ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

OPGW CABLING IN TR LINE

OPGW CABLING AND ASSOCIATED HARDWARE & FITTINGS

This section describes the functional & technical specifications of OPGW cabling and associated hardware & fittings.

1.0 Fibre Optic Cabling

This section defines the requirements for G.652D Dual-window Single mode (DWSM) telecommunications grade fibre optic cable. Bidders shall furnish with their bids, detailed descriptions of the fibres & cable(s) proposed.

All optical fibre cabling including fibre itself and all associated installation hardware shall have a minimum guaranteed design life span of 25 years. Documentary evidence in support of guaranteed life span of cable & fibre shall be submitted by the Contractor during detailed engineering.

1.1 Physical Characteristics

Dual-Window Single mode (DWSM), G.652D optical fibres shall be provided in the fibre optic cables. DWSM optical fibres shall meet the requirements defined in Table 1.

Table –1

DWSM Optical Fibre Characteristics

Fibre Description:	Dual-Window Single-Mode
Mode Field Diameter:	8.6 to 9.5 μm (± 0.6μm)
Cladding Diameter:	125.0 μm ± 1 μm
Mode field concentricity error	≤ 0.6μm
Cladding non-circularity	≤ 1%
Cable Cut-off Wavelength λ_{cc}	≤ 1260 nm
1550 nm loss performance	As per G.652 D
Proof Test Level	≥ 0.69 Gpa
Attenuation Coefficient:	@ 1310 nm ≤ 0.35 dB/km @ 1550 nm ≤ 0.21 dB/km
Chromatic Dispersion; Maximum: **Zero Dispersion Wavelength:** **Zero Dispersion Slope:**	18 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) 1288-1339nm 5.3 ps/(nm x km) 1271-1360nm 1300 to 1324nm 0.092 ps/(nm^2xkm) maximum
Polarization mode dispersion coefficient	≤ 0.2 ps/km^½
Temperature Dependence:	Induced attenuation ≤ 0.05 dB (-60°C - +85°C)
Bend Performance:	@ 1310 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (30±1 mm radius Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (32±0.5 mm dia Mandrel, 1 turn; Attenuation Rise ≤ 0.50 dB

2.0 Fibre Optic Cable Construction

Overhead Fibre Optic Cables shall be 24 core OPGW (Optical Ground Wire). The OPGW cable is proposed to be installed on the transmission line 400kV IBTPS -Meramandali of Orissa Power Transmission Corporation Ltd. (OPTCL). The design of cable shall account for the varying operating and environmental conditions that the cable shall experience while in service. The exact transmission line details shall be collected by the Contractor during survey.

2.1 Optical Fibre Cable Link Lengths

The Contractor shall supply & install the optical fibre cable as required based on detailed site survey to be carried out by the Contractor during the project execution. The Contractor shall verify the transmission line route length during the survey and the Contract price shall be adjusted accordingly.

For the purpose of payment, the optical fibre link lengths are defined as transmission line route lengths from Gantry at one terminating station to the Gantry in the other terminating station. The actual cable lengths to be delivered shall take into account various factors such as sag, service loops, splicing, working lengths & wastage etc. and no additional payment shall be payable in this regard. The unit rate for FO cable quoted in the Bid price Schedules shall take into account all such factors.

Loose tube construction shall be implemented. The individually coated optical fibre(s) shall be surrounded by a buffer for protection from physical damage during fabrication, installation and operation of the cable. The fibre coating and buffer shall be strippable for splicing and termination. Each fibre unit shall be individually identifiable utilizing colour coding. Buffer tubes shall be filled with a water-blocking gel.

2.2 Optical Ground Wire (OPGW)

OPGW cable construction shall comply with IEEE-1138, 2009. The cable provided shall meet both the construction and performance requirements such that the ground wire function, the optical fibre integrity and optical transmission characteristics are suitable for the intended purpose. The cable shall consist of optical fibre units as defined in this specification. There shall be no factory splices within the cable structure of a continuous cable length.

The composite fibre optic overhead ground wire shall be made up of multiple buffer tubes embedded in a water tight aluminium/aluminium alloy/stainless steel with aluminium coating protective central fibre optic unit surrounded by concentric-lay stranded metallic wires in single or multiple layers. Each buffer tube shall have maximum 12 no. of fibres. All fibres in single buffer tube or directly in central fibre optic unit is not acceptable. The dual purpose of the composite cable is to provide the electrical and physical characteristics of conventional overhead ground wire while providing the optical transmission properties of optical fibre.

