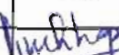




BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION PROJECTS ENGINEERING MANAGEMENT

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TITLE Telecommunication Equipment				SIGN			
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CUSTOMER POWERGRID MEDINIPUR-JEERAT TRANSMISSION LIMITED

PROJECTS 765/400kV Substations at Jeerat & Medinipur (New) & Extension of 400kV Jeerat S/s
Project code : 395

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Section –I

1.0 SCOPE

This technical specification covers the requirements of Survey, planning, design, manufacture, testing at works, packing, dispatch, supervision of erection and site testing and commissioning of the Telecommunication equipments/items, complete in all respect for 765/400kV Jeerat & Medinipur substation. The detailed technical specification is enclosed under Section II of this specification.

Bidder is responsible for the designing, engineering, testing and supply including transportation & insurance, at site of mandatory spares and testing instruments for telecommunication equipments.

This section covers the specific technical requirements of Telecommunication Equipment System. This constitutes minimum technical parameters for the telecommunication system as specified by the customer (POWERGRID). The offered equipment shall also comply with the General Technical Requirements for the project as detailed under Section-III of this specification.

The specification comprise of following sections:

- Section-I: Scope, Specific Technical Requirements & Bill of Quantities
- Section-II: Detailed Technical Requirement - Equipment Specification
- Section-III: Project Details & General Technical Requirements
- Section-IV: Enclosures to Specifications

In case of any conflict between various sections, order of precedence shall be in the same order as listed above.

Note: The terms used in this specification namely, “Employer/Purchaser” refers to Powergrid, “Contractor” refers to BHEL & “Sub-contractor” refers to successful bidder

1.1 THE EQUIPMENT IS REQUIRED FOR THE FOLLOWING PROJECT

Name of Customer : Power Grid Medinipur-Jeerat Transmission Limited

Name of the Project: 765/400kV Substations at Jeerat & Medinipur (New) & Extension of 400kV Jeerat S/s

Refer Section - III for Project Details and General Specifications

1.2 SCOPE:

The broad Scope of the procurement of Communication Equipment shall include planning, designing, engineering, supply, transportation, insurance, delivery at site, unloading handling, storage, installation, termination, testing, training and demonstration for acceptance, commissioning and documentation for :

- i) SDH Equipment along with suitable interfaces and line cards.
- ii) All cabling, wiring, Digital Distribution frame patch facilities and interconnection to the supplied equipment at the defined interfaces.
- iii) System integration of all supplied subsystem.
- iv) Integration with the existing communication system based on SDH and PDH of employer.
- v) Integration of supplied subsystem with SCADA system, PLCC equipment, PABX of RLDC/NLDC, VOIP (SIP compliant) for voice.

1.3 QUALIFYING REQUIREMENTS

The SDH equipment shall be offered from a manufacturer(s) who has been manufacturing SDH equipment for the last three (3) years and SDH equipment manufactured by such manufacturer

(s) shall have been in satisfactory operation in 110kV or higher voltage power substations for the last (2) years as on the date of opening of Bids.

Satisfactory operation means certificate issued by the Employer/ Utility certifying the operation without any adverse remark.

Please note: Forms of undertaking if any (as per customer/BHEL format) shall be furnished to successful bidder during contract stage.

1.4 **BILL OF QUANTITY**

Telecommunication equipment for 765/400kV Jeerat & Medinipur substation.

The BOQ mentioned below is tentative and is liable to change based on the link budget calculations submitted by bidder during detail engineering.

A) FOR JEERAT S/S

SN	DESCRIPTION	UNIT	QTY
1.	JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Base Equipment (Common cards, Cross-connect/control cards, Optical base cards, Power supply cards, power cabling, other hardware & accessories including sub-racks patch cords, DDF etc. fully equipped excluding optical interface cards/SFP and Tributary Cards below)	No.	1
2.	JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- # Optical Interface card/SFP for S16.1	No.	2
3.	JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- # Optical Interface card/SFP for L16.2	No.	2
4.	JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- # Optical Interface card/SFP for S4.1	No.	2
5.	JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- # Optical Interface card /SFP for L4.2	No.	2
6.	JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- # Optical Interface card /SFP for STM-16 Optical Line Interface card (to support upto 150 km) **	No.	2
7.	JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- # Optical Interface card /SFP for STM-16 Optical Line Interface card (to support upto 225 km) **	No.	2

8.	JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Tributary Cards : E1 Interface card (Minimum 16 interfaces per card)	Set	2
9.	JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Tributary Cards : Ethernet interface 10/100Base T with layer-2 switching (Minimum 8 interfaces per card)	No.	2
10.	JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Tributary Cards: Gigabit Ethernet (Layer 2) Interface (Minimum 2nos.)	Set	1
11.	JEERAT S/s : Equipment Cabinets	Set	1
12.	JEERAT S/s : TMN : Network Manager System-Craft Terminal : Hardware Note: 1 Set shall include all required hardware /software for complete TMN/Craft terminal system as specified in the technical specification. NMS facilities for SDH equipment shall include monitoring of Ethernet ports also.	Set	1
13.	JEERAT S/s : TMN : Network Manager System- Craft Terminal : Software Note: 1 Set shall include all required hardware /software for complete TMN/Craft terminal system as specified in the technical specification. NMS facilities for SDH equipment shall include monitoring of Ethernet ports also.	Set	1
14.	JEERAT S/s: VOIP telephone instrument with one common switch (minimum 8 ports)	No.	4
15.	JEERAT S/s : Approach Cable(24 Fiber): 24 Fibers (DWSM)	Km	1
16.	JEERAT S/s :Installation Equipment-Hardware set for 24 fibers; fiber optic approach cable	Set	1
17.	JEERAT S/s :FODP-96 fiber: Indoor Type Rack mounted FCPC Coupling & Pigtails	No.	2
18.	Mandatory Spares : JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Optical Interface cards/SFP For : S16.1 Note: Include each type of optical base card which has been supplied under main quantity meeting the criteria of 10% spare.	No.	1
19.	Mandatory Spares : JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Optical Interface cards/SFP For : L16.2 Note: Include each type of optical base card which has been supplied under main quantity meeting the criteria of 10% spare.	No.	1
20.	Mandatory Spares : JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Optical Interface cards/SFP For : S4.1 Note: Include each type of optical base card which has been supplied under main quantity meeting the criteria of 10% spare.	No.	1
21.	Mandatory Spares : JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Optical cards/SFP For : L4.2 Note: Include each type of optical base card which has been supplied under main quantity meeting the criteria of 10% spare.	No.	1
22.	Mandatory Spares : JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Optical cards/SFP For : Optical Line Interface card (to support upto 150km) for STM-16 **	No.	1

23.	Mandatory Spares : JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Optical cards/SFP For : Optical Line Interface card (to support upto 225km) for STM-16 **	No.	1
24.	Mandatory Spares : JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Tributary cards – E1 Interface card(Minimum 16 interfaces per card)	No.	1
25.	Mandatory Spares : JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Tributary Cards : Ethernet interface 10/100Base T with layer-2 switching (Minimum 8 interfaces per card)	No.	1
26.	Mandatory Spares : JEERAT S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Tributary Cards: Gigabit Ethernet (Layer 2) Interface (Minimum 2nos.)	Set	1
27.	Mandatory Spares : JEERAT S/s : VOIP telephone instrument	No.	1
28.	Mandatory Spares : JEERAT S/s : Pre-connectorized Optical Fiber patch cords (10 meters) – Pack of Six Patch cords	Set	1
29.	Services at Jeerat S/s: Training to employer's personnel at Substation site in field of erection, testing, operation and maintenance of SDH equipment, Mux Equipment, DACS & NMS as per TS for two (2) days.	Lot	1
30.	Services at Jeerat S/s : Maintenance Charges for Communication System for One (1) year during Warranty period as per TS	Lot	1
31.	Services at Jeerat S/s : Site survey, design engineering, integration & FAT of communication equipment	Lot	1
32.	Services at Jeerat S/s : Site installation, SAT & commissioning of communication equipment (station-wise)	Lot	1

B) FOR MEDINIPUR S/S

SN	DESCRIPTION	UNIT	QTY
1.	MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Base Equipment (Common cards, Cross-connect/control cards, Optical base cards, Power supply cards, power cabling, other hardware & accessories including sub-racks patch cords, DDF etc. fully equipped excluding optical interface cards/SFP and Tributary Cards below)	No.	1
2.	MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- # Optical Interface card/SFP for S16.1	No.	2
3.	MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- # Optical Interface card/SFP for L16.2	No.	2
4.	MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- # Optical Interface card/SFP for S4.1	No.	2
5.	MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- # Optical Interface card /SFP for L4.2	No.	2

6.	MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- # Optical Interface card /SFP for STM-16 Optical Line Interface card (to support upto 150 km) **	No.	2
7.	MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- # Optical Interface card /SFP for STM-16 Optical Line Interface card (to support upto 225 km) **	No.	2
8.	MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Tributary Cards : E1 Interface card (Minimum 16 interfaces per card)	Set	2
9.	MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Tributary Cards : Ethernet interface 10/100Base T with layer-2 switching (Minimum 8 interfaces per card)	No.	2
10.	MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Tributary Cards: Gigabit Ethernet (Layer 2) Interface (Minimum 2nos.)	Set	1
11.	MEDINIPUR S/s : Equipment Cabinet	Set	1
12.	MEDINIPUR S/s : TMN : Network Manager System-Craft Terminal : Hardware Note: 1 Set shall include all required hardware /software for complete TMN/Craft terminal system as specified in the technical specification. NMS facilities for SDH equipment shall include monitoring of Ethernet ports also.	Set	1
13.	MEDINIPUR S/s : TMN : Network Manager System- Craft Terminal : Software Note: 1 Set shall include all required hardware /software for complete TMN/Craft terminal system as specified in the technical specification. NMS facilities for SDH equipment shall include monitoring of Ethernet ports also.	Set	1
14.	MEDINIPUR S/s: VOIP telephone instrument with one common switch (minimum 8 ports)	No.	4
15.	MEDINIPUR S/s : Approach Cable(24 Fiber): 24 Fibers (DWSM)	Km	1
16.	MEDINIPUR S/s :Installation Equipment-Hardware set for 24 fibers; fiber optic approach cable	Set	1
17.	MEDINIPUR S/s :FODP-96 fiber: Indoor Type Rack mounted FCPC Coupling & Pigtails (5M)	No.	2
18.	Mandatory Spares : MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Optical Interface cards/SFP For : S16.1 Note: Include each type of optical base card which has been supplied under main quantity meeting the criteria of 10% spare.	No.	1
19.	Mandatory Spares : MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Optical Interface cards/SFP For : L16.2 Note: Include each type of optical base card which has been supplied under main quantity meeting the criteria of 10% spare.	No.	1
20.	Mandatory Spares : MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Optical Interface cards/SFP For : S4.1	No.	1

	Note: Include each type of optical base card which has been supplied under main quantity meeting the criteria of 10% spare.		
21.	Mandatory Spares : MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Optical cards/SFP For : L4.2 Note: Include each type of optical base card which has been supplied under main quantity meeting the criteria of 10% spare.	No.	1
22.	Mandatory Spares : MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Optical cards/SFP For : Optical Line Interface card (to support upto 150km) for STM-16 **	No.	1
23.	Mandatory Spares : MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Optical cards/SFP For : Optical Line Interface card (to support upto 225km) for STM-16 **	No.	1
24.	Mandatory Spares : MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Tributary cards – E1 Interface card(Minimum 16 interfaces per card)	No.	1
25.	Mandatory Spares : MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Tributary Cards : Ethernet interface 10/100Base T with layer-2 switching (Minimum 8 interfaces per card)	No.	1
26.	Mandatory Spares : MEDINIPUR S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 5 MSP protected directions) :- Tributary Cards: Gigabit Ethernet (Layer 2) Interface (Minimum 2nos.)	Set	1
27.	Mandatory Spares : MEDINIPUR S/s :VOIP telephone instrument	No.	1
28.	Mandatory Spares : MEDINIPUR S/s : Pre-connectorized Optical Fiber patch cords (10 meters) – Pack of Six Patch cords	Set	1
29.	Repeater station (Ranchi-Medinipur Line) : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 3 MSP protected directions) :- Base Equipment (Common cards, Cross-connect/control cards, Optical base cards, Power supply cards, power cabling, other hardware & accessories including sub-racks, patch cords, DDF etc. fully equipped excluding optical interface cards/SFP and Tributary Cards below)	No.	1
30.	Repeater station (Ranchi-Medinipur Line) : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 3 MSP protected directions) :- # Optical Interface card/SFP for S16.1	No.	2
31.	Repeater station (Ranchi-Medinipur Line) : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 3 MSP protected directions) :- # Optical Interface card/SFP for L16.2	No.	2
32.	Repeater station (Ranchi-Medinipur Line) : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 3 MSP protected directions) :- # Optical Interface card/SFP for S4.1	No.	2
33.	Repeater station (Ranchi-Medinipur Line) : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 3 MSP protected directions) :-	No.	2

	# Optical Interface card/SFP for L4.2		
34.	Repeater station (Ranchi-Medinipur Line) : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 3 MSP protected directions) :- # Optical Interface card /SFP for STM-16 Optical Line Interface card (to support upto 150 km) **	No.	2
35.	Repeater station (Ranchi-Medinipur Line) : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 3 MSP protected directions) :- # Optical Interface card /SFP for STM-16 Optical Line Interface card (to support upto 225 km) **	No.	2
36.	Repeater station (Ranchi-Medinipur Line) : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 3 MSP protected directions) :- Tributary Cards : E1 Interface card (Minimum 16 interfaces per card)	Set	2
37.	Repeater station (Ranchi-Medinipur Line) : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 3 MSP protected directions) :- Tributary Cards : Ethernet interface 10/100Base T with layer-2 switching (Minimum 8 interfaces per card)	No.	2
38.	Repeater station (Ranchi-Medinipur Line) : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 3 MSP protected directions) :- Tributary Cards: Gigabit Ethernet (Layer 2) Interface (Minimum 2nos.)	Set	1
39.	Repeater station (Ranchi-Medinipur Line) : Equipment Cabinet	Set	1
40.	Repeater station (Ranchi-Medinipur Line) : TMN : Network Manager System-Craft Terminal : Hardware Note: 1 Set shall include all required hardware /software for complete TMN/Craft terminal system as specified in the technical specification. NMS facilities for SDH equipment shall include monitoring of Ethernet ports also.	Set	1
41.	Repeater station (Ranchi-Medinipur Line) : TMN : Network Manager System-Craft Terminal : Software Note: 1 Set shall include all required hardware /software for complete TMN/Craft terminal system as specified in the technical specification. NMS facilities for SDH equipment shall include monitoring of Ethernet ports also.	Set	1
42.	Repeater station (Ranchi-Medinipur Line) : Approach Cable(24 Fiber): 24 Fibers (DWSM)	Km	2
43.	Repeater station (Ranchi-Medinipur Line) : Installation Equipment-Hardware set for 24 fibers; fiber optic approach cable	Set	2
44.	Repeater station (Ranchi-Medinipur Line) : FODP-96 fiber: Indoor Type Rack mounted FCPC Coupling & Pigtail	No.	1
45.	Mandatory Spares: Repeater station (Ranchi-Medinipur Line) : Approach Cable(24 Fiber): 24 Fibers (DWSM)	Km	1
46.	Mandatory Spares: Repeater station (Ranchi-Medinipur Line) : Installation Equipment-Hardware set for 24 fibers; fiber optic approach cable	Set	1
47.	Service at Medinipur S/s : Training to employer's personnel at Substation site in field of erection, testing ,operation and maintenance of SDH equipment, Mux Equipment , DACS & NMS as per TS for two(2) days.	Lot	1
48.	Service at Medinipur S/s : Maintenance Charges for Communication System for One (1) year during Warranty period as per TS	Lot	1

49.	Service at Medinipur S/s : Site survey, design engineering, integration & FAT of communication equipment	Lot	1
50.	Service at Medinipur S/s : Site installation, SAT & commissioning of communication equipment (station-wise)	Lot	2

#

Optical Interface/SFP can be provided with optical base card or control card with the condition that control card shall not be equipped with more than one Optical interface / SFP and optical card with not more than two optical interface /SFP . However main and protection channel shall be terminated on separate cards.

