A. Embilipitiya 132/33kV Grid Substation

The following shall be the contract terminal points:-

(a) Existing Power Transformer and 36kV GIS interface

This contract includes the connection between 36kV side of Power Transformers and 36kV GIS using underground cables, cable terminations, steel structures etc.

(b) 36kV Overhead Line/ Switchgear interfaces

36kV overhead distribution lines terminate at the line bay gantries. This contract includes the connections and connectors from 36kV outdoor terminations to the 36kV line down droppers, which terminate at the line bay gantries.

2.1.4 SITE ENVIRONMENTAL CONDITIONS

Altitude of site above sea level not exceeding	m	1000
Maximum ambient air temperature	^{0}C	40
Minimum ambient air temperature	^{0}C	7
Average ambient air temperature over 24 hours	^{0}C	32
Average yearly temperature	^{0}C	30
Relative humidity (24 hours)	%	90
Average annual rainfall	mm	2000
Maximum recorded rainfall for 24 hours	mm	392
Winds	Maximum 1 to 3 second gusts at 145 km per hour. Mean speed 6 km per hour over 24 hours.	
Thunderstorms	Frequency of thunderstorms is high	
Average isokeraunic level	100 days per annum	
Atmospheric corrosive category (ISO 12944)	C4	

2.1.5 ELECTRICITY, WATER, GAS AND OTHER SERVICES

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

2.1.6 ADHERENCE TO THE ENVIRONMENTAL MITIGATION MEASURES

Bidders are requested to comply with the requirements stated in the Chapter 1, Clause 1.7 of Section 6 Part B -Technical Specifications.

2.2 PLANT & EQUIPMENT INCLUDING MANDATORY SPARE PARTS

2.2.1 EMBILIPITIYA GRID SUBSTATION

2.2.1.1 OUTDOOR SWITCHGEAR

2.2.1.1.1 02 Nos. 36kV Transformer bays each comprising:-

1 Lot - Set of connections, connectors, clamps, access ladders, structures, cable sealing end or terminal arrangement suitable to connect the 36kV cable from 36kV Gas Insulated Switchgear.

1 Lot - Complete set of miscellaneous items required for the safe and efficient operation of the switchgear.

2.2.1.1.2 08 Nos. 36kV Feeder bays for outgoing lines 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.

2.2.1.1.3 02 Nos. 36kV Feeder bays for incoming generation 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.

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

2.2.1.2 SF_6 INSULATED INDOOR SWITCHGEAR

Panel design which allows removal of panel with lowest disturbance to adjacent panels is preferred.

2.2.1.2.1 02 Nos. 36kV Transformer bays each comprising:-

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

1 No - 1250A, 36kV, 25kA, three phase busbar disconnector 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, 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, DFR

Class 0.2 ratio 800/1 for metering.

3 Nos. - Single phase voltage transformers with cores as follows:-

Class 3P ratio 33,000/√3V:110/√3V for HV Main 1 protection and control IED

Class 3P ratio 33,000/√3V:110/√3V for HV Main 2 protection and control IED, AVR and LV protection and control IED

Class 0.2 ratio 33,000/√3V:110/√3V for energy metering system

1 Lot - Cable terminating chamber, complete with cable box, sealing end or terminal arrangement suitable for incoming 36kV cables.

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

2.2.1.2.2 08 Nos. of 36kV Feeder bays for outgoing lines each comprising:-

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

1 No. - 1250A, 36kV, 25kA three phase busbar disconnector 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/√3V:110/√3V: 110/√3V Class 0.2 for energy metering and Class 3P for protection.

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

1 Lot - Complete set of miscellaneous items required for the safe and efficient operation of the switchgear, 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.

2.2.1.2.3 02 Nos. of 36kV Feeder bay for incoming generations each comprising:-

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

1 No. - 1250A, 36kV, 25kA three phase busbar disconnector 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/√3V:110/√3V:110/√3V Class 0.2 for energy metering of incoming generation and Class 3P for protection.

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.

2.2.1.2.4 01 No. of 36kV Bus Section bay comprising:-

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

1 No - 2500A, 36kV, 25kA, three phase circuit breaker complete with operating mechanism.

2 Nos. - 2500A, 36kV, 25kA three phase disconnector with earth switch and motor operating mechanism.

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.

6 Nos. - Single phase voltage transformers with cores as follows:-

Class 3P ratio 33,000/√3V:110/√3V for Protection and control IED

Class 0.2 ratio 33,000/√3V:110/√3V 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.

2.2.1.3 LVAC SWITCH BOARDS

400V switchboards, for supplies to substation services, free standing and for indoor installation, are to be supplied and installed. The incoming supplies to each switchboard are to be interlocked to automatically establish supply to the busbar in the event of failure of the incoming supply and not to parallel any supplies. In case of failure of incoming, Diesel Generator shall be automatically switched on for emergency supplies.

2.2.1.3.1 400V Main switchboard at New Control Building comprising:-

Auto changeover logic for Bus-section breakers, Incoming Breakers & Generator Breaker initiated by:

Incomer No. 1 from 200kVA, 33/0.4kV Auxiliary transformers 1.

Incomer No. 2 from 200kVA, 33/0.4kV Auxiliary transformers 2.

Incomer No. 3 from 40kVA Diesel Generator for emergency supply.

Incomer No. 4 from 50kW Solar PV system

1 Set - Busbars (3 Phases, Neutral and Earth).

9 Nos. - 4 pole MCCBs for two incomer, one solar PV system, one bus section, one Generator and four outgoing (rating shall be according to the load required).

1 Set - Equipment required for interlocking and automatic switch over between incomer 1, incomer 2 and diesel generator including auto changeovers.

3 Sets - Indicator lamps for each distribution board.

3 Nos - Ammeters.

3 Nos - Voltmeters.

2.2.1.3.2 400V Distribution panel comprising:-

MCB for following distribution Circuits (Number of Phases and rating shall be according to the load required.)

Essential loads

Storage Battery Charger No.1 for 110V

Storage Battery Charger No. 1 for 48V

Main transformer No. 1 OLTC & cooling fans

Main transformer No. 2 OLTC & cooling fans

Outdoor & Perimeter lighting

Indoor lighting

Guard House

Inverter Supply

Others as necessary

Spares

Panel No.1

Storage Battery Charger No.2 for 110V

145kV Switchgear Auxiliary Power

36kV Switchgear Auxiliary Power

Cubicle lighting & space heater

Distribution Panel No. 1 for small power supply

Air Conditioning and Ventilation

Outdoor Lighting panel

Power outlet

Water Supply Pump

Others as necessary

Spares

Panel No.2

145kV Switchgear Auxiliary Power

36kV Switchgear Auxiliary Power

Cubicle lighting & space heater

Distribution Panel No. 2 for small power supply

Air Conditioning and Ventilation

Power outlet

Pumps

Others as necessary

Spares

A separate circuit shall be provided for Oil Filtering as shown in the LVAC drawing.

2.2.1.4 ADDITIONS/MODIFICATIONS OF DC DISTRIBUTION BOARDS AND INVERTER EQUIPMENT

Existing 110V DC Distribution board shall be modified to accommodate the scope of works of this contract.

2.2.1.4.1 Inverter System for Substation Automation System

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

2.2.1.4.2 Roof-Top solar power system

a) 50kW solar PV system shall be installed on top of the roof of control building as per clause 3.23 of Technical Specification.

b) Supply and installation of inverter as per clause 3.23.3 of Technical Specification.

c) Supply and installation of combiner boxes as per clause 3.23.4 of Technical Specification.

d) Supply and installation of monitoring and data acquisition system as per clause 3.23.7 of Technical Specification.

e) All required cables, accessories and earthing works.