2.2 Central Fibre Optic Unit

The central fibre optic unit shall be designed to house and protect multiple buffered optical fibre units from damage due to forces such as crushing, bending, twisting, tensile stress and moisture. The central fibre optic unit and the outer stranded metallic conductors shall serve together as an integral unit to protect the optical fibres from degradation due to vibration and galloping, wind and ice loadings, wide temperature variations, lightning and fault current, as well as environmental effects which may produce hydrogen.

The OPGW design of dissimilar materials such as stainless steel tube with aluminium or aluminium –clad-steel wire strands are not allowed. Central fibre optic unit may be of aluminium or stainless steel tube with aluminium protective coating. In case of aluminium protective coating, the coating must completely cover the tubes leaving no exposed areas of tubing that can make electrical contact either directly or indirectly through moisture, contamination, protrusions, etc with the surrounding stranded wires. The tube may be fabricated as a seamless tube, seam welded, or a tube without a welded seam.

2.3 Basic Construction

The cable construction shall conform to the applicable requirements of this specification, applicable clauses of IEC 61089 related to stranded conductors and Table 2.2(a) OPGW Mechanical and Electrical Characteristics. In addition, the basic construction shall include bare concentric-lay-stranded metallic wires with the outer layer having left hand lay. The wires may be of multiple layers with a combination of various metallic wires within each layer. The direction of lay for each successive layer shall be reversed. The finished wires shall contain no joints or splices unless otherwise agreed to by the Employer and shall conform to all applicable clauses of IEC 61089 as they pertain to stranded conductors.
The wires shall be so stranded that when the complete OPGW is cut, the individual wires can be readily regrouped and then held in place by one hand.

2.4 Breaking Strength

The rated breaking strength of the completed OPGW shall be taken as no more than 90 percent of the sum of the rated breaking strengths of the individual wires, calculated from their nominal diameter and the specified minimum tensile strength.

The rated breaking strength shall not include the strength of the optical unit. The fibre optic unit shall not be considered a load bearing tension member when determining the total rated breaking strength of the composite conductor.

2.5 Installation

OPGW installed under live line condition, i.e. with all circuits charged to the rated line voltage as specified in this section shall be generally in accordance with the IEEE Guide to the Installation of Overhead Transmission Line Conductors (IEEE STD. 524 with latest revisions), with additional instructions and precautions for live line working and fibre optic cable handling. Some of the cable may be installed in off-line condition also. The stringing procedure shall be submitted by the Contractor prior to stringing for Employer's approval.

A tower structural analysis shall be carried out by the Contractor, based on the relevant data to be provided by Employer, to ensure that with the replacement of existing earth wire with the OPGW cable, the tower members remain within the statutory safety limits as per Indian Electricity rules and if required the Contractor shall carry out the tower strengthening as necessary. The OPGW cable sections shall normally be terminated & spliced only on tension towers. In exceptional circumstances, and on Employer specific approval, cable may be terminated on Suspension towers, but in this case tower strength shall be examined to ensure that tower loads are within safe limits and if required, necessary tower strengthening shall be carried out by the Contractor.

2.6 Installation Hardware

The scope of supply of the optical cable includes the assessment, supply and installation of all required fittings and hardware such as Tension assembly, Suspension assembly, Vibration dampers, Reinforcing rods, Earthing clamps, Down lead clamps, splice enclosure etc. The Bidder shall provide documentation justifying the adequacy and suitability of the hardware supplied. The quantity of hardware & fittings to meet any eventuality during site installation min@ 1% shall also be provided as part of set/km for each transmission line without any additional cost to POWERGRID. The Contractor shall determine the exact requirements of all accessories required to install and secure the OPGW.

The OPGW hardware fittings and accessories shall follow the general requirements regarding design, materials, dimensions & tolerances, protection against corrosion and markings as specified in clause 4.0 of EN 61284: 1997 (IEC 61284). The shear strength of all bolts shall be at least 1.5 times the maximum installation torque. The OPGW hardware & accessories drawing & Data Requirement Sheets (DRS) document shall consist of three parts: (1) A technical particulars sheet (2) An assembly drawing i.e. level 1 drawing and (3) Component level drawings i.e. level 2 & lower drawings. All component reference numbers, dimensions and tolerances, bolt tightening torques & shear strength and ratings such as UTS, slip strength etc shall be marked on the drawings.