****** Suitable optical interface card(s) or any other solution such as SDH equipment with optical amplifier, wavelength translator or higher aggregate bit rate SDH equipment may be offered to meet the link budget requirements without repeater

NOTE-

- Qty variation shall be +/- 50%.Some line items may be deleted.
- Interface cards have to be installed and commissioned in the existing Multiplexer.
- Software, Hardware (Viz. Optical Patch cable, Signal cable, wiring, connectors, expansion chassis etc) required for installation of above cards is deemed to be included in the scope.
- Doing site survey for the availability of slots in the existing Multiplexer is also in the scope of bidder.
- Maintenance charges as per Sl. No. 30 & 48 above shall include station where the bidder is supplying their equipment under this contract.
- PMU will be procured separately by BHEL whose details are given in Annexure
- It is to be noted that: "Digital protection coupler used as one of the two teleportation channel on the lines between the stations having Optical Fibre link shall be covered under the scope of PLCC supplier. SDH Equipment are placed in Control room where as DPC is placed in switchyard panel. The connection between SDH equipment and each DPC shall be through Optical fibre. Necessary converter(s) for converting E1 signal to optical fibre at both ends (at SPR as well as at Control room) along with FODP shall be in the scope of the PLCC supplier". Proper interfacing of the DPC with offered telecommunication equipment under this tender shall be ensured by the bidder
- Required quantity of Panels/ Cabinets for housing OLTE/ PDH/ Digital Protection Coupler/FODP etc. are deemed to be included in the offered price as per customer approved drawings. No price implication shall be entertained during execution and handing-over of the system.
- Splicing of Fibres 1 Lot = Splicing as required at FODP and OPGW Joint Box for both local and remote ends for successful commissioning of the system shall be included in the offered price.
- Fibre Distribution Panel shall be Stand-alone type/ Panel-mounted as per customer approved drawing. No price implication shall be entertained during contract stage regarding the same.
- Successful commissioning of all the Communication Links with the Remote end stations shall be in bidder's scope for this tender. Necessary co-ordination, modification and interfacing with remote end existing equipments as applicable shall be in bidder's scope.
- SAT & Commissioning of Tele-Communication System including Supervision of Installation --- 1 Lot covers both local and remote ends for successful commissioning of the links under present scope.
- All SFP's shall be mounted in the SDH cabinets being offered.

1.5 APPROVAL CRITERION:

- a) The contract drawings shall preferably be POWERGRID standard approved drawings or shall be approved by POWERGRID in some of their previous project. The approval extension of standard drawings for this project or obtaining fresh approval from POWERGRID Engg shall be the sole responsibility of the bidder without any price and delivery implications to BHEL.
- b) The items offered shall be of approved make and model from POWERGRID and is working satisfactorily in their projects.
- c) In case, the offered item is not POWERGRID approved then it is the sole responsibility of the bidder to get it approved without any price & Delivery implication to BHEL.

1.6 TRAINING:

- a. The supplier shall also impart training to Employer's personnel at substation site in the field of Erection, Testing, operation and maintenance of Telecommunication equipments including SDH Equipment, Mux Equipment, DACS & NMS for two (2) days.

Note: Charges for Tutorials & other training materials for the trainees shall also be included in the price quoted by the bidder.

1.7 TYPE TEST REQUIREMENTS:

As per Technical Specification Section -2.

1.8 INSPECTION, TESTING AND ACCEPTANCE:

Bidder has to follow Technical specification and POWERGRID approved Manufacturing Quality Plan of Power Grid Corporation of India Ltd.

1.9 DEVIATION:

The bidder shall list all the deviation from the specification separately. Offers without specific deviation will be deemed to be totally in compliance with the specification and NO DEVIATION on any account will be entertained at a later date.

2.0 DOCUMENTATION:

Final Documentation (after approval) shall be separate for each Substation. List of documents to be submitted is mentioned in section-2 of specification.

2.1 DOCUMENTS REQUIRED DURING TENDER STAGE:

Following documents are required during tender stage:

- a) Clause wise compliance to the specification
- b) Available catalogs of offered items
- c) Filled checklist
- d) Un-priced Bill of Quantity

SECTION-II

1. TELECOMMUNICATION SYSTEMS

1.1 General

This section describes the Fiber Optic Communication equipment characteristics for communication system to be installed under the project. The sub-systems addressed within this section are:

- (1) Fiber Optic Transmission System (FOTS)
- (2) DDF and Cabling
- (3) Craft Terminal based Network Management System (NMS)
- (4) Repeater Shelter
- (5) FO Approach Cable
- (6) FODP

The equipment supplied shall support existing communication network for Power system operational requirements.

The security related requirements of the equipment shall be as per DoT (Department of Telecommunication) guidelines and all similar security requirements as amended by DoT on time to time basis shall be followed/complied by the vendor at no additional cost to Employer till the implementation of the project.

The manufacturer shall allow the Employer and/or its designated agencies to inspect the hardware, software, design, development, manufacturing, facility and supply chain and subject all software to a security /threat check any time during the supplies of equipment

The ~~contractor~~^{bidder} shall ensure that the supplied equipments have been got tested as per relevant contemporary Indian or International Security Standards e.g. IT and IT related elements against ISO/IEC 15408 standards, for Information Security Management System against ISO 27000 series Standards from an authorized and certified agency/lab.

In case of any deliberate attempt for a security breach at the time of procurement or at a later stage after deployment/installation of the equipment or during maintenance, liability and criminal proceedings can be initiated against the ~~Contractor~~^{bidder} as per guidelines of DoT and any other Government department.

The primary function of the equipment is to provide a highly reliable voice and data communication system for grid operation in support of the SCADA/EMS, RTUs & PMUs and for new technological requirements of Power System Operation such as Special Protection Scheme, Grid Security Expert System, Load Management, Advanced Protection System & Substation Automation System. A brief summary of the system requirements is as follows:

- (a) High speed E1 channel support
- (b) 64kbps & nx64kbps data channel support as required
- (c) Low speed (300 -1200 bps) data channel support as required
- (d) Voice (2 wires, 4 wires) channel support and integration with Employer's/RLDC's EPABX system. The details of EPABX System shall be provided during detailed engineering.
- (e) Data transport supporting Network Management channels
- (f) The connectivity envisaged between Substation and Control Centre over TCP-IP using

Ethernet interface for various services of data and voice such as for PMUs, RTUs, VOIP etc.

1.2 General Technical Requirement

The SDH equipment shall be offered from a manufacturer(s) who has been manufacturing SDH equipment for the last three (3) years and SDH equipment manufactured by such manufacture(s) shall have been in satisfactory operation in 110 kV or higher voltage Power substations for at least two (2) years as on the date of NOA.

2.1 Fibre Optic Transmission System

2.1.1 General Network Characteristics

808 The SDH node shall be used for interconnection of terminal Substation to the fibre optic network and shall be based on the Synchronous Digital Hierarchy (SDH) having bit rate of STM-4/16 as specified in BPS. The ~~contractor~~ Bidder shall follow numbering plan for the proposed voice communication system.

The transmission equipment to be supplied shall be a complete SDH node (add-drop multiplexer) providing all the features e.g. protection and performance monitoring.

This will be used for delivering E1 as per ITU-T G.703 and Giga/fast Ethernet services except repeater stations. In case other interface such as Asynchronous Sub-channel data card (RS232/V.24/V.28), Synchronous data card (V.36/X.21), 2 wire voice channel card or 4 wire (E&M) voice channel card as required, shall be supplied either in the same equipment or as independent PDH equipment.

The ~~Contractor~~ Bidder shall supply the equipment as per the technical specification. The deliverables shall include all installation materials necessary for successful installation and commissioning of the equipment viz. AC & DC power supply cabling, Krone type/75Ω BNC type Digital Distribution Frame (DDF) in enclosure, optical patch cords for FODP-to-equipment and equipment-to-equipment connection, optical attenuator (5dB/10dB), flexible conduits etc. as per site requirement. Additionally one (1) pair of optical patch cord per SDH node will be supplied as spare. User Manual, System Guide shall be delivered with each equipment. The ~~Contractor~~ Bidder shall provide all required minor civil works necessary for full connectivity as required.

Equipment redundancy and Automatic Protection Schemes (APS) are specified in the Table 1. The failure of one element shall not prevent the use of any other that has not failed.

Table 1
Equipment Redundancy Requirements Summary

Fiber Optic transmission Equipment :	
Power Supply & Converters -----	1:1 APS or distributed power supply
Common Control* Cards -----	1:1 APS
* = Common control cards which are essentially required for operation of the equipment.	

The offered equipment shall support automatic switchover function between the redundant modules and all required modules and hardware to support the automatic switch over shall be provided by the ~~Contractor~~ Bidder.

At any digital signal level, reapplication of a lost signal shall result in automatic resynchronization and full restoration to normal operation without manual intervention. All alarms incident to the signal failure, shall be automatically cleared at the equipment, rack and monitoring levels and normal operation indications restored and reported if applicable.

The offered transmission equipment (SDH node) shall support optical link of at least 250 Km for STM-4 and 225Km for STM-16 without any repeater station in between. If required, wavelength translator/optical amplifier shall be provided by the ~~contractor~~ bidder.

2.1.2 Features of Transmission Equipment

- Aggregate interface shall be STM-4/16, with ~~three (3)~~ Five (5) MSP protected directions (as required in ~~BPS~~ ^{OPS}). If bidder is offering equipment with multifunction cards such as cross-connect or control card with optical interface/SFP or tributary interface, such type of multifunction card shall be considered as Common control card and shall be the part of base equipment. In case optical interface/SFP is embedded with control card, the adequate number of optical interface/SFPs shall be offered to meet the redundancy requirements of the specifications. Further, main and protection channel shall be terminated on separate cards. Aggregate interface of STM-4/16 shall have FC/PC. In case other than FC-PC connector is provided in the equipment, suitable patch cord with matching connector are to be provided to connect with FODP.
- All software and hardware shall support IPv4 and IPv6 simultaneously (dual stack).
- SDH equipment shall support dual power feed with redundancies for Power supply unit and Control unit in each rack.
- Minimum 16 nos. x 2 Mbit/s per card, 120Ω/75Ω tributary interface compliant to ITU-T G.703, G.704 with suitable connector
- Ethernet interface shall have minimum 8 nos. per card of RJ-45 port for ingress and egress of Ethernet data (Ethernet over SDH) at 10/100/1000 Base-T speeds/standards (ITU-T G.7041GFP capsulation). Ethernet shall support LCAS feature. It shall support full throughput upto 1000 Mbps on Ethernet port by virtual concatenation of requisite no. of VC-12. There shall be the provision of "Auto Negotiation" and "Flow control" Enabling/disabling through NMS of the system. Also there shall be provision of configuring the equipment for unrestricted nxVC12 bandwidth (upto 1000Mbps). The Ethernet interface shall support VLAN (IEEE 802.1P/Q), spanning tree (IEEE 802.1D) quality of service. The protection scheme for Ethernet traffic should be ERPS based.
- Services channel shall be provided as a function of the SDH equipment and shall be equipped with Service Channel Muldem's that shall provide at a minimum: One voice channel (order wire) with analog interface (0.3 to 3.4 kHz) and one data channel. There shall be a facility to extend the line system order-wire to any other system or exchange lines.
- ADM configuration for traffic protection by using SNCP & MSP.
- Synchronization: The substation GPS can be used for extending synchronization to equipment. Alternately existing network Master Clock can be used for synchronization.
- ISM (In Service Monitoring) circuitry shall be provided as a function of the SDH equipment. Local visual alarm indicators shall be provided on the equipment, as a rack summary alarm panel. Alarms shall be as per ITU-T Standards G.774, G.783 and G.784.
- Downloading of software shall be possible from remote.
- Shall have Embedded Communication Channel (ECC), ports (Ethernet/RS232) for craft terminal and management interface and shall support DCC pass through.
- DCN implementation through protected VC12. Support DCN grooming in VC12.

- Pre-connectorised Optical patch cords shall be of G.625D fibre. The Patch cord return loss shall be equal to or better than 40 dB and insertion loss equal to or less than 0.5 dB. Fiber jumpers shall be of sufficient lengths as to provide at least 0.5m of service loop.
- Manageable by Craft Terminal programme. It shall support performance monitoring, remote software upgrade, configuration management from remote as well as local craft terminal. The craft terminal shall have minimum configuration of 2.4 GHz, 8 GB RAM, 256 MB Video Graphics Memory, DVD RW drive, 320 GB Hard Disk Drive, keyboard, mouse/trackball etc., serial/USB (2.0) ports to accommodate printers, IEEE 802.11a/b/g wireless LAN, Bluetooth, Internal/external Data/Fax modem and a battery back-up of at least 3 hours. VDUs shall be 15" TFT active matrix color LCD with a minimum resolution of 1024 X 768.
- Local Craft Terminal will be provided with requisite software for performing all element level management functions viz. configuration management, fault management, performance management etc.
- Shall be operated with -48 V DC Power Supply. DC power interface shall be suitable to work on a nominal voltage of -48V $\pm$ 20%.
- Compact design suitable for installation in 19" rack.
- The bidder shall be required to provide only Optical Interface/SFP to be installed in the existing/third party SDH equipment at few locations if any. The bidder has to ensure compatibility of the supplied Optical Interface/SFP for the same.

