

**Section 4**  
**Repeater Shelter and Associated Sub-system**  
**(if applicable)**

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## Section-4

### Technical Specifications for Shelters

#### 4 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.

#### 4.1 Repeater Shelter Requirements

##### 4.1.1 Shelter Dimensions

The minimum internal and external dimensions of the shelters shall be as per Table 4.1 as specified below:

Table 4.1 <span style="float: right;"><i>All dimensions are in mm</i></span>				
SNo.	External/Internal	Length (L)	Width (W)	Height (H)
1	External	4500	2700	3160
	Internal	4340	2540	3000

##### 4.1.2 General

The shelters shall be protected and insulated to achieve soundproof, thermal resistance and impact withstand capabilities. The shelters shall be 100% leak and waterproof with IP 55 protection. The shelters shall be maintenance free having a 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 throughout India. The shelters shall be easily assembled and installed at site. The shelters shall be re-locatable as and when required.

##### 4.1.3 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. 4.1.9 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.

#### **4.1.4 Floor**

The floor shall consist of standard PUF sandwich panels suitably reinforced to support the minimum load capacity of 2000 kg/m<sup>2</sup> 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.

#### **4.1.5 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 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.

#### **4.1.6 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. 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.

#### **4.1.7 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.

#### 4.1.8 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.

#### 4.1.9 Insulation

The PUF to be used for insulation of the panels shall be CFC free and conforming to latest IS 12436 standards. The other parameters shall be as per Table 4.2 as given below:

**Table : 4.2**

SNo.	Items	Required Parameter
1	Thickness	78.6 mm
2	Density	40 kg/m <sup>3</sup>
3	Compressive Strength	1.2 kg/cm <sup>2</sup>
4	Tensile Strength	3.6 kg/m <sup>2</sup>
5	Bending Strength	4.0 kg/m <sup>2</sup>
6	Adhesion Strength	2.9 kg/m <sup>2</sup>
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 <sup>2</sup>
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.

#### 4.1.10 Heat Transmission Coefficient

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

#### 4.1.11 Colour

The shelter panels shall be factory coated with good quality and long life paints. The finished panels

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shall be provided with suitably protection to avoid scratches during transportation, handling and installation.

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.

### **4.1.12 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:

- a. An external visual signal and audible alarm sounded outside the shelter.
- b. 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.
- c. Suitable pilferage proof enclosure for visual and audio alarm outside the shelter.

Fire detectors shall be approved by FOC-London or similar International authorities and also by Tariff Advisory Committee of India. The set point shall be adjustable.

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.

### **4.1.13 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.

### **4.1.14 Cable Tray**

The cable tray of size minimum 300 mm width made of Fiberglass 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 fiber 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.

#### **4.1.15 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.

#### **4.1.16 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 Fiberglass 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.

#### **4.1.17 Loading Capacity**

Minimum roof loading capacity : 250 kg/m<sup>2</sup>

Minimum floor load capacity : 2000 kg/m<sup>2</sup>

Minimum wall load capacity : 300 kg/m<sup>2</sup>

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 PrKTCL

#### **4.1.18 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.

#### **4.1.19 Survival wind speed**

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

#### **4.1.20 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.

#### **4.1.21 Structural**

All structural steel shall conform to latest IS: 2062. The ISMBs shall conform to IS – 808. The structural MS pipes shall conform to IS:1161. 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. All nuts and bolts shall be galvanised and conform to IS : 6639. 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.

#### **4.1.22 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.

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.

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

#### **4.1.23 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,

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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.

### **4.1.24 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. 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

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.

### **4.1.25 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 4.1.26 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 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. 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.

#### **4.1.26 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.

#### **4.1.27 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.

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

The Puzzolena cement used in concrete shall conform to IS : 1489. The curing time of Puzzolena 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 PrKTCL approved make shall be supplied.

Concrete aggregate shall conform to IS: 383.

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

Reinforcement shall conform to IS: 432 for MS bars up to 6 mm and hard drawn steel wires and to IS : 1139 and IS : 1786 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 PrKTCL approved makes shall be supplied.

#### **4.1.28 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.

#### **4.1.29 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.

**4.1.30 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.

**4.1.31 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 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.

**4.1.32 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.

**4.1.33 Environmental Conditions**

As indicated in the appendices, the shelters shall be installed all over India. The environmental conditions required are as under:

Normal Internal Temperature	:	+24 ± 1 °C
Maximum Outside Temperature	:	+50 °C
Minimum Outside Temperature	:	0 °C
Maximum Inside Temperature	:	+55 °C
Humidity	:	Up to 100 %.