Note: The requested SCADA signals of the Solar PV system as per the NSCC SCADA Signal List (Annex A3) shall be made available to the NSCC and shall be commissioned up to the NSCC.

2.2.1.5 PROTECTION, METERING, MONITORING AND CONTROL

2.2.1.5.1 Substation Automation System:-

Substation Automation system must be provided as per the Clause: 5.24 of Technical Specification - Grid Substation and typical architecture drawing provided in Volume 06 of bidding document by the SAS manufacturer.

All facilities and requirements including necessary hardware and software shall be provided as specified in all the relevant clauses in Chapter 5 of Technical Specification - Grid Substation.

Remote Web HMI Workstation shall be provided at the existing control room by the SAS manufacturer.

2.2.1.5.2 36kV Protection & Control facilities: -

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

2.2.1.5.2.1 For 08 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	-General Requirements
Clause 5.11.4	-Protection/Control Functions Required in 11kV/33kV Feeder Protection (All the clauses under this shall be complied for TCS, BF protection etc.)
Clause 5.11.5	- Trip Matrix
Clause 5.11.6	- Interlocking
Clause 5.19	- Trip Circuit Supervision.
Clause 5.8.1 and clause 5.8.2	- Control IED'S on 36kV level

Operation counter auto-trip for circuit-breaker.

Operation counter hand-trip for circuit breaker.

2.2.1.5.2.2 For 02 Nos. 36kV feeders 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	- General Requirements
Clause 5.11.4	- Protection/Control Functions Required in 11kV/33kV Feeder Protection (All the clauses under this shall be complied for TCS, BF protection etc.)
Clause 5.11.5	- Trip Matrix

Clause 5.11.6	- Interlocking
Clause 5.19	- Trip Circuit Supervision.
Clause 5.8.1 and clause 5.8.2	- Control IED'S on 36kV level
Clause 5.8.5	- Synchro-check & Synchronizing

Operation counter auto-trip for circuit-breaker.

Operation counter hand-trip for circuit breaker.

2.2.1.5.2.3 For 02 Nos. 36kV Transformer bays each comprising with:-

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

Clause 5.12.2	- Directional and Non-directional Over current protection for LV side - Directional and Non-directional Residual Earth fault protection for LV side - BCU function for LV side - Synchronism Check function for the LV side - Monitoring of Lockout relay
Clause 5.19	- Trip circuit supervision
Clause 5.9.5.2	- Synchrocheck & Synchronizing
Clause 5.8.1 and clause 5.8.2	- Control IED'S on 36kV level

Operation counter auto-trip for circuit breaker.

Operation counter hand-trip for circuit breaker.

2.2.1.5.2.4 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	- Bus Section Bay General requirements
Clause 5.16.4	- General Requirements for 33kV Bus Section Protection including directional OC/EF.
Clause 5.19	- Trip Circuit Supervision.
Clause 5.8.1 and clause 5.8.2	- Control IED'S on 36kV level

Operation counter auto-trip for circuit-breaker.

Operation counter hand-trip for circuit breaker.

2.2.1.5.2.5 Auxiliary LVAC Control

IEDs shall be provided for indication in Automation System.

2.2.1.5.2.6 Gas Pressure Monitoring System

Gas pressure monitoring system shall be provided

Clause 2.2.1.8 (e) –Gas monitoring device

2.2.1.5.3 Energy Metering panels comprising with: -

Not Applicable

2.2.1.6 COMMUNICATION EQUIPMENT AND SCADA GATEWAYS/RTUS

2.2.1.6.1 Fiber Optic Multiplexer at Embilipitiya Grid Substation

The existing Fiber Optic Multiplexer (FO615 by ABB) shall be extended with following interfaces.

1 No.	-	Optical interface module of type SAMO5 with SFP and patch cable for Matara GSS direction

The required extension modules shall be supplied as loose materials. The installation and commissioning work of the existing fibre optic multiplexer at Embilipitiya GS shall be carried out by CEB.

2.2.1.6.2 Required SCADA for Embilipitiya Substation

SCADA Gateway

Gateway System Comprising:

2 Nos.	-	Gateway Computers with 1+1 redundancy and Gateway to be independent from SAS and shall be installed inside a server rack
1 No.	-	Separate Software Access Keys (Separate Dongle/License key) shall be provided

1 No.	-	Laptop/Software tool to access the Gateway computer, for maintenance purposes.
1 Lot	-	500% of the total Gateway Data points as spare Data points
4 Nos.	-	10/100Mbps Ethernet Ports (electrical) with redundancy for each Gateway

All these ports should not be built in a single interface module. There should be separate interface modules for these ports to provide 1+1 redundancy. All the ports shall be surge protected.

Final configuration of Database, Project file and Gateway image (Acronis true image) backup files shall be submitted in the form of Portable external hard disk.

Required SCADA Signals and Commissioning of Embilipitiya GSS

All the signals relevant to the Embilipitiya Substation mentioned in the "Signal List for Embilipitiya Substation- Annex A3" shall be made available as per the IEC 60870 – 5 – 104 protocol for integration and configuration to the National System Control Center (NSCC) SCADA System through the gateways. The Gateway configuration parameters for each signal are given in Annex B. The communication interfaces shall be configured as in Annex C. Finalized Signal List shall be submitted at least 02 weeks prior to the commissioning as per the format given in Annex D.

Required SCADA Signals and Commissioning of Embilipitiya GSS to proposed DCC

All the signals relevant to the Embilipitiya Substation mentioned in the "Signal List for Embilipitiya Substation- Annex A3" shall be made available as per the IEC 60870 – 5– 104 protocol for integration and configuration to the Distribution Control Center (DCC) SCADA System through the gateways. The Gateway configuration parameters and the communication interfaces shall be provided at the commissioning stage. Finalized Signal List shall be submitted at least 04 weeks prior to the commissioning as per the format given in Annex D. Configuration of DCC SCADA Master Station for integration of the signals shall be done by the CEB. The integrated signals shall be tested up to the DCC by the contractor.

All the signals relevant to the augmented bays of Embilipitiya GSS mentioned in the "Signal List for Embilipitiya Grid Substation- Annex A3" shall be made available as per the IEC 60870 – 5 – 104 protocol for integration and configuration to the National System Control Center (NSCC) SCADA System through the gateway. The Gateway configuration parameters for each signal are given in Annex B. The communication interfaces shall be configured as in Annex C. Finalized Signal List shall be submitted

at least 02 weeks prior to the commissioning as per the format given in Annex D. The separate remote control level for NSCC operations shall be configured through the gateway and all the interlocking operations shall be activated for the NSCC operations as well. Configuration of NSCC SCADA Master Station for integration of the signals shall be done by the CEB. The integrated signals shall be tested up to the NSCC by the contractor.

2.2.1.7 ADDITIONS / MODIFICATION OF SUBSTATION EARTHING SYSTEM COMPRISING:-

The existing substation earthing system shall be modified and extended to accommodate the augmentation works as per the requirements stated in Chapter 7 of the Technical Specification – Grid Substation. This shall include excavation, backfilling and reinstatement of the ground, driving the earth rods and making of the connections. This shall include additional earth materials if required to reach the specified value of earth resistance.

2.2.1.8 ADDITIONS / MODIFICATION LIGHTNING PROTECTION SYSTEM COMPRISING:-

Additions and Modification of existing lightning protection system shall include design and erection of lightning protection system with shield earth wires to accommodate the augmentation works. 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.