2.1.2.1 Network Monitoring (Craft Terminal based)

- Manageable by Craft Terminal programme. It shall support performance monitoring, remote software upgrade, configuration management from remote as well as local craft terminal. The craft terminal shall have minimum configuration of 2.4 GHz, 8 GB RAM, 256 MB Video Graphics Memory, DVD RW drive, 320 GB Hard Disk Drive, keyboard, mouse/trackball etc., serial/USB (2.0) ports to accommodate printers, IEEE 802.11a/b/g wireless LAN, Bluetooth, Internal/external Data/Fax modem and a battery back-up of at least 3 hours. VDUs shall be 15" TFT active matrix color LCD with a minimum resolution of 1024 X 768. However, the configuration shall be finalized during detailed engineering as per the latest industrial standards.
- Local Craft Terminal will be provided with requisite software for performing all element level management functions viz. configuration management, fault management, performance management etc.
- Bidder shall provide the telecom equipment which can be integrated with the existing NMS server/s of the respective RLDC/ SLDC. The details of existing NMS server/s shall be provided during detailed engineering or to be ascertained by Bidder conducted during site survey.

2.1.3 Optical Link Budget Calculations

The fibre optic link budget calculations shall be calculated based upon the following criteria:

- (1) Fibre attenuation: The fibre attenuation shall be taken to be the guaranteed maximum fibre attenuation i.e. 0.21 dB/Km @1550nm and 0.35 dB/km @1310nm.
- (2) Splice loss: Minimum 0.05 dB per splice. One splice shall be considered for every 3 kms.
- (3) Connector losses: Losses due to connectors shall be considered to be minimum 1.0 dB per link.
- (4) Equipment Parameters: The equipment parameters to be considered for link budget calculations shall be the guaranteed "End of Life (EOL)" parameters. In case, the End of Life parameters are not specified for the SDH equipment, an End of Life Margin of at least 2 dB shall be considered and a similar margin shall be considered for optical amplifiers.

(5) Optical path Penalty: An optical path penalty of at least 1 dB shall be considered to account for total degradations due to reflections, inter symbol interference, mode partition noise and laser chirp.

(6) Maintenance Margin: A maintenance margin of at least 2.5 dB/100Km shall be kept towards cabling, repair splicing, cable ageing and temperature variations etc.

(7) Other losses: Other losses, if any required specifically for system to be supplied shall also be suitably considered.

(8) Dispersion: The fibre dispersion shall be taken to be the guaranteed maximum dispersion i.e. 18 ps/nm.Km @1550 nm & 3.5 ps/nm.km @ 1310 nm for DWSM fibres.

(9) Bit Error Rate: The link budget calculations shall be done for a BER of 10⁻¹⁰.

The bidders shall determine the total link loss based on the above parameters and shall submit the system design (including link budget calculations) for each fibre optic link during detailed engineering.

For finalising the FOTS system design & BOQ, above methodology shall be adopted taking into account fibre attenuation, dispersion and splice loss determined during the detailed engineering. Accordingly, additions and deletions from the contract shall be carried out based on unit rates indicated in the contract.

2.1.4 Technical Requirement of Repeater Shelter

The detailed requirements for Repeater Shelter are attached at 'Annexure – II

2.2 Fibre Optic Approach Cable

For purposes of this specification, a fibre optic approach cable is defined as the Armoured underground fibre optic cable required to connect Overhead Fibre Optic Cable (OPGW) between the final in line splice enclosure on the gantry / tower forming the termination of the fibre cable on the power line and the Fibre Optic Distribution Panel (FODP) installed within the building. The estimated fibre optic approach cabling length requirements are indicated in the appendices. However, the Contractor shall supply & install the optical fibre approach cable as required based on detailed site survey to be carried out by the Contractor during the project execution and the Contract price shall be adjusted accordingly. Approach Cable shall consist G.652D DWSM Fibers.

2.2.1 Basic Construction

The cable shall be suitable for direct burial, laying in trenches & PVC/Hume ducts, laying under false flooring and on indoor or outdoor cable raceways. The jacket shall conform to ASTM D1248 for density.

2.2.2 Optical Electrical and Mechanical Requirements

Approach cable shall contain fibres with identical optical/ physical characteristics as those in the OPGW cables. The cable core shall comprise of tensile strength member(s), fibre support/bedding structure, core wrap/bedding, and an overall impervious jacket.

2.2.3 Installation Of Approach Cable

The existing cable trenches/ cable raceways proposed to be used shall be identified in the survey report. The Contractor shall make its best effort to route the cable through the existing available cable trenches. Where suitable existing cable trenches are not available, suitable alternatives shall be provided after Employer approval.

Suitable provisions shall be made by the Contractor to ensure adequate safety earthing and insulated protection for the approach cable.

All required fittings, supports, accessories, ducts, inner ducts, conduits, risers and any item not specially mentioned but required for laying and installation of approach cables shall be supplied and installed by the Contractor. *Bidder*

2.3 Optical Fibre Termination and Splicing

Optical fibre terminations shall be done in Fibre Optic Distribution Panels (FODP) designed to provide protection for fibre splicing of preconnectorized pigtails and to accommodate connectorized termination and coupling of the fibre cables. The Contractor shall provide rack /wall mounted Fibre Optic Distribution Panels (FODPs) sized as indicated in the appendices and shall terminate the fibre optic cabling up to the FODPs. The location of FODP rack shall be fixed by the Contractor, with the Employer's approval.

2.3.1 Fibre Optic Distribution Panel

At each location requiring the termination of at least one fibre pair within a cable, all fibres within that cable shall be connectorized and terminated in Fibre Optic Distribution Panels in a manner consistent with the following:

- (a) All fibre optic terminations shall be housed using FODPs provisioned with splice organizers and splice trays. All fibres within a cable shall be fusion spliced to preconnectorized pigtails and fitted to the "Back-side" of the provided fibre optic couplings.
- (b) FODPs shall be suitable for use with each of the cable types provided as part of this contract. FODPs shall accommodate pass-through splicing and fibre terminations.
- (c) FODPs for indoor use shall be supplied in suitable cabinets/racks with locking arrangement.
- (d) The FODP shall be of corrosion resistant, robust construction and shall allow both top or bottom entry for access to the splice trays. Ground lugs shall be provided on all FODPs and the Contractor shall ensure that all FODPs are properly grounded. The FODP shall meet or exceed ingress protection class IP55 specifications.
- (e) Flexible protection shall be provided to the patch cord bunches going out from FODP cabinet to other equipment cabinet.

23 Environmental, EMI, Power Supply Cabling and Earthing Requirements

- Equipment shall operate in accordance with the Environmental Operating limits as shown in Table-2:

Table -2
Environmental Operating Limits

Temperature Range:	(Un Controlled Environment)
Specification	@ to 45°C
Operation without damage	-10 to 55°C
Shipping/storage	-40 to 60°C
Relative Humidity, non-condensing	Upto 90%
Elevation:	
Operating	to 3,000 m
Non-operating	to 10,000 m

- Equipment shall be properly shielded against radiated emissions at each location.
- Power Distribution and Protection: Power supplies/converters for communications equipment shall use -48Vdc uninterrupted primary source power. The Employer will furnish only one power source. Contractor shall provide required distribution panels, circuit breakers, appropriate panel disconnects and

all cabling, fusing, switching required. Distribution Panel feeders, Panel Disconnects, distribution panels and circuit breakers shall be sized and equipped to support at least 100% expanded load requirements. The ~~Contractor~~ ^{Bidder} shall also be responsible for Load Balancing.

- ~~Contractor~~ ^{Bidder} shall provide equipment and rack safety earthing in full compliance with EMI/EMC requirements as per relevant international standards.
- Equipment cabinet (enclosure) shall be designed 19 inch, free standing but shall be mounted on the floor. The dimensions of the cabinet shall be minimum 2200mmx600mmx600mm. All doors and removable panels shall be fitted with long life rubber beading. All panels shall be fabricated from minimum 2.0mm thickness steel sheet. However, for racks with load bearing Aluminium extrusion frame, door panels and side panels may be fabricated from minimum 1.6mm thickness steel sheet and the top & bottom panels shall be fabricated from minimum 2.0mm thickness steel sheet. Equipment cabinet (enclosure) shall be dust and moisture proof as per IP41 specification or better (supporting certificates/documents shall be submitted during detailed engineering).
- The ~~Contractor~~ ^{Bidder} shall provide all required minor civil works necessary for full connectivity as required in the ~~Contractor's~~ ^{Bidder's} scope of work.

Any other miscellaneous items which may be required for successful interfacing for establishment of end-to-end communication is deemed to be included in the scope of the ~~Contractor~~ ^{Bidder}.

24 TESTING

All materials furnished and all work performed under this Contract shall be inspected and tested. The entire cost of testing for factory & site acceptance, routine tests, production tests and other test during manufacture & site activities specified herein shall be treated as included in the quoted unit price of materials, except for the expenses of Inspector/Employer's representative. All tests shall be witnessed by the Employer and/or its authorized representative (hereinafter referred to as the Employer) unless the Employer authorizes testing to proceed without witness.

"Type Tests" shall be defined as those tests which are to be carried out to prove the design, process of manufacture and general conformity of the materials to this Specification. All equipment being supplied shall conform to type tests as per Annexure-I of technical specification. The test reports submitted shall be of the tests conducted within last five (5) years. In case the test reports are older than five (5) years, the ~~Contractor~~ ^{Bidder} shall repeat these tests at no extra cost to the purchaser. In the event of any discrepancy in the test reports or any type tests not carried out, same shall be carried out by ~~Contractor~~ ^{Bidder} without any additional cost implication to the Employer. Type Tests shall be certified or performed by reputed laboratories using material and equipment data sheets and test procedures that have been approved by the Employer.

Equipments to be delivered shall be tested at factory before despatch as per approved procedure. Factory Acceptance Test shall demonstrate the technical characteristics of the equipment in relation to this specification and approved drawings and documents. The ~~Contractor~~ ^{Bidder} shall provide procedures for installation and site acceptance test. The site acceptance testing will comprise of end-to-end testing between the terminal stations and RLDC/SLDC and RTAMC/other CC end.

The detailed requirements for Type Test, Factory Acceptance Test and Site Acceptance Test are attached at 'Annexure - I

25 TRAINING

The ~~Contractor~~ ^{Bidder} will provide a training of suitable duration on supplied SDH equipment for

Employer's personnel to provide working knowledge of the equipment, operation and diagnostic tools, supervision and monitoring using local craft terminal. The training may be provided by the ~~Contractor~~^{Bidder} or its sub-vendor at the site itself, preferably prior to installation, and will include training materials, presentation equipment, and all associated ~~expenses~~^{Bidder}. No separate charges for training shall be payable to the ~~Contractor~~^{Bidder}.

26 SUPPORT SERVICES

Throughout design, implementation, factory testing, and field installation and testing, the ~~Contractor~~^{Bidder} shall supply consulting assistance, as required by the Employer for site preparation, field installation, and other areas where technical support may be required.

The ~~Contractor~~^{Bidder} shall be responsible for minor facility renovation, and maintenance of the supplied system up to and including successful completion of the Site Acceptance Test.

After final acceptance of the communications equipment, the ~~Contractor~~^{Bidder} shall offer continuing technical support and spare parts for the communication equipment for a minimum period of 15 years from operational acceptance by the employer or 7 years after the declaration of withdrawal of equipment from production whichever is earlier. However the termination of production shall not occur prior to Operational Acceptance of the system by the Employer. Some locations have existing SDH & MUX equipment. The traffic may be switched over to new fibre optic communication equipment in phase manner. The ~~Contractor~~^{Bidder} shall review the Employer existing equipment make, integration & switch over recommendation and prepare a detailed field implementation plan.

6.1.1 Technical Support

Consultation with ~~Contractor's~~^{Bidder's} technical support personnel and trained field service personnel shall be readily available on a short-term/long-term basis to assist the Employer personnel in maintaining, expanding, and enhancing the telecommunication network upon expiration of the warranty period.

6.1.2 ~~Contractor's~~^{Bidder's} Future Hardware/Software Changes

The Employer shall be informed of all alterations or improvements to the hardware supplied under this Specification. The Employer shall be placed on the ~~Contractor's~~^{Bidder's} mailing list to receive announcements of the discovery, documentation, and solution of hardware/software problems as well as other improvements that could be made to supplied equipment. The service shall begin at the time of contract award, and shall continue for a minimum period of 15 years from operational acceptance by the employer designed life of the equipment or 7 years after the declaration of withdrawal of equipment from production whichever is earlier. The ~~Contractor~~^{Bidder} shall also include a subscription to the hardware subcontractors' change notification service from the time of contract award through the warranty period, with a Employer renewable option for extended periods.

6.1.3 Mandatory Spare Parts

The ~~Contractor~~^{Bidder} shall be required to supply minimum spares for each subsystem as in ~~BPS~~^{BOS}. The subsystem set of spare parts is defined to include all equipment modules, subunits and parts required to effect replacement, repair and restoration to full operational status of a defined unit of a subsystem (i.e. SDH equipment.).

6.1.4 Warranty Period

The one year period commencing immediately after the operational acceptance is called the Warranty Period/Defect liability Period. In addition to the responsibilities covered under Vol-I Condition of Contracts during Defect Liability Period, the ~~Contractor~~^{Bidder} shall also be responsible for maintenance of the Fibre Optic Transmission System etc. supplied under this Package.

6.1.5 Miscellaneous Supplies

The ~~Contractor~~^{Bidder} shall provide all required consumable and non-consumable supplies necessary to support all installation and test activities through final operational acceptance. However, if there are any problems in the SAT and additional consumables are required, the same shall also be supplied by the ~~Contractor~~^{Bidder} at no additional cost.

27 Documentation

The ~~Contractor~~^{Bidder} shall submit following documents during detailed engineering:

- (a) Data Requirement sheets
- (b) Link Budget calculations
- (c) MQP, FQP
- (d) Bill of Quantity including mandatory spares
- (e) Previous Type test reports
- (f) Factory Test report
- (g) Manuals for each equipment
- (h) Schematic drawing
- (i) Numbering, Marking, labelling document
- (j) Synchronization plan
- (k) Test schedule
- (l) Training manual
- (m) Configuration diagram
- (n) Transportation & handling Procedure
- (o) Installation Manuals
- (p) Maintenance Manuals

Testing Requirement of Communication Equipment

1.1 List of type test to be conducted on Telecom equipment

The type tests for Telecom Equipment with all types of cards are described below:

1.1.1 Temperature and Humidity Tests

The tests listed below are defined in IEC Publication 60068.

(a) Low Temperature Test: Operation to Specifications

Low temperature tests shall be conducted as defined in IEC Publication 60068-2-1, test method Ad, with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for sixteen (16) hours. Its performance is checked during the test.
- (2) Degree of Severity: Test shall be done at 0°C
- (3) Acceptance Criteria: No degradation of performance during and after the test.

(b) Low Temperature Test : Operation without Damage

Low temperature tests shall be conducted as defined in IEC Publication 60068-2-1, test method Ad, with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 72 hours. Its performance is checked during the test and after the test as soon as the thermal equilibrium is reached at the room temperature (*Post-test*).
- (2) Degree of Severity: Test shall be done at -10°C
- (3) Acceptance Criteria: Degradation of performance is allowable during the test, however there shall be no degradation of performance in the *post-test*.