The fittings and accessories described herein are indicative of installation hardware typically used for OPGW installations and shall not necessarily be limited to the following:

(a) Suspension Assemblies: Preformed armour grip suspension clamps and aluminium alloy armour rods/ reinforcing rods shall be used. The suspension clamps shall be designed to carry a vertical load of not less than 25 KN. The suspension clamps slippage shall occur between 12kN and 17 kN as measured in accordance with type test procedures specified in Appendix, Vol. II.

The Contractor shall supply all the components of the suspension assembly including shackles, bolts, nuts, washers, split pins, etc. The total drop of the suspension assembly shall not exceed 150 mm (measured from the centre point of attachment to the centre point of the OPGW). The design of the assembly shall be such that the direction of run of the OPGW shall be the same as that of the conductor.

(b) Dead End Clamp Assemblies: All dead end clamp assemblies shall preferably be of performed armoured grip type and shall include all necessary hardware for attaching the assembly to the tower strain plates. Dead end clamps shall allow the OPGW to pass through continuously without cable cutting. The slip strength shall be rated not less than 95% of the rated tensile strength of the OPGW.

(c) Clamp Assembly Earthing Wire: Earthing wire consisting of a 1500 mm length of aluminium or aluminium alloy conductor equivalent in size to the OPGW shall be used to earth suspension and dead end clamp assemblies to the tower structure. The earthing wire shall be permanently fitted with lugs at each end. The lugs shall be attached to the clamp assembly at one end and the tower structure at the other.

(d) Structure Attachment Clamp Assemblies: Clamp assemblies used to attach the OPGW to the structures, shall have two parallel grooves for the OPGW, one on either side of the connecting bolt. The clamps shall be such that clamping characteristics do not alter adversely when only one OPGW is installed. The tower attachment plates shall locate the OPGW on the inside of the tower and shall be attached directly to the tower legs/cross-members without drilling or any other structural modifications.

(e) Vibration Dampers: Vibration dampers type 4R Stockbridge or equivalent, having four (4) different frequencies spread within the Aeolian frequency bandwidth corresponding to wind speed of 1m/s to 7 m/s, shall be used for suspension and tension points in each span. The Contractor shall determine the exact numbers and placement(s) of vibration dampers through a detailed vibration analysis as specified in technical specifications.

One damper minimum on each side per OPGW cable for suspension points and two dampers minimum on each side per OPGW cable for tension points shall be used for nominal design span of 400 meters. For all other ruling spans, the number of vibration damper shall be based on vibration analysis.

The clamp of the vibration damper shall be made of high strength aluminum alloy of type LM-6. It shall be capable of supporting the damper and prevent damage or chaffing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the OPGW cable without damaging the strands or causing premature fatigue failure of the OPGW cable under the clamp. The clamp groove shall be in uniform contact with the OPGW cable over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or other materials which could cause damage to the OPGW cable when the clamp is installed. Clamping bolts shall be provided with self locking nuts and designed to prevent corrosion of threads or loosening in service.

The messenger cable shall be made of high strength galvanised steel/stain less steel. It shall be of preformed and post formed quality in order to prevent subsequent droop of weight and to maintain consistent flexural stiffness of the cable in service. The messenger cable other than stainless steel shall be hot dip galvanised in accordance with the recommendations of IS:4826 for heavily coated wires.

The damper mass shall be made of hot dip galvanised mild steel/cast iron or a permanent mould cast zinc alloy. All castings shall be free

from defects such as cracks, shrinkage, inclusions and blow holes etc. The surface of the damper masses shall be smooth.

The damper clamp shall be casted over the messenger cable and offer sufficient and permanent grip on it. The messenger cable shall not slip out of the grip at a load less than the mass pull-off value of the damper. The damper masses made of material other-than zinc alloy shall be fixed to the messenger cable in a suitable manner in order to avoid excessive stress concentration on the messenger cables which shall cause premature fatigue failure of the same. The messenger cable ends shall be suitably and effectively sealed to prevent corrosion. The damper mass made of zinc alloy shall be casted over the messenger cable and have sufficient and permanent grip on the messenger cable under all service conditions.

The contractor must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 kN and 5 kN. The clamp when installed on the OPGW cable shall not cause excessive stress concentration on the OPGW cable leading to permanent deformation of the OPGW strands and premature fatigue failure in operation.