2.2.1.9 ADDITIONS / MODIFICATIONS OF GROUNDING SYSTEM COMPRISING:-

The existing grounding system shall be extended to accommodate the augmentation work including connections of all steel structures and electrical apparatus to earth mesh and grounding electrodes.

2.2.1.10 POWER AND CONTROL CABLES

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. However, any direct buried cables are not permitted in the substation. 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.

2.2.1.10.1 36kV Power cables and terminations

02 Lots - 36kV, XLPE insulated, Cu wire or Tape screen, PVC sheathed, Armoured single core cables for connections between Power transformer and 36kV indoor switchgear and termination accessories.

08 Lots - 36kV, XLPE insulated, Cu wire or Tape screen, PVC sheathed, Armoured single core cables for connections from indoor switchgear panels to outdoor gantries for Line feeders and termination accessories.

02 Lots - 36kV, XLPE insulated, Cu wire or Tape screen, PVC sheathed, Armoured single core cables for connections from indoor switchgear panels to outdoor gantries for Generator feeders and termination accessories.

2.2.1.10.2 All low voltage AC power cables and terminations

2.2.1.10.3 All DC power and control cables and terminations

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

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

All cables required for station lighting, small power, fire protection, ventilation equipment. The Contractor shall be responsible for the supply, installation, and 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.

2.2.1.11 DIESEL GENERATOR SYSTEM

A Diesel generator to supply the substation 400V emergency supply with a minimum capacity of 40kVA. The Generator shall be rated for continuous operation for at least 24 hours.

2.2.1.12 SUPPORTING STRUCTURES INCLUDING GANTRIES

The existing 36kV gantries shall be used to terminate the 36kV feeders. New gantries shall be constructed for 4 Nos. of 36kV Feeders as shown in the drawing No. MNEGSAP/EMB/03-02. 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.

2.2.1.13 MISCELLANEOUS WORKS

Any work other than listed above.

2.2.1.14 SPARE PARTS

As per the price schedule

2.2.1.15 TOOLS AND INSTRUMENTS

As per the price schedule.

2.3 CIVIL WORKS, INSTALLATION, OTHER SERVICES AND TRAINING

2.3.1 CIVIL WORKS

2.3.1.1 EMBILIPITIYA GRID SUB STATION

2.3.1.1.1 Preliminary Works

a) Site Survey

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

b) Sub Soil Investigations

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

2.3.1.1.2 Site Clearing

a) Removing existing concrete/ masonry foundations-

Foundations and boulders

b) Removing existing outdoor gantries of 2Nos. of 36kV Feeders as shown in the drawing No. MNEGSAP/EMB/03-01 & 02.

c) Removing the portion of existing control building and wash room as shown in the drawing No. MNEGSAP/EMB/03-01 & 02.

d) Removing existing 36kV Indoor Air Insulated Switchgears and existing buried Power cables. This includes disposal of the Indoor Air Insulated Switchgears from the Embilipitiya Grid Substation.

e) Removing existing chain link fence as shown in the drawing no. MNEGSAP/EMB/03-02.

f) Any other removals required for the execution of the contract

2.3.1.1.3 Site formation and up keeping

a) Cutting and filling earth.

- Formation level shall be existing switch yard level.

b) Rock excavation

- If rock excavation is required during earth works, payment shall be made for actual quantities of rock volume based on the volume ranges mentioned in the price schedule 4 of Volume 2.

c) Earth retaining structures

- Earth retaining walls

- Adequate erosion protection (retaining wall for the boundary) where required.

- All the embankments shall be protected as per specifications and drawings.

- Rubble pitching work

d) Anti-Termite soil treatment

- Anti termite treatment with more than 10 years guaranty shall be done for the control building area.

e) Surface Chipping

- Area covered by the new earth mat.

2.3.1.1.4 Cable Trenches & Ducts

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

- Provision shall be made for all future cables.

2.3.1.1.5 Foundations

a) For takeoff structures & switchgear

- As required for all the equipment support structures.

2.3.1.1.6 Lightning protection system

- Extensions and modifications to lightning protection system as required, as per chapter 13 of Technical Specification - Grid Substation.

2.3.1.1.7 Water supply & drainage system

a) Water supply system for new control building and temporary site office

- As per the Specifications

b) Waste water sewerage system for new control building and temporary site office

- As per the specifications

c) Surface water drainage system for the area covered by new earth mat

- As per the specification

2.3.1.1.8 Construction & Maintenance of Roads

a) Access road and structures

- Extension to the access road as shown in the Drwg No. MNEGSAP/EMB/03-02 and as per chapter 13 of Technical Specification - Grid Substation.

2.3.1.1.9 Fence, Gates and Boundary Walls

a) Chain link fence

- The existing chain link fence shall be extended as shown in the drawing No. MNEGSAP/EMB/03-02. For details refer drawings for fence and gates.

2.3.1.1.10 External Lighting & small power supply services

- Shall include all necessary extensions and modifications to Street and security lighting for the area of new 36kV gantry, new control building and extension of access road.

2.3.1.1.11 Construction of Control & Other Buildings

a) Control Building at Embilipitiya 132/33kV GSS

- As indicated in the drawings and as per chapter 13 of Technical Specification - Grid Substation

b) Temporary Site Office at Embilipitiya – 02 Nos. of 20ft containers with required facilities as shown in the drawing No. MNEGSAP/EMB/03-12

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

d) House for Diesel Generator.

- 1 No. Diesel generator shall be covered with a permanent structure.

2.3.1.1.12 Construction of Building Services

a) Air conditioning & ventilation system

- Refer chapter 13 of Technical Specification - Grid Substation.

b) Fire protection

- Refer chapter 13 of Technical Specification - Grid Substation.

c) Internal Lighting & small power supply services.

- Refer chapter 13 of Technical Specification - Grid Substation

2.3.1.1.13 Miscellaneous Works

- Any work other than listed above.

2.3.2 INSTALLATION

Erection, Installation and commissioning of structures Plant & Equipment specified in the clause 2.2 of Employer's Requirements

a) Embilipitiya 132/33 kV Grid Sub Station

2.3.3 OTHER SERVICES

2.3.3.1 ENGINEERS' LIVING ACCOMMODATION

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

b) Embilipitiya 132/33 kV Grid Substation

The contractor shall provide a fully furnished rented house/building 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.

2.3.4 TRAINING

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

- Minimum Fifteen (15) days training for 02 Electrical Engineers covering the Training module given in 14.2.6: Substation Automation System for offered new SAS by a competent person from OEM

Annex A

Signal List (NSCC)