(c) Dry Heat Test: Operation to Specifications

Dry heat test shall be done as defined in IEC Publication 60068-2-2, test method Bd, with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 96 hours. Its performance is checked during the test.
- (2) Degree of Severity: operation to specification range.
- (3) Acceptance Criteria: No degradation of performance during and after the test.

(d) Dry Heat Test: Operation without Damage

Dry heat tests shall be done as defined in IEC Publication 60068-2-2, test method Bd, with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 96 hours. Its performance is checked during the test and after the test as soon as the thermal equilibrium is reached at the room temperature (*Post-test*).
- (2) Degree of Severity: Test shall be done at 55°C.

- (3) Acceptance Criteria: Degradation of performance is allowable during the test, however there shall be no degradation of performance in the *post-test*.

(e) **Damp Heat Test**

Damp heat testing reveals aging with respect to the humidity level and applies basically to electronic equipment. This test shall be done as defined in IEC Publication 60068-2-3 with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 10 days. Its performance is checked during the test.
- (2) Degree of Severity: Test shall be done at $(40 \pm 2) ^\circ\text{C}$ & $(93 \pm 3) \% \text{ RH}$
- (3) Acceptance Criteria: The equipment shall meet the specified requirement and there shall not be any degradation in BER.

(f) **Temperature Variation Test**

Temperature variation testing shall be as per IEC Publication 60068-2-14 (Gradual Variations, Method Nb). The equipment shall be powered on and various parameters shall be monitored continuously during the test period.

- (1) Number of cycles required is five (5)
- (2) The degree of severity: temperature TL: 0°C , TH: (Operation to specification range)
- (3) Cycle duration for each temperature is three (3) hours.
- (4) Ramp : $1 ^\circ\text{C}/\text{minute}$.
- (5) Acceptance Criteria: The equipment shall meet the specified requirement and there shall not be any degradation in BER.

1.1.2 Power Supply and EMI/EMC tests

The test procedure and acceptance criteria shall be as defined in IEC 60870-2-1.

(a) **Immunity Tests**

The list of Immunity tests are specified below in Table 1:

Table 1: Recommended Immunity Tests

S. No.	Immunity Test	AC Power Supply	DC Power Supply	Control & Signal	Telecom Line	Para- metres
1	Voltage Fluctuations	Yes	Yes	N/A	N/A	Table 11 of IEC 60870-2-1: 1995 - Level : 1
2	Voltage dips and Interruptions	Yes	Yes	N/A	N/A	
3	1.2/50 - 8/20 μs surges	Yes	Yes	Yes	N/A	Table 12 of IEC 60870-2-1: 1995 - Level : 1
4	Fast transient bursts	Yes	Yes	Yes	Yes	Table 12 of IEC 60870-2-1: 1995 - Level : 4
5	Damped oscillatory waves	Yes	Yes	Yes	Yes	Table 12 of IEC 60870-2-1: 1995 - Level : 1
6	Electrostatic discharge	Yes				Table 13 of IEC 60870-2-1: 1995 - Level : 4

Table 1: Recommended Immunity Tests

Table 15 of IEC 60870-2-1: 1995 - Level : 4						
S. No.	Immunity Test	AC Power Supply	DC Power Supply	Control & Signal	Telecom Line	Para-metres
7	Radiated electromagnetic field	Yes				Table 15 of IEC 60870-2-1: 1995 - Level : 4
-End of Table-						

(b) Emission Tests

The list of Emission tests are specified below in Table 2

Table 2:
Recommended Emission Tests

S. NO.	Emission test	AC Power Supply	DC Power Supply	Control & Signal	Telecom Line	Para-metres
						Table 17 of IEC 60870-2-1: 1995 - Class : B
1	RF disturbance voltages CISPR 22	Yes	Yes	N/A	N/A	
2	RF disturbance currents CISPR 22	N/A	N/A	N/A	Yes	
3	RF radiated fields CISPR 22	Yes				
-End Of Table-						

(c) Insulation Withstand Voltages

As per section 6 of IEC 870-2-1. Recommended class: VW1 of Table 18.

1.1.3 Mechanical Tests**(a) Mechanical Vibration Test**

The procedure for this test is described in IEC Publication 60068-2-6. The testing procedure shall be carried out in the sequence 8.1 + 8.2.1 + 8.1 as described in document 60068-2-6. For the vibration response investigation (clause 8.1 of 60068-2-6), the test shall be carried out over a sweep cycle under the same conditions as for the endurance test (described later), but the vibration amplitude and the sweep rate may be decreased below these conditions so that the determination of the response characteristics can be obtained.

The endurance tests conditions are selected according to the vibration withstand requirements.

Transportation tests shall be performed with the equipment packed according to the Contractor's specifications.

(b) Shock Test

The procedure of this test is defined in IEC Publication 60068-2-27 (each test) with a semi-sinusoidal shape (clause 3.1.1.2).

The recommended severity shall be $A = 294 \text{ m/s}^2$, $D = 18 \text{ ms}$. Three shocks per axis per direction shall be applied to the equipment packed according to the Contractor's specifications.

Or Free Fall Test

This test could be performed as an alternative to the shock or Bump test. The procedure is defined in IEC publication 60068-2-32. The equipment shall be packed according to the Contractor's specifications. The drop height shall be defined in accordance with IEC 68-2-32. The surface of the packing case which comes into contact with the ground is the surface on which the packing case normally rests; if the packing does not have any features (inscription, special shape, etc.) identifying this surface, the test is carried out successively on all the surfaces of the packing.

Or Bump Test

This test could be performed as an alternative to Shock test or Free Fall test. The procedure is defined in IEC 60068-2-29.

1.2 Type tests for Optical Fibres

The type tests listed below in Table 3 shall be conducted on DWDM fibres to be supplied as part of Approach cable. The tests specific to the cable type are listed in subsequent sections.

Table 3
Type Tests For Optical Fibres

S. No.	Test Name	Acceptance Criteria	Test procedure
1	Attenuation	As per Standard	IEC 60793-1-40 Or EIA/TIA 455-78A
2	Attenuation Variation with Wavelength	As per Standard	IEC 60793-1-40 Or EIA/TIA 455-78A
3	Attenuation at Water Peak	As per Standard	IEC 60793-1-40 Or EIA/TIA 455-78A
4	Temp. Cycling (Temp dependence of Attenuation)		IEC 60793-1-52 Or EIA/TIA 455-3A, 2 cycles
5	Attenuation With Bending (Bend Performance)		IEC 60793-1-47 Or EIA/TIA 455-62A
6	Mode Field dia.		IEC 60793-1-45 Or EIA/TIA 455-164A/167A/174
7	Chromatic Dispersion		IEC 60793-1-42 Or EIA/TIA 455-168A/169A/175A
8	Cladding Diameter		IEC 60793-1-20 Or EIA/TIA 455-176
9	Point Discontinuities of attenuation		IEC 60793-1-40 Or EIA/TIA 455-59

Table 3
Type Tests For Optical Fibres

S. No.	Test Name	Acceptance Criteria	Test procedure
10	Core -Clad concentricity error		IEC 60793-1-20 Or EIA/TIA 455-176
11	Fibre Tensile Proof Testing		IEC 60793-1-30 Or EIA/TIA 455-31B
-End Of table-			

1.3 Type tests for Fibre Optic Approach Cable

The type tests to be conducted on the Fibre Optic Approach cable are listed in Table 4: Type Tests for Fibre Optic Approach Cable. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

Table 4:
Type Tests Fibre Optic Approach Cable

S.NO.	Test Name	Test Procedure
1	Water Ingress Test	(IEC 60794-1-F5 / EIA 455-82B) Test duration : 24 hours
2	Seepage of filling compound	(EIA 455-81A) Preconditioning : 72 hours, Test duration : 24 hours.
3	Crush Test	(IEC 60794-1-E3/ EIA 455-41)
4	Impact Test	(IEC-60794-1-E4/ EIA 455-25A)
5	Stress strain Test	(EIA 455-33A)
6	Cable Cut-off wavelength Test	(EIA 455-170)
7	Temperature Cycling Test	(IEC60794-1-F1/EIA-455-3A) – 2 cycles
-End Of Table-		

1.4 Factory Acceptance Test Requirement

Table 5:
Factory Acceptance Testing for Fibre Optic Transmission System

Item:	Description:
1.	Physical inspection for conformance to DRS, BOQ, drawings and appearance of equipment
2.	Optical output power
3.	Transmitter lightwave spectral analysis
4.	Low receive level threshold
5.	Generation of bit error rate curve

Table 5:
Factory Acceptance Testing for Fibre Optic Transmission System

6.	Measurement of analog and digital service channel parameters as well as service channel functionality
7.	Performance of supervision, alarm, Craftsperson interface, diagnostics, loop backs etc.
8.	Electrical interface tests which include: output and input jitter, bit error rate, pulse shape, cable compensation, and line rate tolerance for multiplexers
9.	At a minimum tests on Ethernet interface shall include demonstration of ping test, throughput test, Latency test, Packet Loss test as per RFC 2544
11.	Simulation of failure conditions and failover of each redundant unit.
12.	VLAN (Layer-2 switching) feature testing configuration.
13.	Protection scheme for Ethernet Traffic (ERPS)
14.	Test of spare card slots
15.	Checks of power supply/converter voltage margins
16.	Random inspections to verify the accuracy of documentation
17.	Test of spare parts/modules/cards as per applicable tests

Table 6
FAT on NMS (Craft Terminal)

1	Physical inspection of NMS hardware (Craft Terminal) for conformance to approved BoQ, DRS & drawing
2	Testing of NMS to demonstrate proper operation of all functions: Configuration Management, Performance Management, Fault Management and Security Management.

Table 7
Factory Acceptance Tests On Approach Cable

Factory Acceptance Test
Attenuation Co-efficient at 1310 nm and 1550 nm
Point discontinuities of attenuation
Visual Material verification and dimensional checks as per approved DRS/Drawings

Table 8
Factory Acceptance Test

Visual check of Quantities and Specific Component Number for each component of FODP and dimensional checks against the approved drawings.

1.5 Site Acceptance Tests

All equipment shall be tested on site under the conditions in which it will normally operate.

The tests shall be exhaustive and shall demonstrate that the overall performance of the contract works satisfies every requirement specified. At a minimum Site Acceptance Testing requirement for Telecom equipment, NMS etc. is

outlined in following section. This testing shall be supplemented by the ^{Bidder's} ~~Contractor's~~ standard installation testing program, which shall be in accordance with his quality plan(s) for Telecom equipment installation.

During the course of installation, the Employer shall have full access for inspection and verification of the progress of the work and for checking workmanship and accuracy, as may be required. On completion of the work prior to commissioning, all equipment shall be tested to the satisfaction of the Employer to demonstrate that it is entirely suitable for commercial operation.

1.5.1 Phases for Site Acceptance Testing

The SAT shall be completed in following phases:

1.5.1.1 Installation Testing

The field installation test shall be performed for all equipment at each location. If any equipment has been damaged or for any reason does not comply with this Specification, the ^{Bidder} ~~Contractor~~ shall provide and install replacement parts at its own cost and expense.

In the installation test report, the ^{Bidder} ~~Contractor~~ shall include a list of all hardware or components replaced or changed between the completion of factory tests and the start of field tests and show that documentation and spare parts have been updated.

The minimal installation testing requirements for fiber optic transmission subsystem are provided in the table below:

Table 9
Fibre Optic Transmission system Installation Testing

Item:	Description:
1.	Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling
2.	Equipment power supply (DC-DC converter) output voltage measurements
3.	Terminal transceiver performance testing (Tx power, Tx spectrum, receive signal strength, connector losses etc.)
4.	Service channel performance
5.	Craftsperson interface, alarm and control functional performance
6.	Rack and local alarms: No alarms shall be present and all alarms shall be demonstrated to be functional
7.	Network management interface and supervision performance
8.	Correct configuration, level setting & adjustments and termination of Input/ output interfaces
9.	Proper establishment of Safety and signalling earthing system and resistance to ground to be checked.
10.	Simulation of failure conditions and failover of protected components.

1.5.1.2 Link Commissioning Tests

The commissioning tests shall verify that communication can be performed over the fiber optic link under test. Delay measurement, Bit Error measurements & service channel performance monitoring shall be made on the fibre optic links to verify compliance with designed link performance.

For Ethernet interface: At a minimum the following test requirements shall be demonstrated as per RFC 2544:

- a) Ping test
- b) Throughput test
- c) Latency test
- d) Packet Loss

The links shall be tested for 12 Hour. In case any link does not meet the performance requirements during 12 hour, then the cause of failure shall be investigated and the test shall be repeated after rectifying the defects.

This phase of testing shall be conducted by the ^{Bidder} Contractor and witnessed by the Employer. Field adjustments shall be made to meet established standard, however if the field adjustments fail to correct the defects the equipments may be returned to the ^{Bidder} Contractor for replacement at his own expense. In case any adjustments are required to be made during the interval of the test then the test shall be repeated.

1.5.1.3 Integrated Testing

Prior to commencement of integrated testing the overall system shall be configured as required to provide all the data and voice channel required to interconnect to control centres and other nodes in existing system. The integrated testing shall include end-to-end testing of communication.. The intent of integrated testing is to demonstrate that the equipment is operational end to end under actual conditions, that all variances identified during factory and field installation and communications testing have been corrected, and that the communication equipment is compatible with other equipment. The Integrated System Test shall include all fibre optic transmission equipment, the network management subsystem (Craft Terminal) and other components.

At a minimum the following tests shall be included in the integrated testing:

- (1) Equipment configuration shall be checked to establish that it supports the channel routing.
- (2) End to end testing of all individual voice circuits (VOIP) and to demonstrate proper operation of channels over wideband systems. Operation shall be checked in terms of quality of voice, call initiation and call termination processes.
- (3) End-to-end testing of all individual Data Circuits (Ethernet). Operation shall be checked in terms of monitoring of BER/packet loss.
- (4) Testing of NMS (Craft Terminal) to demonstrate proper operation of all functions. All the standard features of the NMS (Craft Terminal) shall be demonstrated for proper functioning.
- (5) All the standard features of the existing NMS server (at RLDC/ SLDC) shall be demonstrated for proper functioning with respect to supplied communication equipment/ Node.
- (6) Demonstration of Protection switching and synchronization of equipment.

Section: Repeater Shelter**1 Introduction**

This section describes the functional requirement, major technical parameters and all the testing requirements for telecom shelter system, including its sub-systems, Air-conditioning system, DG Set, PIU & 48V DC Power Supply.

1.1 Repeater Shelter Requirements**1.1.1 Shelter Dimensions**

The minimum internal and external dimensions of the shelters shall be as per Table 2.1 as specified below:

Table 3.1 <i>All dimensions are in mm</i>				
SNo.	External/Internal	Length (L)	Width (W)	Height (H)
1	External	4500	2700	3160
	Internal	4340	2540	3000

1.1.2 General

The shelters shall be protected and insulated to achieve sound proof, thermal resistance and impact withstand capabilities. The shelters shall be 100% leak and water proof with IP 55 protection. The shelters shall be maintenance free having minimum life of 15 years. These shelters shall be suitable for outdoor and may be mounted at any location including ground and rooftop and in any climatic conditions. The shelters shall be easily assembled and installed at site. The shelters shall be re-locatable as and when required.