**4.1.34 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 mess size shall be of 75 mm, the nominal dia of the mess 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. 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.

**4.1.35 External Alarms**

The Communication equipment being provided under this package shall have provision of taking input of external alarms from various equipment e.g. DG set, air-conditioning system, DCPS, fire &



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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 Communication equipment.

### **4.1.36 Testing of Shelter system along with all sub-systems**

#### **4.1.36.1 Type testing**

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

#### **4.1.36.2 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.

#### **4.1.36.3 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.

### **4.1.37 Marking**

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

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

## **4.2 Requirements of Air Conditioning System**

### **4.2.1 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 fiber 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.

### **4.2.2 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.

### **4.2.3 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.

#### **4.2.4 Operational Life**

The air conditioning system to be supplied shall have operational life of 10 years. These air conditioning systems shall be installed in telecom shelters on pan India basis in climatic conditions prevailing in India.

#### **4.2.5 Construction**

The air-conditioning system shall be completely self-contained, consisting of two AC units of rated capacity, their components and a common microprocessor based controller in a powder coated single cabinet. The color of the cabinet shall be finalized during detailed engineering. The system shall be assembled, wired, piped, charged with refrigerant, and fully factory tested to ensure trouble free installation and start-up. Each AC Unit shall be so placed inside the cabinet so that it could be maintained/repaired/ taken out from the cabinet without affecting the running of the other unit. The body of the cabinet shall be rust proof.

#### **4.2.6 Layout**

The layout of air-conditioning system shall be finalised during detail engineering to have a better circulation of the air inside the shelter to avoid any hot air pockets.

#### **4.2.7 Codes & Standard**

The design, manufacturing, inspection and testing of the air-conditioning system shall comply with all currently applicable statutes, regulation and safety codes in the locality, where the equipment are to be installed. The equipment shall conform to the latest edition of IS: 8148 with suitable provisions for the offered type of air-conditioning system.

#### **4.2.8 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:  $\pm 1$  °C
- Ambient Air Design Temp : 45 °C

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(entering the Condenser)

- No. of Refrigeration Circuits : Two
- Type of load Factor : High sensible heat load (SHR>0.9)

### 4.2.9 Required Features of various components

Both the compressors of twin circuit air conditioning system shall be hermetically sealed Scroll type of reputed make, very reliable, trouble free and long operating life. Both Compressors shall be installed on vibration isolated mountings or manufacturer's recommended approved mounting. Valves shall be provided for charging / topping up of refrigerant. The Bidder shall furnish the details of their compressors indicating the MTBF, life of the compressor and continuous run time of the compressors without failure. The Contractor shall also furnish details of all accessories i.e. refrigeration system, evaporator coil, condenser coil, evaporator blower, filter, cabinet, indoor supply and return grills etc during detail engineering. All compressors shall have minimum 5 years Warranty from the date of commissioning

### 4.2.10 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:	$\pm 1^{\circ}\text{C}$
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	<p>Potential Free contacts for Remote monitoring at NOC</p> <ul style="list-style-type: none"> <li>a) AC unit1 fails alarm</li> <li>b) AC unit2 fails alarm</li> <li>c) High Temp inside shelter alarm</li> <li>d) Power Fail alarm</li> <li>e) Indication for free cooling</li> </ul> <p>In addition to the above, following minimum LED Indications shall also be available in the Controller Mimic Panel for local indication;</p> <ul style="list-style-type: none"> <li>a) Alarm.</li> <li>b) Power Healthy.</li> <li>c) Blower Working.</li> <li>d) Compressor Working.</li> </ul>
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.

#### **4.2.11 Earthing**

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

#### **4.2.12 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.

#### **4.2.13 Testing**

**4.2.13.1 Type Testing**

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

**4.2.13.2 Factory Acceptance Testing**

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

**4.2.13.3 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.

**4.2.14 Installation**

The transportation of air conditioning system and its complete installation at respective sites shall be carried out by the Contractor. Entire air conditioning system cabinet containing both the cooling and condensing units (for both the units) shall be kept outside the conditioned area, shall not protrude inside the shelter. Only the supply air/ return air grill area along with microprocessor based controller display shall come into the conditioned space. The support arrangement and associated civil works required for proper installation of the air-conditioning system shall also be provided by the Contractor. The exact cut outs required in the shelters to mount the air-conditioning units shall be taken care properly before installation of the units. The cut outs in the shelters for air-conditioning system shall be properly sealed. The details of mounting and support arrangements shall be submitted for Employer's approval

**4.3 Requirements for DG Set****4.3.1 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.

**4.3.2 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.

**4.3.3 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.

#### **4.3.4 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. In addition, the horsepower rating shall take into account the generator efficiency, losses and maximum rated environmental conditions stipulated in Clause 4.3.19. 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.