Annex A1

Mannar 220/33 kV GS	TYPE OF SIGNAL	VOLTAGE	220/33 kV T/F 2		220/33 kV T/F 3		33 kV																
		BAY No	208	311	209	319	307	308	309	310	312	313	315	316	317	318	320	321	306	314			
		BAY TYPE	220 kV side	33 kV side	220 kV side	33 kV side	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	BS 1	BS 2	BB 1	BB 2	Station
CONTROLS		**ACTION**																					
Circuit Breaker	DPC	Open/Close	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2			
BB Isolator 1	DPC	Open/Close	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2			
BB Isolator 2	DPC	Open/Close	2		2														2	2			
Line Isolator	DPC	Open/Close					2	2	2	2	2	2	2	2	2	2	2	2					
Capacitor Bay Isolators	DPC	Open/Close																					
Earth Switch	DPC	Open/Close																					
Tap Changer (AVR) Raise / Lower	DPC	Raise/Lower	2		2																		
Tap Changer (AVR) Auto / Manual	DPC	Auto /Manual	2		2																		
AVR Operating mode **(One of the 2 modes will be available)**	DPC	Master/ Follower																					
	DPC	Minimum Circulation Current	2		2																		
AVR Independent / Parallel	SPC	Independent/Parallel	1		1																		
Protection Master Relay Reset /(Protection Reset Command K86.1) (/Lockout Relay Reset)	SPC	Reset	1	1	1	1													1	1			
Protection Master relay Reset Command K86.2	SPC	Reset	1	1	1	1													1	1			
Protection Reset Command K96 (BB/BCF relay Reset)	SPC	Reset	1	1	1	1													1	1			
Load Shedding OFF	SPC	On/Off																					
STATUS INDICATIONS		**STATUS**																					
Circuit Breaker	DPI	Open/Close	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2			
BB Isolator 1	DPI	Open/Close	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2			
BB Isolator 2	DPI	Open/Close	2		2														2	2			
Line Isolator	DPI	Open/Close					2	2	2	2	2	2	2	2	2	2	2	2					
Capacitor Bay Isolator	DPI	Open/Close																					
Earthing Switch	DPI	Open/Close		2		2	4	4	4	4	4	4	4	4	4	4	4	4	4	4			
Bay Control	DPI	Local/Superv/Remote	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2			
TRANSFORMER																							
Tap Control	DPI	Local/Superv	2		2																		
T/F AVR Operating mode	DPI	Manual /Auto	2		2																		
T/F AVR Operating mode **(One of the 2 modes will be available)**	DPI	Master/Follower																					
	DPI	Minimum Circulation Current	2		2																		
AVR Parallel / Indipendent	SPI	Paralle/ Indipendant	1		1																		
Capacitor Bank																							
Capacitor Bank Operating Mode	SPI	Manual /Auto																					
A L A R M INDICATIONS																							
CIRCUIT BREAKER																							
Circuit Breaker Triping Indication	**SPI**	**Healthy/Faulty**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**			
Breaker Fault (critical) - ***	SPI	Healthy/Faulty	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
a SF6 Gas Presure low. (2nd stage)																							
b Trip Circuit Supervision Fail 1 (Trip circuit faulty)																							

Mannar 220/33 kV GS		TYPE OF SIGNAL	VOLTAGE	220/33 kV T/F 2		220/33 kV T/F 3		33 kV																
			BAY No	208	311	209	319	307	308	309	310	312	313	315	316	317	318	320	321	306	314			
			BAY TYPE	220 kV side	33 kV side	220 kV side	33 kV side	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	BS 1	BS 2	BB 1	BB 2	Station
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 Presure 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	1	1			
a	SF6 Gas Pressure Low - First step																							
b	PT Secondary MCB Trip (Protection VT MCB Failed/ Incoming Voltage MCB trip/ VT MCB trip)																							
c	AC/DC Voltage Failure Indication (Auxiliary Fail)																							
TRANSFORMER MECHANICAL PROTECTION																								
Tap Changer Mechanism Fault (OLTC failure)		SPI	Healthy/Faulty	1	1	1	1																	
Tap out of step (TAP OUT ERROR)		SPI	Onset/Reset	1	1	1	1																	
Transf Buchholz Alarm - * **		SPI	Onset/Reset	1	1	1	1																	
a	Transf Buchholz Alarm																							
b	OLTC Buchholz Alarm																							
Transf Buchholz Trip		SPI	Operated/Normal	1	1	1	1																	
OLTC Buchholz Trip (OLTC OIL Flow Relay Trip)		SPI	Operated/Normal	1	1	1	1																	
ET Transf Buchholz Trip		SPI	Operated/Normal	1	1	1	1																	
AT Transf Buchholz Trip		SPI	Operated/Normal	1	1	1	1																	
Temperature Alarm - * **		SPI	Onset/Reset	1	1	1	1																	
a	Oil Temperature Alarm																							
b	Winding HV Temperature Alarm																							
c	Winding LV Temperature Alarm																							
Temperature trip - * **		SPI	Operated/Normal	1	1	1	1																	
a	Oil Temperature trip																							
b	Winding HV Temperature trip																							
c	Winding LV Temperature trip																							
General Alarm - * **		SPI	Onset/Reset	1	1	1	1																	
a	Cooling Fan Fail (Group 1/Group 2)																							
b	Transformer Oil Level low																							
c	OLTC Oil level low																							
General Trip - * **		SPI	Operated/Normal	1	1	1	1																	
a	OLTC Surge Trip																							
b	Main tank Presure 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																					

Mannar 220/33 kV GS	TYPE OF SIGNAL	VOLTAGE	220/33 kV T/F 2		220/33 kV T/F 3		33 kV																
		BAY No	208	311	209	319	307	308	309	310	312	313	315	316	317	318	320	321	306	314			
		BAY TYPE	220 kV side	33 kV side	220 kV side	33 kV side	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	BS 1	BS 2	BB 1	BB 2	Station
Main 1 - Distance Zone 2 operated	SPI	Operated /Normal																					
Main 1 - Distance Zone 3 operated	SPI	Operated /Normal																					
Main 1 - Distance Zone 4 operated	SPI	Operated /Normal																					
Main 1 -Distance protection operated	SPI	Operated /Normal																					
Main 1 - Directional Earth Fault operated	SPI	Operated /Normal																					
Main 1 - Distance Protection Aided Trip	SPI	Operated /Normal																					
Main 2- Differential protection operated	SPI	Operated /Normal																					
Main 2 - Distance Zone 1 operated	SPI	Operated /Normal																					
Main 2 - Distance Zone 2 operated	SPI	Operated /Normal																					
Main 2 - Distance Zone 3 operated	SPI	Operated /Normal																					
Main 2 - Distance Zone 4 operated	SPI	Operated /Normal																					
Main 2 - Distance protection operated	SPI	Operated /Normal																					
Main 2 - Directional Earth Fault operated	SPI	Operated /Normal																					
Main 2 - Distance Protection Aided Trip	SPI	Operated /Normal																					
Over Current Protection trip	SPI	Operated /Normal					1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Earth Fault Protection Operated	SPI	Operated /Normal					1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Pole Discrepancy Protection Operated	SPI	Operated /Normal																					
Auto Recloser Operated / Success / Progress	SPI	Operated /Normal																					
Direct Intertrip Send	SPI	Operated /Normal																					
Direct Intertrip Received	SPI	Operated /Normal																					
Permissive Intertrip Send (carrier send)	SPI	Operated /Normal																					
Permissive Intertrip Received (carrier receive)	SPI	Operated /Normal																					
DEF Protection carrier Send	SPI	Operated /Normal																					
DEF Protection carrier Receive	SPI	Operated /Normal																					
Distance Protection Block	SPI	Operated /Normal																					
Communication Fail (Differential block)	SPI	Operated /Normal																					
Switch On To Fault trip (SOTF trip)	SPI	Operated /Normal																					
Over Voltage trip (OV)	SPI	Operated /Normal																					
Breaker Failure Protection Operated	SPI	Operated /Normal	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Trip Relay Operated/ Protection Relay K86.1 /Lockout Relay operated	SPI	Set/Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Trip Relay Operated/Protection Relay K86.2	SPI	Set/Reset	1		1														1	1			
Protection Relay K96	SPI	Set/Reset																	1	1			
Under Frequency Trip	SPI	Operated /Normal					1	1	1	1	1	1	1	1	1	1	1	1					
Over Frequency Trip	SPI	Operated /Normal					1	1	1	1	1	1	1	1	1	1	1	1					
Main 1 Protection Relay Fail	SPI	Healthy/ Fail	1		1																		
Main 2 Protection Relay Fail	SPI	Healthy/ Fail	1		1																		
Back Up Protection Relay Fail	SPI	Healthy/ Fail	1		1																		
Auto Relcose ON/OFF	SPI	ON / OFF																					
33kV protection Operated	SPI	Operated /Normal																					
BUSBAR PROTECTION																							
Bus Bar Protection Operated	SPI	Operated /Normal	1		1														1	1			