1.1.3 Shelter Panels

The shelter shall be made of “sandwich insulated panels” 80 mm thick with Poly Urethane Foam (PUF) as filler material between polyester pre-coated cold rolled aluminium sheets. The insulation characteristics of PUF material shall conform to Clause no. 1.3.19 of these specifications.

For Steel shelters, the thickness of the inner-side and outer steel sheets except floor panel sheets shall be minimum 0.8 mm and 0.6 mm respectively. For Aluminium shelters, the thickness of both inner side and outer side aluminium sheets except floor panel sheets shall be minimum 0.91 mm. The outer bottom sheet shall be hot dip galvanised steel sheets and aluminium sheets of minimum 1.0 mm and 1.2 mm thickness respectively to avoid rusting of the bottom panel. The sandwich panels shall be manufactured by high pressure injection technique. The panels to be provided with tubular element precast in panels while foaming to form an integral part through this precast element GI steel rods of required sizes shall be inserted and fastened to top and bottom structures. The steel and aluminium sheets of standard and reputed make shall only be used.

1.1.4 Floor

The floor shall consist of standard PUF sandwich panels suitably reinforced to support the minimum load capacity of 2000 kg/m² and having at least 19 mm Marine plywood covered with anti static PVC flooring. In case of floor panel, 19 mm Marine plywood shall be provided on top of the panel and no steel or aluminium sheet shall be provided inside the panel. The anti static flooring shall be provided with pacific blue anti static vinyl robust rolls of at least 2 mm thickness. The floor shall be even surfaced, scratch proof having long life. The installation of various proposed equipment shall be possible either by direct placement on the floor or by grouting to the floor or through C rails. The Contractor shall submit the reinforcement and other details calculations in support of the meeting the load capacity.

1.1.5 Roof

Roofs shall be made of the panels same as specified for walls. A secondary slanting roof of suitable material shall be provided to protect the primary roof from direct sunlight and rainwater. A minimum down slant of 1:50 shall be maintained from front to back. The secondary roof shall have minimum projections and shall be hidden by angular profiles on the rooftop to decrease the aerodynamic effect and improve on aesthetics. The secondary roof shall be suitably clamped/ bolted to the shelter panels to withstand the specified wind load. The details of the secondary roof and its attachment arrangement shall be submitted for Employer's approval during detail engineering. The cable tray shall be attached suitably from the roof and the roof shall have sufficient strength to support the load of cable trays and the cables installed on the cable tray.

1.1.6 Door

The Shelters shall have one door for main entrance. The door dimensions shall be 1000 mm (W) X 2200 mm (H). Main door opening outwards shall be provided with external and internal handles/knobs respectively. A reputed make lock shall be provided in door handle. The make of the lock shall be got approved during detail engineering. The door can be opened from inside when locked. Door, when locked cannot be removed even if the hinges are removed. The door shall generally be hinged at right, however, other option may be also required at some sites to meet the actual site condition. The door shall have aluminium biddings extrusions in door/jamb profile, replaceable and suitable neoprene rubber gaskets around its border for proper weather proofing. The door shall also be equipped with a hydraulic auto closure and the door latch / stopper shall be provided to keep the door in open position. The door shall have a limit switch to indicate intrusion and switch on one light provided inside the shelter. A canopy of minimum size 1200 mm X 500 mm shall also be fixed up above the external light / door for protection from direct sun/rain. The canopy shall suitable slope and shall be covered from both sides.

1.1.7 Jointing

All panel to panel connections shall be made with eccentric cam locks or suitable locking system. The wall to floor and wall to roof jointing shall be made with angular frames of suitable size. The panel to panel jointing at the corners shall either be suitably angular frames of suitable size or a single corner panel may be provided. All internal corners shall be jointed suitable angles. All the joints shall be suitable sealed with PU or silicon sealant to provide 100 % leakage and water proofing. The Contractor shall submit the drawing indicating details of all joints in support of meeting the specified requirement.

1.1.8 Opening

The shelter shall have provision for openings for required air-conditioners, piping and all electrical and optical cablings on the wall panels. The details of openings required for different applications and the locations of the openings shall be decided during detail engineering. All openings shall be custom built based upon the actual application required at each site. The Contractor shall provide the required cut outs for above purpose. Any sealed cut outs required for future use may also be provided and the size of this cut out shall be finalised during detail engineering. All the openings shall be sealed for water and leak proof with suitable flexible sealing arrangement for the proposed cable connections and also for addition and deletion of cables/pipes in future. The sealing arrangement shall be fire retardant and type/make/details shall be got approved by the Employer.

1.1.9 Insulation

The PUF to be used for insulation of the panels shall be CFC free and conforming to latest IS 12436 standards or equivalent International standard. The other parameters shall be as per Table 3.2 as given below:

Table : 3.2

SNo.	Items	Required Parameter
1	Thickness	78.6 mm
2	Density	40 kg/m ³
3	Compressive Strength	1.2 kg/cm ²
4	Tensile Strength	3.6 kg/m ²
5	Bending Strength	4.0 kg/m ²
6	Adhesion Strength	2.9 kg/m ²
7	Dimensional Stability	At (-) 25 °C : 0.1%, at 38 °C : 0.1% and at 100 °C : 0.4%
8	Temperature Range	(-)15 °C to 95 °C
9	Thermal Conductivity	0.02 kcal/hr/m/°C
10	Fire Resistance	As per BS-4735 horizontal burn < 125 mm
11	Water Absorption	0.2 % @100% RH
12	Vapour Permeability	0.08/0.12 g/hr/m ²
13	Self Extinguishing	Yes
14	Biodegradable	Yes

The Contractor shall submit the earlier carried out type tests reports for PUF material. In case the contractor does not submit the reports or the submitted reports are not meeting the requirements, the contractor shall carry out the type tests on PUF material for the following:

Thickness, Density, Compressive strength, Tensile Strength, Dimensional Stability, Thermal Conductivity and Fire resistance.

1.1.10 Heat Transmission Coefficient

The installed shelter with one door shall have the heat transmission coefficient $K \leq 0.3$.

1.1.11 Colour

The colour shall be stabilised grey on all external sides and off white on all internal sides. The colour of the slanting roof shall also be stabilised grey. However, the actual colouring scheme shall be finalised during detail engineering.

1.1.12 Fire and Smoke Detection System

Suitable fire & smoke detection system shall be provided in each of the shelters. The offered fire & smoke detection system shall work on DC supply (-48V) being provided by the Contractor under this contract. In case, the smoke detector and fire alarm system requires other voltage than the above stipulated voltage (-48V DC) for operations, suitable converter & hardware shall also be provided by the Contractor. The Contractor shall provide all required cabling & accessories for full functioning of the offered system with both power supplies. At least two ionisation type smoke detectors along with fire detection panel shall be provided below the roof panel in strategic locations inside the shelter. The alarm should activate only if both fire detectors are actuated to avoid any false alarm. The details, locations and its various logistics shall be finalised during detail engineering. The operation/activation of the fire detector shall result in the following:

- An external visual signal and audible alarm sounded outside the shelter.
- A signal to be given to the telecom equipment panel through potential free dry contact as a local alarm for its remote monitoring in the control centre.
- Suitable pilferage proof enclosure for visual and audio alarm outside the shelter.

All the detectors installed shall be tested for actuation and its required operations during SAT. The exact method of the testing shall be detailed in SAT procedures.

1.1.13 Lighting system

Normal and emergency lighting shall be provided inside the shelters. The normal lights shall consist of two nos. (36 Watts) of reputed make fluorescent lights along with requisite fittings and shall be powered with ac supply from ACDB. Two nos. emergency light with requisite fittings shall also be provided which shall be powered with dc supply available (-48 V DC) for telecom equipment from DCDB. In the event, the emergency lighting system requires other voltage than the above stipulated voltage for operations; suitable converter & hardware shall be provided by the Contractor. The outside light shall be bulk head type, powered with ac power supply from ACDB, provided at top of the door and covered with the door canopy. The bulk head type shall be provided with metallic guard to prevent pilferage. The switch of both internal and external lights shall be inside the shelter but adjacent to the entrance for easy accessibility. Additionally, at least one of the normal lights inside the shelter shall be lit up with the opening of the shelter door. One 5 A / 15 A duplex socket with switch shall also be provided in addition to the requisite switches for the normal and emergency lights.

1.1.14 Cable Tray

The cable tray of size minimum 300 mm width made of Fibreglass Reinforced Polymer (FRP) material shall be provided inside/outside the shelter for supporting various cables and shall be attached to the roof top/wall panels. The alternate material for the cable tray, if required shall be with specific approval of the Employer. The cable trays shall have sufficient strength to take loading of various cables like fibre optic cables, various power, signal & control cables, earthing flats etc. The rungs along the cable ladder shall be separated by not more than 300 mm. The colour of the cable tray shall match with the inside colour of the shelter. The Contractor shall submit the cable tray details for Employer's approval. The cable tray shall run along the four sides just below the ceiling with smooth curvatures at the bends/corners. The actual routing including length and height of the cable tray for each site shall be finalised during detail engineering. The Contractor shall clamp the cables suitably with the trays after installation of the cables.

1.1.15 C – Rails

C-rails made of extruded aluminium alloy of suitable size along with required number of lock-nuts shall be provided inside and outside the shelter to support various items like lighting, AC Distribution Box (ACDB), DC Distribution Box (DCDB), Fire detector along with the panel, cables and all other accessories. The C-rails may also be used for supporting cable trays from the roof, mounting of equipment on the floor and on the wall. The requirement of C-rails shall be finalised during detail engineering.

1.1.16 Energy Meter Box

An IP 55 compliant weatherproof box shall be provided for housing the energy meter along with MCBs and fuse units. The energy meter box shall have two different doors and compartments, one for accessing/housing energy meter and another for accessing/housing MCBs and fuses. The energy meter box shall have glass for view of meter reading from outside. The energy meter box shall be of Fibreglass Reinforced Polymer (FRP) material. The alternate material, if required, shall be with specific approval of the Employer. The box shall be provided with pad lock arrangement and shall be installed on external shelter panels with suitable fittings. Proper sealing shall also be done to avoid any water leakage into the panel. The size and locations of meter installation shall be finalised during detail engineering.

1.1.17 Loading Capacity

Minimum roof loading capacity: 250 kg/m^2
Minimum floor load capacity: 2000 kg/m^2
Minimum wall load capacity: 300 kg/m^2

The above load capacities have been identified as minimum requirement. However, during detail engineering, to meet the actual load requirement for cable tray, ACDB, DCDB, C-rails, Air-conditioning system, battery, batteries chargers, telecom equipment, lighting etc. to be supplied and installed inside the shelter, the actual localised loading requirement may be higher and the supplied shelter loading capacity shall meet the actual localised loading requirement at no additional cost to POWERGRID.

1.1.18 Structural Stability

- Resistant to various volumes of rain, dust & sand impinging from various directions over different durations and different speeds.
- Resistant to corrosion against water, industrial air and saline air.
- Resistant to decomposing vegetation, rodents, termites and micro-organisms.

1.1.19 Survival wind speed

The shelter shall be designed to withstand a wind load of 200 kmph.

1.1.20 Cables and Cabling

All cables and cabling of required size and capacity shall be supplied, installed and terminated with necessary and required accessories among all the equipment/systems being supplied under this Package. The cables from cable ladder to equipment cable entry height shall be installed in the wall of the shelter in PVC cable conduits and in flexible conduits from shelter wall to equipment. The cables shall be dressed properly and suitably attached with the shelter panel. No hanging cables shall be allowed.

1.1.21 Structural

All structural steel shall conform to latest IS: 2062 or equivalent International standard. The ISMBs shall conform to IS – 808 or equivalent International standard. The structural MS pipes shall conform to IS:1161 or equivalent International standard. The steel work shall be galvanised after full fabrication as per latest IS standards and the coating thickness shall be greater than 127 micron. All welding shall be as per IS – 816 or equivalent International standard. All nuts and bolts shall be galvanised and conform to IS : 6639 or equivalent International standard. All fittings and hardware used in the shelters shall be made of corrosion-resistant aluminium or galvanised steel as specified in the relevant clauses of this specification.

The requirement of steel/aluminium sections shall also be provided and no separate payment shall be made in this regard.

1.1.22 Earthing

For satisfactory operation of the equipment inside the shelter, good and proper earthing is required at each site. The earthing resistance generally varies depending on soil resistivity. The earthing system at each site shall be provided by the Contractor with earthing resistance not exceeding the five (5) ohms. The Contractor shall provide the pipe type earthing along with the necessary hardware and accessories required. Minimum two earth pits shall be made at each location. However, if required resistivity is not met, then, sufficient nos. of pipe type earthing shall be provided by the Contractor. The Contractor shall submit the earthing pit diagram for Employer's approval.

An earthing ring of copper strip of minimum size 25mmX3mm shall be made inside the shelter. Each equipment shall be connected to above earthing ring through 70sqmm copper cable. The connectivity from earthing pit to the shelter earthing ring shall be made by the Contractor through two (2) nos. of 50 X 6 mm GI strips. The connection of GI strips with the copper strips shall be made through flexible copper cable and bi-metal washers for proper connectivity. The GI strips for earthing pit to shelter shall be buried inside the ground.

Three days after completion of the earthing pit, the earth resistance shall be measured in the presence of Employer's representative and test results for each location shall be submitted for Employer's approval.

All the equipment shall be connected properly to this earthing system for their safe operation.

1.1.23 Foundation System for Shelter

The Contractor shall design and construct complete foundation system for all finalised shelter locations depending on the type of soil, including supply and furnishing all the material & labour, tools & tackles, plant and machineries etc. as required for successful completion of the job. The foundation system shall also include the following:

- Site preparation
- Soil characteristics assessment as required for foundation design for each site including detail soil investigation, if required.
- Water level assessment
- Raising of site level above maximum flood limit level to avoid any water logging in the shelter area.
- Concrete pedestals (in situ) along with base slab for the foundations located on ground and concrete pedestals for roof top locations along with supply and fixing of necessary holding down / anchor bolts.
- PCC and finish of surface below and around shelter location with suitable slope.
- Installation of base frame and sub-frames on the pedestals through ISMB channels.
- Stair access for shelter.

1.1.24 Site Preparation at Shelter locations

For each of the shelter to be installed on the ground, the Contractor shall execute the work for site preparation, such as clearing of the site, levelling of the site, the supply and compaction of fill material (if required), excavation and compaction of backfill for foundation, trenches etc with available excavated earth. At certain locations, the finished ground level (FGL) site shall be fixed above High flood level (HFL) to avoid water logging in the shelter area. The site shall be prepared to meet the specified requirement for each site and up to satisfaction of the Employer. If fill material is required for site preparation, the fill material shall be provided with suitable protection so as to prevent the erosion by wind and water from its final compacted position or the in-situ position of undisturbed soil. Quantities of Earth filling with suitable protection have been identified in BoQ for above purpose.