#### **4.3.5 Governor**

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

#### **4.3.6 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 4.3.19. 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.

#### **4.3.7 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. The fuel tank shall be so mounted within the enclosure that it shall be possible to refill the fuel while DG is running and shall have a lockable cap to prevent unauthorised access. The fuel tank shall be provided with suitable stopcock towards the fuel supply lines to engine. The tank shall have overflow pipe, air vent pipe with air filter, drain pipe & fuel level indicator. It shall be equipped with low level fuel alarm potential free contacts for connection to the Equipment NMS system.

The engine shall be equipped with necessary fuel filters, fuel pumps, fuel lines, and fuel shut-off valves necessary to supply the diesel fuel to the engine under the environmental conditions stated in Clause 4.3.19. Braided high pressure tubes shall be used for connections to the engine, fuel tank, and where necessary to endure proper connection for engine and generator set vibrations.

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.

#### **4.3.8 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.

#### **4.3.9 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.

#### **4.3.10 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.

## **Repeater Shelter and Associated Sub-system.**

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.

#### **4.3.11 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.

#### **4.3.12 Mounting Arrangement**

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

#### **4.3.13 DG set Enclosures**

**4.3.13.1** 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. 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.



**4.3.13.2** 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.

**4.3.13.3** 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.

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

**4.3.13.5** 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.

**4.3.13.6** 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.

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

#### **4.3.14 Construction Features:**

**4.3.14.1** 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.

**4.3.14.2** 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.

**4.3.14.3** **The suitable material** of required density and thickness shall be used with fire retardant thermo – setting resin to make the Enclosure sound proof as per CPCB standards.

**4.3.14.4** 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.

#### **4.3.15 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.

#### **4.3.16 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;

##### **4.3.16.1 Start Operation**

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

#### **4.3.16.1.1 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.

#### **4.3.16.1.2 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.

#### **4.3.16.1.3 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.

#### **4.3.16.2 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.

#### **4.3.17 Remote and Local Monitoring**

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

**4.3.17.1 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)

**4.3.17.2 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.

**4.3.18 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.

**4.3.18.1 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.

**4.3.18.2 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.

**4.3.18.3 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.

**4.3.19 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.

#### 4.3.20 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.

##### 4.3.20.1 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.

#### 4.3.21 Testing of DG sets

##### 4.3.21.1 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 for Employer's approval. The type tests on Alternators shall be carried out as per Table 5.10(a) as given below.

##### 4.3.21.2 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-4.3(a)**  
**List of Tests for DG Set**

SNo.	Test	Type Test	Factory Acceptance Test	Site Acceptance Test
<b>A. ALTERNATOR</b>				
1.	Measurement of resistance	√		

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SNo.	Test	Type Test	Factory Acceptance Test	Site Acceptance Test
2.	Regulation 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				
<b>B. <u>DG Set (including Alternator)</u></b>				
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.				
1) During FAT, Load test shall be conducted on each rating of DG sets before dispatch to site as follows: <div>a) No load test for 15 minutes b) 100% Load test for 8 hrs c) 110% load test for 1 hr</div> 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---				

### 4.3.21.3 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 4.3(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

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site conditions. The detailed SAT procedure shall be submitted by the Contractor for Employer's approval.

### 4.3.22 Marking

The following information shall be provided on each DG sets:

- g. PrKTCL 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

### 4.3.23 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	<i>Nose Pliers</i>	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
<b>--End of Table--</b>			

## 4.4 Requirements for Power Interface Unit (PIU)

### 4.4.1 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.

#### **4.4.2 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

#### **4.4.3 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 stabilizer 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.

#### **4.4.4 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):**

<b>Between</b>	<b>Requirement</b>
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)**



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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.

### 4.4.5 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 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 $\Phi$ , 4 wire	3 $\Phi$ , 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 $\mu\text{sec}$	400 V in 1 $\mu\text{sec}$
5	Efficiency (excluding IT)	> 96%	> 96%
6	Frequency	48 – 52 Hz	48 – 52 Hz

### 4.4.6 Automatic Mains Failure (AMF) Panel

The PIU unit shall support the microprocessor based AMF panel for DG set. 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 4.3.16.1.1 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 4.3.10 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.

#### **4.4.7 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
- xv) Other Common DG Faults

It must support a RS 232 port for PC interface for programming / reconfiguration of the parameters through laptop.