Mannar 220/33 kV GS	TYPE OF SIGNAL	VOLTAGE	220/33 kV T/F 2		220/33 kV T/F 3		33 kV																
		BAY No	208	311	209	319	307	308	309	310	312	313	315	316	317	318	320	321	306	314			
		BAY TYPE	220 kV side	33 kV side	220 kV side	33 kV side	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	BS 1	BS 2	BB 1	BB 2	Station
TRANSFORMER PROTECTION																							
Differential Protection Operated	SPI	Operated /Normal	1		1																		
HV Restricted Earth Fault	SPI	Operated /Normal	1		1																		
LV Restricted Earth Fault	SPI	Operated /Normal	1		1																		
Transformer earth Fault Protection Operated	SPI	Operated /Normal	1	1	1	1																	
Transformer Stand By EF Protection Operated	SPI	Operated /Normal	1	1	1	1																	
Transformer Over Current Protection trip (OCProtection I>trip)	SPI	Operated /Normal	1	1	1	1																	
Over Voltage Protection	SPI	Operated /Normal	1		1																		
Over Fluxing Protection	SPI	Operated /Normal	1		1																		
T/F Thermal Overload	SPI	Operated /Normal	1		1																		
CAPACITOR BANK																							
Phase OverVoltage Operated	SPI	Operated /Normal																					
STATION ALARMS																							
Under Frequency Load Shedding Operated	SPI	Operated/Normal					1	1	1	1	1	1	1	1	1	1	1	1					
Bus Voltage Failure - ***	SPI	Healthy/Faulty																					
a Auxialary Supply Voltage	SPI	Healthy/Faulty																					
b DC Voltage Failure (110V DC MCB Trip)	SPI	Healthy/Faulty																					
Gateway Alarm(Running A/Running B)	SPI	Healthy/Faulty																					
Communication Alarm (Communication Malfuntion)	SPI	Healthy/Faulty																					
Battery Charger Failure (Communication) - ***	SPI	Healthy/Faulty																					
a 48V Battery Charger 2 Fail																							
b 48V Battery Charger 1 Fail /(Rectifier 1 Fault)																							
Battery Charger Failure (Station)-***	SPI	Healthy/Faulty																					
a 220 V Battery Charger 2 Fail /(Rectifier 1 Fault)																							
b 220 V Battery Charger 1 Fail (Rectifier 2Fault)																							
Station Urgent Fault - ***	SPI	Operated /Normal																					
a Fox Faulty Urgent Alarm																							
Station Non Urgent Fault - ***	SPI	Operated/Normal																					
a Diesel Generator Alarm																							
b Fox Faulty Non Urgent Alarm																							
Station Control Remote/Supervisory	DPI	Remote/Superviosry																					
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	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	
Frequency	AI	Hertz	1	1	1	1															1	1	
Active Power	AI	MW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Reactive Power	AI	MVAr	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Current	AI	Amperes	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Transformer Tap Position	AI	Tap number		1		1																	
Power Factor	AI	PF																					
GENERAL																							
Air Condition Temprature	AI	Celcius																					1
Humidity	AI	RH %																					1

Mannar 220/33 kV GS	TYPE OF SIGNAL	VOLTAGE	220/33 kV T/F 2		220/33 kV T/F 3		33 kV																	
		BAY No	208	311	209	319	307	308	309	310	312	313	315	316	317	318	320	321	306	314			
		BAY TYPE	220 kV side	33 kV side	220 kV side	33 kV side	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	BS 1	BS 2	BB 1	BB 2	Station
Solar Iradiance	AI	W/m^2																					

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	AI	Analogue Measurement
SPC	Single Point Control Command	AO	Analogue Output
DPI	Double point indication input		
SPI	Single point indciation input		

Double points are counted individually

***** :- Grouped Alarms**

Annex A2

Nadukuda 220/33 kV GS	TYPE OF SIGNAL	VOLTAGE	220/33 kV T/F 4	
		BAY No	207	318
		BAY TYPE	220 kV side	33 kV side
C O N T R O L S		**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	4	2
Bay Control	DPI	Local/Superv/Remote	2	2
TRANSFORMER				
Tap Control	DPI	Local/Superv	2	
T/F AVR Operating mode	DPI	Manual /Auto	2	
T/F AVR Operating mode **(One of the 2 modes will be available)**	DPI	Master/Follower	2	
	DPI	Minimum Circulation Current		
AVR Parallel / Indipendent	SPI	Paralle/ Indipendant	1	
Capacitor Bank				
Capacitor Bank Operating Mode	SPI	Manual /Auto		
A L A R M INDICATIONS				
CIRCUIT BREAKER				
Circuit Breaker Triping Indication	**SPI**	**Healthy/Faulty**	**1**	**1**
Breaker Fault (critical) - ***	SPI	Healthy/Faulty	1	1
a SF6 Gas Presure low. (2nd stage)				
b Trip Circuit Supervision Fail 1 (Trip circuit faulty)				
c Trip Circuit Supervision Fail 2 ((Trip circuit 2 faulty)				
d Spring Not Charge (Spring Supervision)				
e Hydraulic Pressure Low				
f Pneumatic Pressure Low.				
g CB Pole Discrepancy				
h Trip Lockout/Close Lockout (SF6 Lock out)				
i Control Voltage Failure (DC MCB trip)				
j Internal Arc trip				
h SF6 Gas Presure 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				

Nadukuda 220/33 kV GS		TYPE OF SIGNAL	VOLTAGE	220/33 kV T/F 4	
			BAY No	207	318
			BAY TYPE	220 kV side	33 kV side
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 Presure 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		

Nadukuda 220/33 kV GS	TYPE OF SIGNAL	VOLTAGE	220/33 kV T/F 4	
		BAY No	207	318
		BAY TYPE	220 kV side	33 kV side
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 Relcose 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 Auxialary Supply Voltage	SPI	Healthy/Faulty		
b DC Voltage Failure (110V DC MCB Trip)	SPI	Healthy/Faulty		
Gateway Alarm(Running A/Running B)	SPI	Healthy/Faulty		
Communication Alarm (Communication Malfuntion)	SPI	Healthy/Faulty		
Battery Charger Failure (Communication) - ***	SPI	Healthy/Faulty		
a 48V Battery Charger 2 Fail				
b 48V Battery Charger 1 Fail /(Rectifier 1 Fault)				
Battery Charger Failure (Station)-***	SPI	Healthy/Faulty		
a 220 V Battery Charger 2 Fail /(Rectifier 1 Fault)				
b 220 V Battery Charger 1 Fail (Rectifier 2Fault)				
Station Urgent Fault - ***	SPI	Operated /Normal		
a Fox Faulty Urgent Alarm				
Station Non Urgent Fault - ***	SPI	Operated/Normal		
a Diesel Generator Alarm				
b Fox Faulty Non Urgent Alarm				
Station Control Remote/Supervisory	DPI	Remote/Superviosry		
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	1	1
Active Power	AI	MW	1	1
Reactive Power	AI	MVAr	1	1
Current	AI	Amperes	1	1
Transformer Tap Position	AI	Tap number		1
Power Factor	AI	PF		
GENERAL				
Air Condition Temprature	AI	Celcius		
Humidity	AI	RH %		
Solar Iradiance	AI	W/m^2		