Backfill material around foundation and shelter shall be suitable for the purpose for which it is used and compacted to the satisfaction of the Employer. Excavated material not suitable for use or not required for backfill shall be disposed off in area as directed by the Employer, including all leads and lifts.

Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom of the excavation level during excavation, concreting and backfilling.

For roof top shelters, the Contractor shall also prepare the site suitably for shelter installation on the pedestals. In all cases, each site shall be fully prepared before start of foundation activities up to satisfaction of the Employer.

1.1.25 Concrete Pedestals and Foundation system

Two types of foundations are envisaged for shelters viz. (i) required for shelters to be installed on ground & (ii) required for shelters to be installed on roof top of a building.

The foundation of shelters to be installed on the ground shall consist of RCC pedestals of minimum 600 mm above levelled ground. The depth of pedestals below the ground shall be minimum 1500 mm including bottom slab. The size of bottom RCC slab of the foundation shall be minimum 600 mm X 600 mm for a minimum 250 mm depth. The reinforcement shall be as stipulated at clause 2.4.4 below. The PCC (1:4:8) of minimum depth 75 mm shall be provided below the bottom slab of minimum size 750 mm X 750 mm. The size of the pedestals shall be minimum 300 mm X 300 mm. The grade of concrete shall be M20 (1:1.5:3). The concrete cover for the reinforcement shall be minimum 50 mm.

The foundation of shelters to be installed on the roof top shall consist of RCC pedestals of size minimum 300 mm X 300 mm and 300 mm above roof surface of M20 (1:1.5:3) grade. The bottom of the pedestal shall be connected and attached with the existing roof structure/slab. The reinforcement shall be as stipulated at clause 2.4.4 below.

The exposed portion of the concrete pedestals shall be plastered with 1:4 cement plaster for smooth finish.

The above pedestal dimensions are minimum requirement and the Contractor shall provide the required size of pedestals depending upon the soil bearing capacity and other soil parameters of each site to support the installed shelter along with all equipment. The detailed design for all above type of foundations shall be submitted to the Employer and got it approved before commencement of work at site.

The shelter shall be fixed to the pedestals through ISMBs 200 mm minimum and sufficient number of sub-frames with suitable anchor bolts. The required ISMBs and sub-frames shall be provided by the Contractor as part of shelter/foundations. The required number of pedestals shall be provided for shelter installations, however, minimum one pedestal is to be provided at each corner of the shelter. The Contractor shall provide the required and necessary foundation system at each site irrespective of soil to meet the requirement and submit the civil/structural/foundation design and drawings along with the load calculation for Employer's approval. All required foundation system and related works shall be in Contractor's scope and no additional payment shall be paid to the Contractor irrespective of soil characteristics and site conditions.

The suitable staircase shall be provided at each shelter location in front of the door for easy entry into the shelter as a part of foundation/pedestal system and no separate payment shall be made in this regard.

1.1.26 Concreting

After completion of foundation work at each shelter location, PCC (1:2:4) of depth minimum 100 mm shall be provided below the shelter position and outer sides for shelter as decided during detail engineering / execution. There shall be adequate slope in the Shelter area PCC to avoid water logging.

The Contractor shall also provide the RCC platform of about 600 mm height for installation of DG set. The exact area and the height of RCC required for DG set and shelter area shall be finalised during detailed engineering. At few locations, PCC platform for DG set may be provided. Quantities of PCC have been identified in BoQ for above.

1.1.27 Properties of Concrete

The cement concrete used for foundation shall be of grade M-20 corresponding to 1:1.5:3 nominal mix ratio with 20 mm coarse aggregate. All the properties of concrete regarding its strength under compression, tension, shear, punching and bend etc. as well as workmanship will conform to latest IS standards or equivalent International standard.

The Portland cement used in concrete shall conform to 33 grade (IS:269) or 43 grade (IS:8112) or 53 grade (IS:12269) or equivalent International standards.

The Pozzolana cement used in concrete shall conform to IS : 1489 or equivalent International standard. The curing time of Pozzolana cement shall be decided at the time of execution of the work under the contract based on the certificate from a reputed laboratory which will be obtained and submitted by the Contractor. Cement of only POWERGRID approved make shall be supplied.

Concrete aggregate shall conform to IS: 383 or equivalent International standard.

The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalis, organic materials or other deleterious substances. Portable water is generally preferred.

Reinforcement shall conform to IS: 432 or equivalent International standard for MS bars up to 6 mm and hard drawn steel wires and to IS : 1139 and IS : 1786 or equivalent International standard for deformed and cold twisted bars 8 mm and above respectively. All reinforcement shall be clean and free from loose mill scales, dust, loose rust and coats of paint, oil or other coatings, which may destroy or reduce bond. Contractor shall supply, fabricate and place reinforcement to shapes and dimensions as indicated or as required to carry out the intent of drawings and specifications. Reinforcement of only POWERGRID approved makes shall be supplied.

1.1.28 Mixing, Placing and Compacting of Concrete

Mixing shall be continuous until there is uniform distribution of material and the mix is uniform in colour and consistency. Normal mixing shall be done close to the foundation, but exceptionally the concrete may be mixed at the nearest convenient place. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by methods which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.

Form boxes shall be used for casting all types of foundations and pedestals.

The concrete shall be laid down in 150 mm layers and consolidated well, so that the cement cream works, up to the top and no honey-combing occurs in the concrete. Preferably, a mechanical vibrator shall be employed for compacting of concrete. However, in case of difficult terrain, manual compaction may be permitted at the discretion of the Employer. Monolithic casting of foundations must be carried out. After concreting the pedestal portion to the required height, the top surface should be finished smooth.

Wet locations shall be kept completely dewatered, both during and 24 hours after placing the concrete, without disturbance of the concrete.

If the concrete surface is found to be defective after the form work has been removed, the damage shall be repaired with rich cement sand mortar to the satisfaction of the Employer before the foundation is back filled.

1.1.29 Curing

The concrete shall be cured by maintaining the concrete wet for a period of at least 10 days after placing. Once the concrete has set for 24 hours, the pit may be backfilled with selected moistened soil and well consolidated in layers not exceeding 200 mm thickness and thereafter both the backfill earth and exposed pedestal shall be kept wet for the remainder of the prescribed 10 days. The exposed concrete chimney shall also be kept wet by wrapping empty cement bags around it and wetting the bags continuously during the critical 10 days period.

1.1.30 Other associated civil works

The Contractor shall also carry out other minor civil works in the shelter area for the equipment/system being supplied under the Contract at no additional cost to the Employer.

1.1.31 Installation

The shelter shall be installed on the foundation system as specified above and to meet the actual requirement as per actual site/soil conditions. The installation of shelters shall be carried out in such a way that it shall meet all specified requirement. The installed shelters shall be suitable for both transporting in assembled condition to another location and dismantling, transporting to another site and reassembling there.

The Contractor shall make their own arrangement for AC supply / DG set during installation/testing of the system.

1.1.32 Finish

The final finish of the installed shelter system shall show good workmanship. The panels and floor shall be totally scratchproof. The floor shall not have any uneven surface. The total shelter shall be air tight, the roof and all joints shall be leak and water proof and the door shall be easily lockable & unlockable.

1.1.33 Wire Mesh Fencing System for Outside Protection

To protect the shelters along with the installed equipment, air-conditioners, DG sets etc. from vandalism, wire mesh fencing shall be constructed at each of the shelter locations installed at ground. The wire mesh size shall be of 75 mm, the nominal dia of the mesh wires shall be 3.5mm and fencing shall be at least 2.0 m height from ground level. The pipes/angles of adequate size and capacity shall be provided to support the fencing. An iron gate of minimum size of 2 m or as per site requirement with pad locking facility shall also be provided at each location to enter the protected area. The fencing system shall also be painted (one coat of primer and 2 coats of final paint) for better reliability. The paint colour shall be finalised during detailed engineering. The provisional quantities of wire mesh fencing system including the gate in running meters have been indicated in the BOQ and the actual quantity shall be finalised during detail engineering based upon the actual site conditions. All associated civil works for the fencing shall also be carried out by the Contractor. The Contractor shall submit the layout of the shelter and other equipment and the barbed wire fencing for each of the locations for Employer's approval.

1.1.34 External Alarms

The telecom equipment being provided under separate package shall have provision of taking input of external alarms from various equipment e.g. DG set, air-conditioning system, DCPS, fire & smoke detection system, PIU unit etc. The Contractor shall provide necessary dry contacts at all the equipment being provided under this package and shall wire up these up to the telecom equipment. Contractor shall integrate and extend the Potential Free Contacts minimum for the alarms indicated at Cl.6.3.5 of specification.

1.1.35 Testing of Shelter system along with all sub-systems

1.1.35.1 Type testing

The Contractor shall provide the earlier carried type test reports for the PUF material and other sub systems of the shelter.

1.1.35.2 Factory Acceptance Testing (FAT)

The following tests shall be carried out during Factory Acceptance testing (FAT):

- a. Dimensional and checks as per approved DRS/drawings
- b. BOQ verification as per approved drawings/documents
- c. Test certificates from the Original Equipment Manufacturer.
- d. Density test, Compression test and Thermal Conductivity test on the PUF material.

FAT on other items shall be carried out as specified in this specifications and relevant standards.

1.1.35.3 Site Acceptance Testing (SAT)

The site acceptance testing shall be carried out for each site. The installed system shall be powered up and all the equipment shall be tested and commissioned. The various installed system shall be tested for the specified functional requirements and shall be as per approved drawings. The SAT shall be carried in an integrated way and not individual equipment basis to demonstrate the integrated functioning of the installed system. The tests shall be carried out on following minimum items during SAT:

- i. Site preparedness, PCC and RCC.
- ii. Civil Pedestals and Steel structure for Base of Shelter System

- iii. Shelter (including water proof test)
- iv. Air-Conditioning System
- v. Cable Tray
- vi. Lighting System
- vii. Fire and Smoke Detector System
- viii. C-Rails
- ix. Earthing System
- x. Wire Mess Fencing

The detailed SAT procedure shall be submitted for Employer's approval.

1.1.36 Marking

The following information shall be provided outside the shelter and near the door engraved on a steel metal plate:

- a. POWERGRID logo and name.
- b. Project Name
- c. Shelter location name
- d. Identification no.
- e. Year of Manufacture
- f. Shelter dimension

1.2 Requirements of Air Conditioning System

1.2.1 General

The air conditioning system shall be provided in the shelters to be used for housing Telecom equipment, power interface unit, VRLA batteries, battery charger etc. throughout the country. Repeater Shelters are placed for amplification of telecom signals in between the fibre optic links. The Contractor may note that these shelters are generally located in unmanned areas; therefore, the air-conditioning system shall be rugged, reliable, maintenance free and designed for long life.

1.2.2 Technical Experience

The Air Conditioners shall be offered from a manufacturer and Air Conditioners manufactured by such manufacturer should have been in operation for at least one (1) year as on the originally scheduled date of bid opening.

Bidder shall furnish the details/document in support of above Technical experience of manufacturer along with bid.

1.2.3 Operational Requirements

The air-conditioning is required for critical applications i.e. for maintaining the temperature of the critical telecom equipment inside the shelters on 24hours, 365 days of the year operation basis. Thus, to provide redundancy for such critical applications, Contractor shall offer twin circuit air conditioning system comprising of two air conditioning units packed in a single frame working in conjunction, controlled by the single inbuilt Micro processor based controller for desired operation.

Depending upon the size and location of shelter, following type of air conditioning systems shall be supplied:

- i) 2X2TR capacity air conditioning system with free cooling unit
- ii) 2X2TR capacity air conditioning system without free cooling unit
- iii) 2X1.5TR capacity air conditioning system with free cooling unit

iv) 2X1.5TR capacity air conditioning system without free cooling unit

Both units shall be independent of each other. The units shall run one by one in pre settable time bound cyclic ON/OFF mode. However, during running of AC unit 1, if the inside temperature of the shelter reaches to a predefined value, the AC unit 2 shall also start running to maintain the inside temperature to specified 24 °C. After achieving this temperature, the other unit shall again shut off.

Problem/ fault in one of the unit shall not hamper the working of other unit and during such fault in any of the unit; the alternate unit shall take over and continue to operate till the faulty unit is operational again.

Both units shall never start at the same time. If the condition is such that both units shall start together then internal time delay of at least 10sec shall be provided in starting of each unit to avoid surge.

In free cooling mode, the refrigerant cycle of AC unit shall be switched off and outside air (after filtration) shall be circulated inside the conditioned space through the operation of dampers provided with suitable sensors. It should be possible to run the Free Cooling Unit (FCU) on both AC & -48V DC Power supplies. This mode shall come into operation in the following conditions;

- i. When the ambient temperature is below a preset value, which is to be decided during detailed engineering.
- ii. In case of failure of refrigeration system of both the units.

The failure of free-cooling feature shall not hamper the normal operation of Air Conditioning units.

1.2.4 Operational Life

The air conditioning system to be supplied shall have operational life of 10 years.

1.2.5 Design

The air-cooled self contained package AC system shall be designed as per following conditions:

- Rated Capacity : 1.5TR/2TR
- Type of Discharge : Free Flow.
- Air inlet Temp (Return Air) : 24 °C (DB) RH : 50
- Temperature Variation allowed: ± 1 °C
- Ambient Air Design Temp : 45 °C
(entering the Condenser)
- No. of Refrigeration Circuits : Two
- Type of load Factor : High sensible heat load (SHR>0.9)

1.2.6 Micro processor based Controller

The air conditioning system shall have a common microprocessor based controller for both AC units, packed within the same cabinet. The microprocessor based controller shall have the following features;

Controller	Common for AC1+AC2
Mode of Operation	RUN/TEST/ Standby mode
Temperature Setting	16 -30 deg. C with 1 deg C resolution
Temperature variation from set temperature: ± 1 °C	
Cycle Time, Duty Changeover	2, 4, 6, 8, 10, 12 hours.

Unit Changeover	Both the AC units shall operate in pre-settable cyclic mode. Also, if one unit is faulty the controller shall be able to detect & put the other unit in operation automatically.
Running of both units:	Start of IInd unit along with Ist unit in case sensor senses high temperature.
Memory	Non-volatile memory for various settings supported by Battery backup eg. Set temp., working hours & ON / OFF Status
Alarms Displays	Potential Free contacts for Remote monitoring at NOC a) AC unit1 fails alarm b) AC unit2 fails alarm c) High Temp inside shelter alarm d) Power Fail alarm e) Indication for free cooling In addition to the above, following minimum LED Indications shall also be available in the Controller Mimic Panel for local indication; a) Alarm. b) Power Healthy. c) Blower Working. d) Compressor Working.
Time Delay	On / Off sequence delay shall be available.
Cumulative hours run	For each compressor of Air-conditioning system
Free Cooling	Operates the blower fans & changeover damper position to circulate outside air.
Enthalpy/Temperature Sensor:	As required along with free cooling.
Further, the free cooling function may be enabled/ disabled with help of the controller.	