The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed in Technical Specification, shall have to be submitted. The technical particulars for vibration analysis and damping design of the system are as follows:

Sl No.	Description	TechnicalParticulars
1	Span Length in meters (i) Ruling design span : (ii) Maximum span : (iii) Minimum Span :	 400 meters 1100 meters 100 meters
2	Configuration :	As per Specifications
3	Tensile load in each :	As per sag tension calculations
4	Armour rods used :	Standard preformed armour rods/AGS

5	Maximum permissible dynamic strain :	+/- 150 micro strains

The damper placement chart for spans ranging from 100m to 1100m shall be submitted by the Bidder. Placement charts should be duly supported with relevant technical documents and sample calculations.

The damper placement charts shall include the following

(1) Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per OPGW cable per span.

(2) Placement distances clearly identifying the extremities between which the distances are to be measured.

(3) Placement recommendation depending upon type of suspension clamps (viz Free center type/Armour grip type etc.)

(4) The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers

3.0 Fibre Optic Splice Enclosures (Joint Box

All splices shall be encased in Fibre Optic Splice Enclosures. Suitable splice enclosures shall be provided to encase the optical cable splices in protective, moisture and dust free environment. Splice enclosures shall comply to ingress protection class IP 66 or better. The splice enclosures shall be designed for the storage and protection of required number of optical fibre splices and equipped with sufficient number of splice trays for splicing all fibres in the cable. No more than 12 fibres shall be terminated in a single splice tray. They shall be filled with suitable encapsulate that is easily removable should re-entry be required into the enclosures.

Splice enclosures shall be suitable for outdoor use with each of the cable types provided under this contract. Splice enclosures shall be appropriate for mounting on transmission line towers above anti-climb guard levels at about 10 metres from top of the tower and shall accommodate pass-through splicing. The actual mounting height and location shall be finalised after Survey. Contractor shall be responsible for splicing of fibres and installation of splice enclosures.

3.1 Optical Fibre Splices

Splicing of the optical fibre cabling shall be minimized through careful Contractor planning. There shall be no mid-span splices allowed. All required splices shall be planned to occur on tower structures. All optical fibre splicing shall comply with the following:

(f) All fibre splices shall be accomplished through fusion splicing.

(g) Each fibre splice shall be fitted with a splice protection sheath fitted over the final splice.

(h) All splices and bare fibre shall be neatly installed in covered splice trays.

(i) For each link, bi-directional attenuation of single mode fusion splices, shall not average more than 0.05 dB and no single splice loss shall exceed 0.1 dB when measured at 1550 nm.

(j) For splicing, fibre optic cable service loops of adequate length shall be provided so that all splices occurring at tower structures can be performed at ground level.

4.0 Fibre Optic Approach Cables

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.

4.1 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.

4.2 Jacket Construction & Material

The Approach Cable shall be a UV resistant, rodent proof, armoured cable with metallic type of armouring. The outer cable jacket for approach cable shall consist of carbon black polyethylene resin to prevent damage from exposure to ultra-violet light, weathering and high levels of pollution. The jacket shall conform to ASTM D1248 for density.

4.3 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.

4.4 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. However, the approach cable shall be laid in the HDPE pipe in all condition.

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.

5.0 Optical Fibre Termination and Splicing

Optical fibre terminations shall be installed 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.

5.1 Fibre Optic Distribution Panel

At each location requiring the termination of at least one fibre 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:

(k) 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.

(l) 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.

(m) FODPs for indoor use shall be supplied in suitable cabinets/racks with locking arrangement

(d) All FODPs 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 to other equipment.

5.2 Optical Fibre Connectors

Optical fibres shall be connected with FC-PC type connectors preferably. Alternatively connector with matching patch cord shall also be acceptable. Fibre optic couplings supplied with FODPs shall be appropriate for the fibre connectors to be supported. There shall be no adapters.

6.0 Service Loops

For purposes of this specification, cable and fibre service loops are defined as slack (extra) cable and fibre provided for facilitating the installation, maintenance and repair of the optical fibre cable plant.

(a) Outdoor Cable Service Loops: In-line splice enclosures installed outdoors and mounted on the utility towers, shall be installed with sufficient fibre optic cable service loops such that the recommended minimum bend radius is maintained while allowing for installation or maintenance of the cable to be performed in a controlled environment at ground level.

(b) Indoor Cable Service Loops: FODPs shall provide at least three (3) metres of cable service loop. Service loops shall be neatly secured and stored, coiled such that the minimum recommended bend radius' are maintained.