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 indciation input

AI Analogue Measurement
AO Analogue Output

Double points are counted individually
***** :- Grouped Alarms**

Annex A3

Embilipitiya 132/33 kV GIS	TYPE OF SIGNAL	VOLTAGE	132/33 kV T/F 1		132/33 kV T/F 2		33 kV													
		BAY No	103	303	107	310	301	302	304	305	308	309	311	312	306	313	307			
		BAY TYPE	220 kV side	33 kV side	220 kV side	33 kV side	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	BS 1	BB 1	BB 2	Station
CONTROLS		**ACTION**																		
Circuit Breaker	DPC	Open/Close	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2			
BB Isolator 1	DPC	Open/Close	2	2	2	2	2	2	2	2	2	2	2	2	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		2															
Tap Changer (AVR) Auto / Manual	DPC	Auto /Manual	2		2															
AVR Operating mode **(One of the 2 modes will be available)**	DPC	Master/ Follower																		
	DPC	Minimum Circulation Current	2		2															
AVR Independent / Parallel	SPC	Independent/Parallel	1		1															
Protection Master Relay Reset /(Protection Reset Command K86.1) (/Lockout Relay Reset)	SPC	Reset	1	1	1	1											1			
Protection Master relay Reset Command K86.2	SPC	Reset	1	1	1	1											1			
Protection Reset Command K96 (BB/BCF relay Reset)	SPC	Reset	1	1	1	1											1			
Load Shedding OFF	SPC	On/Off																		
STATUS INDICATIONS		**STATUS**																		
Circuit Breaker	DPI	Open/Close	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2			
BB Isolator 1	DPI	Open/Close	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2			
BB Isolator 2	DPI	Open/Close															2			
Line Isolator	DPI	Open/Close																		
Capacitor Bay Isolator	DPI	Open/Close																		
Earthing Switch	DPI	Open/Close		2		2	2	2	2	2	2	2	2	2	2	2	4			
Bay Control	DPI	Local/Superv/Remote	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2			
TRANSFORMER																				
Tap Control	DPI	Local/Superv	2		2															
T/F AVR Operating mode	DPI	Manual /Auto	2		2															
T/F AVR Operating mode **(One of the 2 modes will be available)**	DPI	Master/Follower																		
	DPI	Minimum Circulation Current	2		2															
AVR Parallel / Indipendent	SPI	Paralle/ Indipendant	1		1															
Capacitor Bank																				
Capacitor Bank Operating Mode	SPI	Manual /Auto																		
ALARM INDICATIONS																				

Embilipitiya 132/33 kV GIS	TYPE OF SIGNAL	VOLTAGE	132/33 kV T/F 1		132/33 kV T/F 2		33 kV													
		BAY No	103	303	107	310	301	302	304	305	308	309	311	312	306	313	307			
		BAY TYPE	220 kV side	33 kV side	220 kV side	33 kV side	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	BS 1	BB 1	BB 2	Station
CIRCUIT BREAKER																				
Circuit Breaker Triping Indication	**SPI**	**Healthy/Faulty**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**			
Breaker Fault (critical) - ***	SPI	Healthy/Faulty	1	1	1		1	1	1	1	1	1	1	1	1	1	1			
a	SF6 Gas Presure low. (2nd stage)																			
b	Trip Circuit Supervision Fail 1 (Trip circuit faulty)																			
c	Trip Circuit Supervision Fail 2 ((Trip circuit 2 faulty)																			
d	Spring Not Charge (Spring Supervision)																			
e	Hydraulic Pressure Low																			
f	Pneumatic Pressure Low.																			
g	CB Pole Discrepancy																			
h	Trip Lockout/Close Lockout (SF6 Lock out)																			
i	Control Voltage Failure (DC MCB trip)																			
j	Internal Arc trip																			
h	SF6 Gas Presure 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			
a	SF6 Gas Pressure Low - First step																			
b	PT Secondary MCB Trip (Protection VT MCB Failed/ Incoming Voltage MCB trip/ VT MCB trip)																			
c	AC/DC Voltage Failure Indication (Auxiliary Fail)																			
TRANSFORMER MECHANICAL PROTECTION																				
Tap Changer Mechanism Fault (OLTC failure)	SPI	Healthy/Faulty	1	1	1	1														
Tap out of step (TAP OUT ERROR)	SPI	Onset/Reset	1	1	1	1														
Transf Buchholz Alarm - ***	SPI	Onset/Reset	1	1	1	1														
a	Transf Buchholz Alarm																			
b	OLTC Buchholz Alarm																			
Transf Buchholz Trip	SPI	Operated/Normal	1	1	1	1														
OLTC Buchholz Trip (OLTC OIL Flow Relay Trip)	SPI	Operated/Normal	1	1	1	1														
ET Transf Buchholz Trip	SPI	Operated/Normal	1	1	1	1														
AT Transf Buchholz Trip	SPI	Operated/Normal	1	1	1	1														
Temperature Alarm - ***	SPI	Onset/Reset	1	1	1	1														
a	Oil Temperature Alarm																			
b	Winding HV Temperature Alarm																			
c	Winding LV Temperature Alarm																			
Temperature trip - ***	SPI	Operated/Normal	1	1	1	1														
a	Oil Temperature trip																			
b	Winding HV Temperature trip																			
c	Winding LV Temperature trip																			
General Alarm - ***	SPI	Onset/Reset	1	1	1	1														
a	Cooling Fan Fail (Group 1/Group 2)																			
b	Transformer Oil Level low																			
c	OLTC Oil level low																			
General Trip - ***	SPI	Operated/Normal	1	1	1	1														
a	OLTC Surge Trip																			

Embilipitiya 132/33 kV GIS	TYPE OF SIGNAL	VOLTAGE	132/33 kV T/F 1		132/33 kV T/F 2		33 kV													
		BAY No	103	303	107	310	301	302	304	305	308	309	311	312	306	313	307			
		BAY TYPE	220 kV side	33 kV side	220 kV side	33 kV side	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	BS 1	BB 1	BB 2	Station
b Main tank Presure Release Valve (PRV) Trip																				
c OLTC Pressure Release Valve																				
d Transformer Oil Level low TRIP																				
e OLTC Oil level low																				
PROTECTION SIGNALS																				
LINE PROTECTION																				
Main 1 - Differential protection operated	SPI	Operated /Normal																		
Main 1 - Distance Zone 1 operated	SPI	Operated /Normal																		
Main 1 - Distance Zone 2 operated	SPI	Operated /Normal																		
Main 1 - Distance Zone 3 operated	SPI	Operated /Normal																		
Main 1 - Distance Zone 4 operated	SPI	Operated /Normal																		
Main 1 -Distance protection operated	SPI	Operated /Normal																		
Main 1 - Directional Earth Fault operated	SPI	Operated /Normal																		
Main 1 - Distance Protection Aided Trip	SPI	Operated /Normal																		
Main 2- Differential protection operated	SPI	Operated /Normal																		
Main 2 - Distance Zone 1 operated	SPI	Operated /Normal																		
Main 2 - Distance Zone 2 operated	SPI	Operated /Normal																		
Main 2 - Distance Zone 3 operated	SPI	Operated /Normal																		
Main 2 - Distance Zone 4 operated	SPI	Operated /Normal																		
Main 2 - Distance protection operated	SPI	Operated /Normal																		
Main 2 - Directional Earth Fault operated	SPI	Operated /Normal																		
Main 2 - Distance Protection Aided Trip	SPI	Operated /Normal																		
Over Current Protection trip	SPI	Operated /Normal					1	1	1	1	1	1	1	1	1	1	1			
Earth Fault Protection Operated	SPI	Operated /Normal					1	1	1	1	1	1	1	1	1	1	1			
Pole Discrepancy Protection Operated	SPI	Operated /Normal																		
Auto Recloser Operated / Success / Progress	SPI	Operated /Normal																		
Direct Intertrip Send	SPI	Operated /Normal																		
Direct Intertrip Received	SPI	Operated /Normal																		
Permissive Intertrip Send (carrier send)	SPI	Operated /Normal																		
Permissive Intertrip Received (carrier receive)	SPI	Operated /Normal																		
DEF Protection carrier Send	SPI	Operated /Normal																		
DEF Protection carrier Receive	SPI	Operated /Normal																		
Distance Protection Block	SPI	Operated /Normal																		
Communication Fail (Differential block)	SPI	Operated /Normal																		
Switch On To Fault trip (SOTF trip)	SPI	Operated /Normal																		
Over Voltage trip (OV)	SPI	Operated /Normal																		
Breaker Failure Protection Operated	SPI	Operated /Normal	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Trip Relay Operated/ Protection Relay K86.1 /Lockout Relay operated	SPI	Set/Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Trip Relay Operated/Protection Relay K86.2	SPI	Set/Reset	1		1												1			
Protection Relay K96	SPI	Set/Reset															1			