1.2.11 Earthing

The AC equipment shall be properly earthed by connecting it to the earthing system.

1.2.12 Power Supply

The offered air-conditionings equipment shall work satisfactorily for the power supply range as mentioned at mentioned below:

Nominal Voltage: 230 V (Single phase)

Variations: $\pm 10\%$

System frequency: 50 Hz ($\pm 5\%$)

Supply and installation of all required cabling, wiring and termination and accessories including surge arrestors, motor starters, circuit breakers and switches from the power supply point/ Meter point to the various units via ACDB shall be carried out by the Contractor.

1.2.13 Testing

1.2.13.1 Type Testing

The type testing of the air-conditioning system shall conform to latest IS: 8148 standards or equivalent International standard.

1.2.13.2 Factory Acceptance Testing

The factory acceptance testing shall be carried out as per latest IS: 8148 standards or equivalent International standard.

1.2.13.3 Site Acceptance Testing (SAT)

The site acceptance testing for air-conditioning system shall be carried out by the Contractor after successful installation of the air conditioning system. The SAT shall demonstrate all its functions properly. The detailed SAT procedure shall be submitted by the Contractor for Employer's approval.

1.3 Requirements for DG Set

1.3.1 General

The DG sets shall generally be installed on ground and the required RCC/PCC floor shall be provided by the Contractor. Single Phase DG sets of rated capacity without AMF panel are required. AMF panel shall be the part of Power Interface Unit (PIU). Most of these DG sets shall be installed at unmanned sites located in rural/remote villages/towns. The DG set shall have an operational life of 10 years.

1.3.2 Technical Experience

The DG set shall be offered from a manufacturer of Diesel Generator set and Diesel Generator set manufactured by such manufacturer should have been in operation for at least one (1) year as on the originally scheduled date of bid opening.

Bidder shall furnish the details/document in support of above Technical Experience of manufacturer along with bid.

1.3.3 Generator Set Configuration

The generator set shall consist of a diesel engine directly coupled to an electric generator, together with the switchgear, controls, battery and other associated accessories required to provide continuous electric power for any duration of failure of the normal AC source. The DG sets shall be rated for continuous operation.

1.3.4 Diesel Engine

The Contractor shall provide diesel engines of standard designs of original manufacturers in their DG sets. It shall be from reputed manufacturers i.e. Kirloskar Oil Engine / Cummins / Ashok Leyland / Mahindra / Crompton Greaves / Eicher makes conforming to latest BS 5514/ ISO 3046 standards. The bidder shall submit the details of the engine along with their bid.

The diesel engine shall be direct injection, 4 stroke cycles, multi cylinder, air-cooled/ water-cooled, naturally aspirated/ turbo charged, instantly started, operating at a nominal speed of 1500 R.P.M. and capable of developing requisite Brake Horse Power i.e. the rated horsepower of the engine, at the generator synchronous speed, with all accessories attached, shall not be less than the required power as specified in the appendices. In addition, the horsepower rating shall take into account the generator efficiency, losses and maximum rated environmental conditions stipulated in Clause 1.3.19. All moving parts of the engine shall be mechanically guarded in such a manner that a human finger cannot touch a moving part. The diesel engine shall be equipped with a dry type air filter system.

1.3.5 Governor

The engine shall be equipped with class A-1 governor or better as per IS 10000 Part-VII or any other equivalent International standard. The speed regulation shall be as per the above governing class.

1.3.6 Engine Cooling

The bidder may offer air-cooled or water-cooled type DG sets. However, no preference / compensation shall be applicable for any particular type of offered DG sets. The cooling system shall provide adequate cooling

to the generator set when operated on full load for prolonged periods of time at the maximum environmental conditions stated in Clause 3.3.19. In case of water-cooled engine, necessary breathing arrangement shall be provided with the radiator to take care of the expansion/ contraction of the coolant water in the radiator.

1.3.7 Fuel System

The engine shall operate on a commercial grade diesel fuel; no premium fuel shall be required. The DG set shall be provided with inbuilt fuel storage tank with capacity to last 12 hrs on 100% load. It shall be equipped with low level fuel alarm potential free contacts for connection to the Equipment NMS system.

The Contractor shall also indicate the fuel consumption of the offered DG sets at 25%, 50%, 75% and 100% of rated loads along with their bid in the DRS format.

Fuel required to carry out all kind of tests including site acceptance tests shall be supplied by the Contractor.

1.3.8 Exhaust System

The DG set shall be provided with a suitable exhaust system capable of carrying exhaust gases from the engine and dissipate them to the atmosphere as quickly and silently as possible meeting the latest noise and emission norms of CPCB. The exhaust system shall be equipped with proper heat shielding to protect personnel and facilities.

1.3.9 Starting System

The engine shall be equipped with an electric starting system with a 12/24 volt heavy duty lead acid battery of suitable AH capacity sufficient to provide a minimum of twelve (12) successive abortive starts of the engine without recharging. A suitable battery charger complete with voltage regulator, float or booster selector switch, on-off switch, digital voltmeter and ammeter shall be supplied (along with the battery) for charging the battery from mains. The battery charging system shall operate on an input of 240 V AC, 50 Hz from the ACDB. The battery shall be housed within the DG enclosure suitably.

The engine control shall provide for multiple crank start-up cycles. Each cycle shall be approximately 10-seconds of cranking followed by 10-seconds of rest. The starting circuit shall automatically be disconnected after the start up of the engine. If the engine does not start after three (user adjustable number) attempts, the starting circuit shall be disabled and an alarm indication ("over crank") shall be provided. A potential free contact shall be provided to interface these alarms with the Equipment NMS.

The starting time of the DG set in 'AUTO' mode shall be continuously and linearly adjustable from 5 minutes to 8 hours from the time of power failure sensing. The starting of DG set shall be based on the condition of the 48V DC battery voltage (being used for telecommunication equipment) and temperature inside shelter. For this purpose, the required auxiliary contacts from DC power supply system shall be available in DCPS cabinet and for sensing temperature inside shelter, the required thermostat shall be provided by the DG Contractor. The exact time setting and other settings of DG start up shall be finalised during site acceptance on site-to-site basis based on the actual site conditions.

1.3.10 Instrumentation and Controls

The Employer shall procure DG sets with the capability to extend the controls to external PIU unit equipped with AMF control panel.

The microprocessor based AMF (Automatic Mains Failure) panel shall be equipped with standard instrumentation including interlock and protection arrangement, suitable annunciation and indications etc. for proper start up, monitoring, control and safe operation of the DG set. The AMF shall start the DG set in case of AC mains failure and transfer the load from normal source to diesel generator without any human intervention. Similarly on restoration of mains supply it shall be able to transfer the load to mains supply and switch off the DG automatically.

The AMF panel shall be equipped with following minimum instrumentation:

- a). Microprocessor based relay with composite meter for digital display of;
 - i. AC mains Voltage & Generator Voltage
 - ii. Generator Current
 - iii. Power Factor
 - iv. Output KW meter
 - v. Output AC frequency meter
 - vi. RPM indication
 - vii. Over speed indication
 - viii. Engine hours indication (Cumulative)
- b). Mode selector switch for setting the panel on any one position such as OFF or Auto/ Manual/ Test. The operation of the DG set shall be possible in any of the modes.
- c). Engine ON/OFF switch (Push button type)
- d). Emergency Stop switch (Push button type)
- e). ON delay timer for load change over.
- f). ON delay timer for engine shut off.
- g). Indicating lamps to indicate 'Mains ON', 'Load on Mains', 'DG Running', 'Load on DG', 'Battery charger ON'
- h). Audio visual alarm for
 - i. Low lubricating oil pressure
 - ii. High water temperature (for water cooled DG)
 - iii. High cylinder head temperature (for air cooled DG)
 - iv. Start failure
 - v. DG over load.
- i). Suitable battery charger complete with voltage regulator, float or booster selector switch, on-off switch, digital voltmeter and ammeter for charging the battery from mains operating 240V/ 50 Hz
- j). MCCB of suitable rating
- k). Two no. contactors of suitable ratings (one for DG set and one for AC mains) with overload relay.
- l). Under voltage relay for Mains.
- m). Instrument and control fuses.
- n). Any other switch, instrument, relay or contactor etc. essential for smooth and trouble free functioning of DG set with AMF panel. (To be specified by the bidder with complete detail of the item).

Standard colour codes and numbered ferrules shall be used for wiring the AMF panel. Sensing and control relays shall be of continuous duty, industrial control grade type. The transfer breaker shall be rated for continuous duty. The breaker shall be interlocked to ensure non-paralleling SEB power supply and DG supply.

Following automatic shut down protection system for DG set shall also be integrated in the control panel;

- i. Low lubricating oil pressure shut down.
- ii. High coolant (water) temperature shut down.
- iii. Engine over speed shut down.
- iv. Over load shut down.
- v. Short Circuit shut down.
- vi. Over Voltage shut down
- vii. Low Fuel Level
- viii. Earth Fault shut down.
- ix. Emergency Stop

The AC mains supply shall be of either single Phase or three Phase. The loads connected shall be single phase in nature.

1.3.11 Alternator

The Contractor shall supply alternators in their offered DG sets only from the reputed manufacturers i.e. Crompton-Greaves / Kirloskar / FG Wilson / ELGI / KEL makes as per latest BS 5000/ IS 4722 standards. Details of alternator shall be submitted by the Contractor along with the bid.

The alternator shall be self excited, self regulated, screen protected, double bearing, brushless type, drip proof, continuous duty type, synchronous and suitable for 1500 RPM. 0.8 P.F lagging, horizontal foot mounted, with class H insulation.

The alternator shall also have a solid state type Automatic Voltage Regulator (AVR) suitable for single running with control limits of 1% from no load to full load under normal load changes. It shall be of static type and complete with cross current compensation. The regulator shall be provided with voltage adjusting potentiometer and shall be complete with all alarm contacts, internal wiring etc.

The alternator shall be capable of carrying 50% overload for a duration of one minute.

The alternator shall be suitable for 20% over speed for two minutes.

The alternator shall be capable of carrying 10% overloading for one hour in any period of 12 hrs running without injury.

1.3.12 Mounting Arrangement

Engine and alternator shall be mounted on a common MS fabricated base frame with anti vibration pads.

1.3.13 DG set Enclosures

1.3.13.1 A suitable weather-proof enclosure which shall be provided for protection from rain, sun, dust etc. Further, in addition to the weather proofing, acoustic enclosures shall also be provided such that the noise level of acoustic enclosure DG set shall meet the requirement of MOEF The diesel generator sets should also conform to Environment (Protection) Rules, 1986 as amended. An exhaust fan with louvers shall be installed in the enclosure for temperature control inside the enclosure. The enclosure shall allow sufficient ventilation to the enclosed D.G. Set so that the body temperature is limit to 50°C. The air flow of the exhaust fan shall be from inside to the outside the enclosure. The exhaust fan shall be powered from the DG set supply output so that it starts with the starting of the DG set and stops with the stopping of the DG set. The enclosure shall have suitable viewing glass to view the local parameters on the engine.

1.3.13.2 Fresh air intake for the Engine shall be available abundantly; without making the Engine to gasp for air intake. A chicken mess shall be provided for air inlet at suitable location in enclosure which shall be finalized during detailed engineering.

1.3.13.3 The Enclosure shall be designed and the layout of the equipment inside it shall be such that there is easy access to all the serviceable parts.

1.3.13.4 Engine and Alternator used inside the Enclosure shall carry their manufacturer's Warranty for their respective Models and this shall not degrade their performance.

1.3.13.5 Exhaust from the Engine shall be let off through Silencer arrangement to keep the noise level within desired limits. Interconnection between silencer and engine should be through stainless steel flexible hose/ pipe.

1.3.13.6 All the Controls for Operation of the D.G. Set shall be easily assessable. There should be provision for emergency shutdown from outside the enclosure.

1.3.13.7 Arrangement shall be made for housing the Battery set in a tray inside the Enclosure.

1.3.14 Construction Features:

1.3.14.1 The enclosure shall be fabricated from at least 14 Gauge CRCA sheet steel and of Modular construction for easy assembling and dismantling. The sheet metal components shall be pre-treated by Seven Tank Process and Powder coated (PURO Polyester based) both-in side and out side – for long life. The hard-

ware and accessories shall be high tensile grade. Enclosure shall be given a lasting anti-rust treatment and finished with pleasant environment friendly paint. All the hardware and fixtures shall be rust proof and able to withstand the weather conditions.

1.3.14.2 Doors shall be large sized for easy access and provided with long lasting gasket to make the enclosure sound proof. All the door handles shall be lockable type.

1.3.14.3 High quality rock wool of required density and thickness shall be used with fire retardant thermo – setting resin to make the Enclosure sound proof.

1.3.14.4 Points for Neutral/Body earthing shall be available at two side of the enclosure with the help of flexible copper wires from alternator neutral, and electrical panel body respectively. The earthing point shall be isolated through insulator mounted on enclosure.

1.3.15 Main Circuit Breaker of DG

The DG set shall be connected to the Input ACDB buses through main circuit breaker (MCCB type). Separate cables from DG set to the breaker shall be laid to extend DG power supply.

1.3.16 DG Set Mode of Operation

Operation of DG set shall only be allowed when the selector switch is in the Manual/Automatic/Test positions. Moving the selector switch to the OFF position shall properly shut down the generator set, remove it from the AC loads and inhibit it from starting in any mode. The DG set shall be capable of operation in the following modes;

1.3.16.1 Start Operation

- a. Auto Mode
- b. Manual Mode
- c. Test Mode

1.3.16.1.1 Auto Mode

In the 'AUTO' mode, the DG Set shall start only after a set time delay when either the primary AC source has failed or conditions prevail as indicated below;

When the main source power fails, the DG set shall include detection and control to automatically disconnect the primary AC source, start the DG set and extend power to ACDB after the set time period of the timer. The time delay is continuously & linearly adjustable at site from 5 minutes to 8 hours as specified at Clause 5.2.6. The engine shall also start automatically after detecting a predefined temperature (20 °C to 55 °C continuous) inside the shelter or initiation from 48V DC under-voltage contact from DCPS. All required control like thermostat, extension of potential DC under-voltage contact from DCPS shall be provided by the Contractor to support the above controls.

All phases of primary AC sources voltage shall be monitored. The automatic start-up system shall detect failure or abnormal conditions specified and start the generator set. At the time of loss of primary voltage or an abnormal condition of low phase voltage, a start control shall be initiated. The automatic start shall try the start-up of the generator set for three successive attempts. If the primary AC returns during the start-up attempt, the start-up sequence shall be stopped.

If at any time during operation of the generator set the selector switch is set to 'OFF' position, the generator shall shut down and be disabled from starting.