#### **4.4.8 AC Distribution Panel**

There shall be AC distribution panel for termination of the load. The SMPS, Air conditioners etc. shall be connected to this AC distribution panel through suitable MCBs. The ratings of the MCBs shall be selected to provide safe and continuous operation of the DCPS system, Air conditioning system etc being supplied under this contract. The Contractor shall submit the details of MCB ratings for Employer's approval.

The AC mains and DG set shall be connected to PIU unit through MCCBs of suitable ratings.

#### **4.4.9 PIU with Dual DG logic**

At few of the remote Telecom locations, two DG sets may be required. For those locations, PIU capable of controlling two DGs shall be supplied. In case of power failure, command shall always go to that DG which was in standby mode during previous cycle of Power failure. For the sites operated purely on DG supply, the logic shall be to run the DG Set for a prefixed time within the range of 0 to 10 hrs. After every set time of DG run the load of the Repeater Shelters need to be shifted to battery bank. DC load need to be fed through battery till time either shelter temperature exceeds the set threshold or battery bank voltage falls below the set threshold. In case of crossing of any of these thresholds, the PIU to give DG start command to second DG set. DG sets supplied under earlier packages having capacity 15kVA or below may also be available at sites.

#### **4.4.10 Constructional Features of Rack**

Only a single cabinet shall accommodate all the systems that include phase selector, surge protection devices, static voltage stabilizer, AMF panel and PIU controller, digital displays and meters, wires and cables, associated sub systems etc. The dimensions of the rack shall be such that it shall occupy minimum space inside the shelter.

The enclosure (rack) shall be freestanding type of design and shall have sufficient structural strength to withstand the ultimate mechanical load capacity without any deformity. Cable entry shall be from the bottom/top of the enclosures. The design of the rack (enclosure) shall be modular allowing easy maintenance and installation such that replacement or taking out of one subsystem for repair or maintenance shall not require dismantling of whole system. The rack shall be free of sharp edges or sharp corners. Rack mounting arrangement shall provide easy access from front, rear and top for installation and maintenance.

Where cables pass through metal panels suitable arrangement including bushings shall be provided to protect cables from damage. Bus-bars shall be suitably spaced and insulated to prevent any possibility of short circuit between bus-bar and/ or rack.

With doors in position, all visual alarms and meters shall be clearly visible. In case of hinged doors, meters and alarm indicators are permitted on the door provided the fixtures on the door do not restrict the movement of door in any way.

##### **4.4.10.1 Components**

The component parts of the equipment shall be of professional grade from reputed manufacturer to ensure continuous and safe operation of the equipment including its sub systems. The component shall conform to relevant IEC/IS standards and Complete PIU unit shall ensure compliance to safety as per IEC-60950 or any other international standard.

##### **4.4.10.2 Finish and Painting**

The finish of Steel/Aluminium structure and panels shall conform to relevant IS specification (or equivalent international specifications). The colour scheme for Rack, Door and Modules shall be decided during detailed engineering.

##### **4.4.10.3 Earthing**

The PIU unit including its subsystems shall be properly earthed by connecting it to the earthing

system being provided by the Contractor under this Package.

#### **4.4.11 MTBF**

The mean time between the faults of the PIU and its subsystems shall be more than 70,000 hrs.

#### **4.4.12 Installation**

The transportation of PIU unit and its complete installation at respective sites shall be carried out by the Contractor. All type of cables or associated accessories shall be supplied and installed by the Contractor. Connection to SEB supplied AC mains and ACDB etc shall also be carried out by the Contractor

#### **4.4.13 Testing**

##### **4.4.13.1 Type Testing**

PIU shall conform to EMI/EMC requirements as per IEC-870-2-1 standards. It shall also conform the Environmental requirements as per the TEC Standard for Environmental testing i.e. SD: QM-333 Mar 2010 (with amendments, if any) in category B2.

Electrical and mechanical safety and Performance test shall also be carried out on PIU as per specification. The Contractor can also submit the earlier carried out type test reports on the offered system for above tests.

##### **4.4.13.2 Factory Acceptance Testing**

The Contractor shall submit the detailed format of factory acceptance testing plan for PIU unit incorporating various tests for testing of all its systems and sub systems and get it approved from the Employer. The FAT shall be conducted on the offered PIU units as per approved FAT tests and procedure.

##### **4.4.13.3 Site Acceptance Test**

After successful installation, the site acceptance testing for PIU unit including its subsystems shall be carried out by the Contractor for each site demonstrating all its functions properly. The detailed SAT procedure shall be submitted by the Contractor for Employer's approval.