Embilipitiya 132/33 kV GIS	TYPE OF SIGNAL	VOLTAGE	132/33 kV T/F 1		132/33 kV T/F 2		33 kV													
		BAY No	103	303	107	310	301	302	304	305	308	309	311	312	306	313	307			
		BAY TYPE	220 kV side	33 kV side	220 kV side	33 kV side	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	BS 1	BB 1	BB 2	Station
Under Frequency Trip	SPI	Operated /Normal					1	1	1	1	1	1	1	1	1	1				
Over Frequency Trip	SPI	Operated /Normal					1	1	1	1	1	1	1	1	1	1				
Main 1 Protection Relay Fail	SPI	Healthy/ Fail	1		1															
Main 2 Protection Relay Fail	SPI	Healthy/ Fail	1		1															
Back Up Protection Relay Fail	SPI	Healthy/ Fail	1																	
Auto Relcose ON/OFF	SPI	ON / OFF																		
33kV protection Operated	SPI	Operated /Normal																		
BUSBAR PROTECTION																				
Bus Bar Protection Operated	SPI	Operated /Normal	1		1												1			
TRANSFORMER PROTECTION																				
Differential Protection Operated	SPI	Operated /Normal	1		1															
HV Restricted Earth Fault	SPI	Operated /Normal	1		1															
LV Restricted Earth Fault	SPI	Operated /Normal	1		1															
Transformer earth Fault Protection Operated	SPI	Operated /Normal	1	1	1	1														
Transformer Stand By EF Protection Operated	SPI	Operated /Normal	1	1	1	1														
Transformer Over Current Protection trip (OCProtection I>trip)	SPI	Operated /Normal	1	1	1	1														
Over Voltage Protection	SPI	Operated /Normal	1		1															
Over Fluxing Protection	SPI	Operated /Normal	1		1															
T/F Thermal Overload	SPI	Operated /Normal	1		1															
CAPACITOR BANK																				
Phase OverVoltage Operated	SPI	Operated /Normal																		
STATION ALARMS																				
Under Frequency Load Shedding Operated	SPI	Operated/Normal					1	1	1	1	1	1	1	1	1	1				
Bus Voltage Failure - ***	SPI	Healthy/Faulty																		1
a Auxialary Supply Voltage	SPI	Healthy/Faulty																		
b DC Voltage Failure (110V DC MCB Trip)	SPI	Healthy/Faulty																		
Gateway Alarm(Running A/Running B)	SPI	Healthy/Faulty																		1
Communication Alarm (Communication Malfuntion)	SPI	Healthy/Faulty																		1
Battery Charger Failure (Communication) - ***	SPI	Healthy/Faulty																		1
a 48V Battery Charger 2 Fail																				
b 48V Battery Charger 1 Fail /(Rectifier 1 Fault)																				
Battery Charger Failure (Station)-***	SPI	Healthy/Faulty																		1
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																		1
a Fox Faulty Urgent Alarm																				
Station Non Urgent Fault - ***	SPI	Operated/Normal																		1
a Diesel Generator Alarm																				
b Fox Faulty Non Urgent Alarm																				
Station Control Remote/Supervisory	DPI	Remote/Superviosry																		2
ENERGY MEASUREMENTS																				

Embilipitiya 132/33 kV GIS	TYPE OF SIGNAL	VOLTAGE	132/33 kV T/F 1		132/33 kV T/F 2		33 kV													
		BAY No	103	303	107	310	301	302	304	305	308	309	311	312	306	313	307			
		BAY TYPE	220 kV side	33 kV side	220 kV side	33 kV side	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	BS 1	BB 1	BB 2	Station
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	1	1	1	1	1	1	1	1	1	1	1	1		1	1	
Frequency	AI	Hertz	1	1	1													1	1	
Active Power	AI	MW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Reactive Power	AI	MVAr	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Current	AI	Amperes	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Transformer Tap Position	AI	Tap number		1		1														
Power Factor	AI	PF																		
GENERAL																				
Air Condition Temprature	AI	Celcius																		1
Humidity	AI	RH %																		1
Solar Iradiance	AI	W/m^2																		

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	AI	Analogue Measurement
SPC	Single Point Control Command	AO	Analogue Output
DPI	Double point indication input		
SPI	Single point indciation input		

Double points are counted individually

***** :- Grouped Alarms**

Annex B

Gateway/RTU Configuartion Parameters of Signals

	Signal Description	Type Of Signal	Signal Type Description				User Data of Class
			For IEC 60870 - 5 - 101		For IEC 60870 - 5 - 104		
			Type ID No.	Description	Type ID No.	Description	
	Control Command						
	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 / Manua	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 Curren	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 / Manua	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	GENERATOR CONTROLS						
	MW Setpoint	AO	50	C_SE_NC_1	50	C_SE_NC_1	Class 1
	MVAr Setpoint	AO	50	C_SE_NC_1	50	C_SE_NC_1	Class 1
	MW Control	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	MVAr Control	DPC	46	C_DC_NA_1	46	C_DC_NA_1	Class 1
	Protection Master Relay Reset /(Protection Reset Command K86.1) (/Lockout Relay Reset)	SPC	45	C_SC_NA_1	45	C_SC_NA_1	Class 1
	Protection Master relay Reset Command K86.2	SPC	45	C_SC_NA_1	45	C_SC_NA_1	Class 1
	Protection Reset Command K96 (BB/BCF relay Reset)	SPC	45	C_SC_NA_1	45	C_SC_NA_1	Class 1
	Load Shedding OFF	SPC	45	C_SC_NA_1	45	C_SC_NA_1	Class 1
	Status Indications						
	Circuit Breaker	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	BB Isolator 1	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 2
	BB Isolator 2	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 2
	Capacitor Bay Isolators	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 2
	Line Isolator	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 2
	Earthing Switch	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 2
	Bay Control	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 2
	TRANSFORMER AVR/TC						
	Tap Control (Local/Remote)	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	Tap Changer (AVR) Auto / Manua	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	AVR Operating mode **(One of the 2 modes will be available)**						
	Master/Follower	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	Minimum Circulation Curren	DPI	4	M_DP_TA_1	31	M_DP_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)	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	Tap Changer (AVR) Auto / Manua	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	CAPACITOR BANK/REACTOR BAY						
	Capacitor Bank Operating Mode	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	Reactor Operating Mode	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	GENERATOR STATUS INDICATIONS						
	Oper. mode of Governor	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	Oper. mode of Gen. AVR	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	Gen ready to Start	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	Generator Status	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	Generator Control	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	Setpoint Validation	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Raise /Lower Enable	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Alarm Indications						
	CIRCUIT BREAKER						
	Breaker Fault (critical) -***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	SF6 Gas Presure low. (2nd stage)						
b	Trip Circuit Supervision Fail 1 (Trip circuit faulty						
c	Trip Circuit Supervision Fail 2 ((Trip circuit 2 faulty						
d	Spring Not Charge (Spring Supervision						
e	Hydraulic Pressure Low						
f	Pneumatic Pressure Low.						
g	CB Pole Discrepancy						
h	Trip Lockout/Close Lockout (SF6 Lock out						
i	Control Voltage Failure (DC MCB trip)						
j	Internal Arc trip						
k	SF6 Gas Presure low in Bus Bar Chambe						
	Bay Fault (Non critical).***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	SF6 Gas Pressure Low - First step						
b	PT Secondary MCB Trip(Protection VT MCB Failed/ Incoming Voltage MCB trip/ VT MCB trip)						
c	AC/DC Voltage Failure Indication (Auxiliary Fail						
	TRANSFORMER MECHANICAL PROTECTION						