1.3.16.1.2 Test Operation

A test operation of DG set shall be possible by putting the control switch in "TEST" position from where the generator shall initiate an automatic start, just as if there had been a power interruption to the primary power. Upon removal of the selector switch from "TEST" position, the generator shall initiate an automatic

shutdown sequence. However, there shall be interlock such that Main circuit breaker of DG set is in 'OFF' condition while the engine is started in "TEST" position.

1.3.16.1.3 Manual Operation

When the control switch is in "MANUAL" position, the generator set can be started using the manual start push-button on the control panel. The generator set will be stopped by setting the control switch back to the "OFF" position or by pressing stop button on the AMF panel. During manual operation, all main and AC source breakers must be operated manually to transfer load to or from the generator set.

1.3.16.2 Automatic Shutdown

When the primary power is restored and remains normal continuously for a period of 5 minutes (locally user adjustable from 0 to 15 minutes), the load will be switched over from DG set to primary power and the generator shall be automatically stopped and be enabled for another future start-up request.

1.3.17 Remote and Local Monitoring

The DG set shall be capable of being monitored from remote as well as local.

1.3.17.1 Visual Annunciation

The following minimum visual annunciation shall be provided for DG set shut down due to:

- (i) Low fuel level
- (ii) Engine failed to start (failed to start in 60 sec. after receiving the first start impulse)

1.3.17.2 Remote Monitoring

The above parameters shall also be monitored remotely through telecom equipment NMS or any other independent remote monitoring arrangement. Suitable potential free dry contacts (NO) for this purpose shall be provided by the Contractor. The contractor shall do all the required wiring for such purpose.

1.3.18 General Requirements

The DG sets shall be generally installed at outdoor positions near to the shelter locations. The DG sets shall be installed either on ground near to Shelter installed at ground or on rooftop near to shelter installed at roof top. However, in some cases, the DG sets may be installed on ground and shall be connected to shelter installed on rooftop. The exact requirement shall be finalised during detail engineering based on actual site conditions.

1.3.18.1 Mounting and Installation

The generator set shall be skid mounted using anti vibration pads. At some locations, DG set may be installed on the rooftop. The required RCC floor/ PCC pedestals shall be provided by the Contractor.

1.3.18.2 Earthing

The Contractor shall suitably connect the DG sets with the integrated earthing system being provided by the Contractor under this package. The neutral of alternator shall be earthed separately.

1.3.18.3 Trenching

The Contractor shall prepare necessary cable routes for installing cables and earthing system from DG set to the shelter and earthing pits. The cables shall always be installed inside the GI pipes of suitable size embedded properly with PCC finish. In case the DG set is installed on ground and the shelter is installed at roof top, the necessary cable trenching/ GI pipe shall be provided from DG set to the building ground from where the cables shall be installed in the wall of the building. The cable trays with proper cover and supports shall be provided from bottom of the trench at the ground near the building up to the shelter installed at the roof top. The Contractor shall submit the detail drawings for the same for Employer's approval.

1.3.19 Operating Environment

The generator sets shall operate within the following ambient environmental requirements:

- (a) Operating temperature range: +2°C to +50°C
- (b) Maximum relative humidity at 23°C of 95% (non-condensing)
- (c) In non-filtered air containing a high proportion of dust
- (d) In a corrosive atmosphere (at high humidity)
- (e) At altitudes of up to 500 metres above sea level
- (f) The equipment must withstand mechanical vibrations as defined in the IEC 68-2-6 test requirements.

1.3.20 Cables and ACDBs

All cables of required size and ratings for proper functioning of the DG set including all accessories shall be supplied, installed and terminated by the Contractor.

1.3.20.1 AC Distribution Boards

The contractor shall provide AC Distribution Boards associated with each system. The AC distribution boards shall distribute power to the equipment and provide protection against failures on feeder circuits.

Generally, ACDBs shall be part of Power Interface unit (PIU), however, at few locations, Standalone ACDB shall be required where PIU is not required. ACDBs shall be wall mounted enclosure/panel as finalized during detailed engineering. They shall have indicating lamps and voltmeter to indicate three phase voltage on the bus.

The MCCB and sub-assemblies shall be easily replaceable and maintainable. The MCCBs of requisite ratings must conform to IEC-60947-2 and IS 13947-2/IEC 60947-2. All MCCBs shall provide over-current, short circuit protection and coordinate with associated breakers in upstream & downstream such that faults are cleared reliably with discrimination.

The contractor shall extend safety earth connections from Input ACDB panel & Output ACDB panel to nearest earthing system being provided under this contract.

1.3.21 Testing of DG sets

1.3.21.1 Type Test

The Contractor shall submit the earlier carried type test reports for the engines, Alternator & enclosure of the offered DG sets for the highest rating of offered DG set as per the latest relevant IS standards or equivalent International standard for Employer's approval. The type tests on Alternators shall be carried out as per Table 5.10(a) as given below.

1.3.21.2 Factory Acceptance Test

A complete DG set shall be assembled and installed at factory as being envisaged at site and shall be run to check proper installation and assembly of all items of the DG set. It shall demonstrate all specified design features and functional requirements as per specifications, for adopting the same at sites. Manufacturer's internal test reports of Alternators for each DG set shall be submitted during FAT.

Table-5.10(a)
List of Tests for DG Set

SNo.	Test	Type Test	Factory Acceptance Test	Site Acceptance Test
A. ALTERNATOR				
1.	Measurement of resistance	√		
2.	Regulation test	√	√	√

SNo.	Test	Type Test	Factory Acceptance Test	Site Acceptance Test
3.	Measurement of open circuit characteristics	√		
4.	Measurement of short circuit characteristics	√		
5.	Efficiency test	√		
6.	Temperature rise test	√		
7.	Occasional excess current test	√		
8.	Over speed test	√		
9.	Insulation resistance (both before & after high voltage test)	√		
10.	High Voltage test	√		
11.	Determination of deviation of voltage waveform sinusoidal	√		

Note : All the above tests as per IS: 4722 or equivalent International standard

B. DG Set (including Alternator)

1.	Noise and vibration test	For all		√
2.	Load Test	Type tests	√	√ (Note)
3.	Functional tests on control panel, starting provision AVR and speed governor		√	√

Note: SNo. 1 above: As per standard IS 12065/12075 or equivalent International standard.

1) During FAT, Load test shall be conducted on each rating of DG sets before dispatch to site as follows:

- a) No load test for 15 minutes
- b) 100% Load test for 8 hrs
- c) 110% load test for 1 hr

2) During SAT, 6 hours load test shall be carried out with existing load.

3) The Oil consumption, governing, noise and vibration shall be recorded during the testing period.

Further during above test, AMF panel associated with highest rating DG set shall be integrated to check all the functional requirements and other requirements as per technical specifications.

---End of Table---

1.3.21.3 Site Acceptance Test

After successful installation of the DG set, Site Acceptance Testing for each DG set shall be carried out at respective site. The total installed system in power up condition shall be tested for the specified functional requirements. The minimum requirements for SAT are given in Table 5.10(a) above. The timer setting for automatic DG set starting after normal power supply failure and for automatic shut off after restoration of normal supply shall be done at each site based on the actual site conditions. The detailed SAT procedure shall be submitted by the Contractor for Employer's approval.

1.3.22 Marking

The following information shall be provided on each DG sets:

- g. POWERGRID and its logo
- h. DG Set location name
- i. Identification no.
- j. Year of Manufacture
- k. DG set dimension
- l. DG set weight
- m. KVA rating, HP Rating
- n. Voltage, Per phase current

1.3.23 Tool Kit

One set of following tools of Taparia or other reputed make shall be supplied with each DG set;

Tool kit

SNo.	Item Description	Unit	Qty
1	Digital Multimeter	No.	1
2	Cutter	No.	1
3	Pliers	No.	1
4	Nose Pliers	No.	1
5	D Spanner set (All sizes from 6 mm to 22 mm)	Set	1
6	Ring Spanner set (All sizes from 6 mm to 22 mm)	Set	1
7	Cable Cutter	No.	1
8	Hammer – 250 gm with handle	No.	1
9	Hack Saw	No.	1
10	Wire Stripper	No.	1
11	Screw Driver Set (-) type (6 Nos. of different sizes)	Set	1
12	Screw Driver Set (x) type (6 Nos. of different sizes)	Set	1
13	Tool Box (To accommodate all the above specified tools)	No	1
--End of Table--			

1.4 Requirements for Power Interface Unit (PIU)

1.4.1 General Requirements

Power Interface Unit (PIU) shall integrate the surge protection devices, AMF panel for DG control, AC voltage stabilizer, and AC distribution panel etc. in a single unit to save the valuable floor space inside the shelter and to provide quality AC power supply to the various systems including SMPS based DC power supply system, air conditioning system etc. used in telecom applications.

The PIU unit to be supplied shall have an operational life of 15 years.

1.4.2 System Configuration

PIU unit shall consist of following subsystems integrated in a single cabinet suitable for indoor installations.

- 1) Healthy Phase Selector
- 2) Surge Protection Devices
- 3) Static Voltage Stabilizer
- 4) AMF Panel
- 5) PIU controller
- 6) AC distribution panel

1.4.3 Healthy Phase Selector

Generally the AC supply shall be taken directly from available rural/urban overhead distribution supply. Healthy phase selector shall select the healthy phase out of the available phases. PIU in one of the following three configurations shall be provided at each location;

- i) 15kVA PIU working on best two phase with input voltage 240-480 Normal L-L for Urban locations
- ii) 10kVA PIU working on best single phase with input voltage 155-280 Normal L-N for Rural locations
- iii) 10kVA PIU working on best single phase with input voltage 155-280 Normal L-N for Rural locations capable of controlling two DG sets (as per clause 6.3.7)

Suitable circuitry along with all hardware, cables, relays, sensors etc. shall be so provided that it shall be possible to select the healthy phase(s) automatically and have the output at the stabiliser and the load requirement can be met. The Contractor shall submit the scheme for Employer's approval during detail engineering.

There should be a Manual by pass arrangement for bypassing the Healthy Phase Selector.

1.4.4 Lightning & Surge Protection

The PIU unit shall be equipped with lightning and surge protection devices to provide protection to all the equipment being connected and integrated against incoming lightning and low voltage surges. The lightning/surge protection shall be in compliance with IEC-61312, IEC-61024 and VDE-0100-534 for following surges:

A) Lightning Electromagnetic impulse and other High Surges (Class B):

Between	Requirement
R, Y, B & N	$I_{imp} \geq 50 \text{ kA}, 10/350 \mu\text{S}$ for each phase
N & PE	$I_{imp} \geq 100 \text{ kA}, 10/350 \mu\text{S}$
I_{imp} = Value of Lightning Impulse Current	

B) Low Voltage Surges (Class C)

Between	Requirement
R, Y, B & N	$I_n \geq 10 \text{ kA}, 8/20 \mu\text{S}$ for each phase
N & PE	$I_n \geq 20 \text{ kA}, 8/20 \mu\text{S}$
I_n = Value of Nominal Discharge Current.	

The protection system for both the above stages shall be reusable after clearance of surge. In case of fault, provision for manually bypassing the protection system should be available to ensure the operation without protection system. The manufacturer shall give complete details of the arrangement provided for the purpose during detail engineering and also ensure and demonstrate the effectiveness of the arrangement. Test Certificate from a reputed third party lab may be accepted provided the protective devices of both stages have been tested in the same lab.

1.4.5 Static Voltage Stabilizer

AC Static automatic voltage stabiliser using microprocessor based controller shall provide the stabilised quality power supply to the air-conditioners, battery charger, lighting etc. through ACDB. The capacities/ratings of voltage stabiliser shall be as per appendices. The stabiliser shall conform to the following parameters specified in Table 6.1 below:

Table 6.1

S. No.	Items	PIU for Urban locations	PIU for Rural locations
1	Input Power	3 Φ , 4 wire	3 Φ , 4 wire
2	Input Voltage (Volts)	240-480 Normal L-L on best two phase working	155-280 L-N when working on single phase
3	Output Voltage (Volts)	230 V $\pm$ 10% (Single Phase)	230 V $\pm$ 10% (Single Phase)
4	Voltage correction speed	400 V in 1 μsec	400 V in 1 μsec

Table 6.1

S. No.	Items	PIU for Urban locations	PIU for Rural locations
5	Efficiency (excluding IT)	> 96%	> 96%
6	Frequency	48 – 52 Hz	48 – 52 Hz

1.4.6 Automatic Mains Failure (AMF) Panel

The PIU unit shall support the microprocessor based AMF panel for various capacity DG sets as per BoQ. The AMF shall start the DG set and transfer the AC load from normal source to diesel generator automatically in case of AC mains failure with availability of other conditions as per section 5.6.1.1 of this specification. Similarly on restoration of mains supply it shall be able to transfer the load to mains supply and switch off the DG automatically. Provision for a suitable delay shall be kept for starting of DG and changeover of load between DG & Mains.

The AMF panel shall be equipped with suitable instrumentation, interlock and protection arrangement, suitable annunciation and indications etc. as defined in the Section 5.2.7 of this specification for proper start up, monitoring, control and safe operation of the DG set.

An option for selection of Auto / Manual Mode operation should be provided on the front panel of the PIU. Operation (Start / Stop) of the DG set in manual mode should be available on the PIU. In manual mode, AMF logic will be totally bypassed. However during manual mode, the DG protections will not be bypassed. A change over switch shall also be provided for total bypassing the AMF.

1.4.7 PIU Controller

Contractor shall integrate the Alarms of various Auxiliaries of shelter with the PIU and Alarms shall be monitored by Central Supervisory Unit. Central Supervisory Unit shall be designed to facilitate better interface of man and machine. It shall consist of High-Speed micro controller displaying true RMS for all voltage & current through LCD display. All the inputs to the measurement board shall be duly protected against surge as per IEEE-62.41. The measurement circuit shall be rated at 1.5 times the maximum input range. The unit shall be equipped to log 500 events with date and time stamping including DG start and stop logs. It shall display various site conditions like Mains ON, DG ON, Smoke/ Fire Alarm, Over Load, Charger MODULE fail, DG Fuel Low, DG fail to start, DG fail to stop, Alternator fail, LLOP, DG overload, Mains Fail, Site battery low, DG battery low, HCT/HWT, High Shelter temperature etc. Various Mains and DG related measurements viz. Mains energy measurement, DG energy measurement, DG accumulated hours, peak energy requirement of site etc. shall also be displayed.

Contractor shall integrate and extend the Potential Free Contacts for monitoring at NOC for following minimum alarms;

- i) Mains Fail
- ii) Door Open
- iii) High Room Temperature
- iv) DCPS battery Low
- v) Rectifier Fail
- vi) Fire and Smoke
- vii) DG Fail to Start
- viii) LLOP
- ix) Fuel Low
- x) DG ON LOAD
- xi) DG ON
- xii) HCT
- xiii) DG Over speed
- xiv) DG Fail to Stop