	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	
	Tap Changer Mechanism Fault	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Tap out of step	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Transf Buchholz Alarm - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Transf Buchholz Alarm						
b	OLTC Buchholz Alarm						
	Transf Buchholz Trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	OLTC Buchholz Trip (OLTC OIL Flow Relay Trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	ET Transf Buchholz Trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	AT Transf Buchholz Trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Temperature Alarm - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Oil Temperature Alarm						
b	Winding HV Temperature Alarm						
c	Winding LV Temperature Alarm						
	Temperature trip - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Oil Temperature trip						
b	Winding HV Temperature trip						
c	Winding LV Temperature trip						
	General Alarm- ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Cooling Fan Fail (Group 1/Group 2						
b	Transformer Oil Level low						
c	OLTC Oil level low						
	General Trip- ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	OLTC Surge Trip						
b	Main tank Presure Release Valve (PRV) Trip						
c	OLTC Pressure Release Valve						
d	Transformer Oil Level low TRIP						
e	OLTC Oil level low						
	PROTECTION SIGNALS/ALARMS						
	Main 1 - Differential protection operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 1 - Distance Zone 1 operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 1 - Distance Zone 2 operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 1 - Distance Zone 3 operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 1 - Distance Zone 4 operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 1 -Distance protection operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 1 - Directional Earth Fault operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Main 1 - Distance Protection Aided Trip	SPI	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 Relcose 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

	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	
	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 operatec	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 Operatec	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Transformer Stand By EF Protection Operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Transformer Over Current Protection trip (OCProtection I>trip	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Over Voltage Protection	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Over Fluxing Protection	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	T/F Thermal Overload	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	STATION ALARMS						
	Under Frequency Load Shedding Operated	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Bus Voltage Failure - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Auxialary Supply Voltage						
b	DC Voltage Failure (110V DC MCB Trip)						
	RTU Alarm	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
	Communication Alarm (Communication 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
a	48V Battery Charger 2 Fail						
b	48V Battery Charger 1 Fail /(Rectifier 1 Fault)						
	Battery Charger Failure (Station) - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	220 V Battery Charger 2 Fail /(Rectifier 1 Fault)						
b	220 V Battery Charger 1 Fail (Rectifier 2Fault)						
	Station Urgent Fault - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Fox Faulty Urgent Alarm						
	Station Non Urgent Fault - ***	SPI	2	M_SP_TA_1	30	M_SP_TB_1	Class 1
a	Diesel Generator Alarm						
b	Fox Faulty Non Urgent Alarm						
	Station Control Remote/Supervisory	DPI	4	M_DP_TA_1	31	M_DP_TB_1	Class 1
	ENERGY MEASUREMENTS						
	Active Energy	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Re-Active Energy	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Measurements						
	Voltage	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Frequency	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Active Power	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Reactive Power	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Current	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Transformer Tap Position	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	GENERATOR MEASUREMENTS						
	Unit Generation	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Active Power (included above)	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Reactive Power (included above)	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Active Energy	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Reactive Energy	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Droop Setting - Hand dressed	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	GENERAL						
	Air Condition Temprature	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2
	Humidity	AI	13	M_ME_NC_1	13	M_ME_NC_1	Class 2

LEGEND

DPI - Double Point Indication
SPI - Single Point Indication
DPC - Double Point Command
SPC - Single Pont Command
BCP - Binary Coaded Measurement
AI - Analog Input
AO - Analog Out Put
TC -Tap Controller

ASDU Type ID

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 timw tag CP56Time2a
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**

Annex C

Communication Path Configurations (NSCC & Communication Branch)

Communication Path Configurations for Embilipitiya Grid Substation 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

NSCC SIGNAL LIST - SINGLE POINT INDICATIONS

Annex D

(Name of GSS) NSCC SIGNAL LIST - SINGLE POINT INDICATIONS

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 / Indipendent- High(1)=..... Low(0)=.....

(Name of the Station) NSCC SIGNAL LIST - CONTROLS AND DOUBLE POINT INDICATIONS

Bay No.	Bay Name	Signal Description	Type Of Signal	Signal Type Description				User Data of Class	Information Object Address	Remarks
				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 / Indipendent(SPC)- High(1)=..... Low(0)=.....

(Name of the Station) NSCC SIGNAL LIST - MEASUREMENTS

Bay No.	Bay Name	Signal Description	Type Of Signal	Signal Type Description				User Data of Class	Information Object Address	Remarks
				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 Contrator):
(Project Name) :

Checked By
Name:
Signature:
Date:
CEB
(Project Name) :

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

E01 Bay Fault - Non critical:
CB Heater Fault

E02 Bay Fault - Non criti
CB Heater Fault

E03 Bay Fault - Non critical:
CB Heater Fault

E04 Bay Fault - Non critical:
CB Heater Fault

……..(Substation name)

Name of the contarctor **…….**

Annex E

Specification of Fiber Optic Splicing Machine (Single Mode and Multimode)

Fiber Optic Splicing Machine used for Fiber Fusion Splicer and Welding Splicer with following features and tools.

- Fusion splicer main unit
- Fiber Optic Cleaver (Single Mode and Multimode), High Precision Cleaver
- Fiber Optical Power Meter (Single Mode and Multimode)
- Fiber Optical Power Source (Multimode)
- Fiber Optical Power Source (Single Mode)
- Core Alignment Fusion Splicer Kit, OTDR 33/31dB, Power Meter, Laser Source, VFL

Optical fiber requirements are Material Silica glass Profile types SMF (ITU-T G.652), MMF (ITU-T G.651), DSF (ITU-T G.653), NZDSF (ITU-T G.655), BIF (ITU-T G.657), EDF Fiber diameter Cladding diameter: 80 μm ~ 150 μm, Coating diameter: 100 μm ~ 1,000 μm Applicable fiber or cable size up to φ1,000 μm Drop cable (2.0x3.1 mm), Indoor cable (2.0x2.0 mm) Cleave length 5~16 mm 10 mm Standard performance Splice loss (typical) SMF: 0.02 dB, MMF: 0.01 dB, DSF: 0.04 dB, NZDSF: 0.04 dB.