(c) Fibre Units Service Loops: For all fibre optic cable splicing, the cable shall be stripped back a sufficient length such that the fan-out of fibre units shall provide for at least one (1) metre of fibre unit service loop between the stripped cable and the bare fibre fan-out.

(d) Pigtail Service Loops : Connectorised pigtails spliced to bare fibres shall provide at least 1 metre of service loop installed in the FODP fibre organizer and at least one (1) metre of service loop to the couplings neatly stored behind the FODP coupling panels.

(e) Fibre Service Loops : At least 0.5 metre of bare fibre service loop shall be provided on each side of all fibre splices. The bare fibre service loops shall be neatly and safely installed inside covered splice trays.

7.0 Methodology for Installation and Termination

All optical fibre cable termination, installation, stringing and handling plans, guides and procedures, and engineering analysis (e.g. tension, sag, vibration etc.) shall be submitted to the Employer for review and approval in the engineering/design phase of the project, prior to establishing the final cable lengths for manufacture. Installation procedures including details of personnel and time required shall be documented in detail and submitted to Employer for approval. All installation practices shall be field proven and ISO accredited.

All cable segments shall include service loops as specified in this specifciation .The maximum allowable stringing tension, maximum allowable torsional shear stress, crush strength and other physical parameters of the cable shall not be exceeded. The preventative measures to be taken shall be documented in detail and submitted to Employer in advance of installation.

Optical fibre attenuation shall be measured after installation and before splicing. Any increase in attenuation or step discontinuity in attenuation shall not be acceptable and shall constitute a cable segment failure. In the event of cable damage or any fibre damage, the complete section (tension location to tension location) shall be replaced as mid-span joints are not acceptable.

Any or all additional steel work or modifications required to attach the fibre cabling to the overhead transmission/ distribution line towers shall also be carried out by the Contractor. It shall be the Contractors responsibility to provide

adequate communications among all crew members and support staff to ensure safe and successful installations.

Section 2

Network Configuration and Equipment Characteristics

1.0 Introduction

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

(1) Fibre Optic Transmission System (FOTS)
(2) Termination Equipment Subsystems
(3) Network Management System (NMS)
(4) MDF, DDF and Cabling

The requirements described herein are applicable to and in support of network configurations depicted in Appendix and Network Management System (NMS) for monitoring and control of this communication network. TMN and NMS have been interchangeably used in this specification.

1.1 General Network Characteristics

1.2 Description

The proposed fibre optic communication network shall support the voice & data communication requirements of RTUs and the SCADA/EMS system. The communication system shall provide data & voice connectivity across the various locations or connectivity of RTUs with Control Centres. The RTUs located at various locations will report to Control Center using IEC 60870-5-101 or IEC 60870-5-104 Protocol. The proposed communication system shall provide connectivity of some RTUs over TCP/IP protocol using Ethernet interface and other RTUs over serial interface.

The fibre optic network shall be based on the lowest bit rate of the Synchronous Digital Hierarchy (SDH) i.e. STM-1. However, the offered equipment can be upgraded to STM-4 by changing the optical card only.

The Contractor can propose a system based on higher bit rate systems, if required, so as to meet the link budget requirements or any other specification requirement. The detailed BOQ is described in appendices.

2.0 Functional Requirement

The primary function of the communication network is to provide a highly reliable voice and data communication system in support of the SCADA/EMS. The communications support requirement for SCADA/EMS system is for low & high speed data, express voice circuits and administrative voice circuits as defined in appendices. A brief summary of the communication system requirements is as follows:

(a) High speed E1 channel support

(b) 64kbps & nx64kbps data channel support

(c) Low speed (300 -1200 bps) data channel support

(d) Voice (2 wires, 4 wires) channel support.

(e) Data transport supporting Network Management channels
(f) Interface support for teleprotection

(g) The connectivity envisaged between RTUs and Control Centre is Wide Area Network (WAN) on TCP-IP using IEC 60870-5-104 protocol and IEC 60870-5-101 protocol.

2.1 General Systems Requirements

Required characteristics are defined and specified herein at the system level, subsystem level, and equipment level.

2.2 System Synchronization

The Contractor shall synchonize all the equipments under the contract using GPS based clock. In addition to GPS input reference, the synchronization clock must have provision to take INPUT reference coming from other clock. The contractor shall submit the synchronisation plan as per standard ITU-T G.811. All sync equipments proposed under

this contract should meet ITU-T G.811 criterion. The holdover quality of clock shall meet ITU-T G.812 standard requirements.

The Contractor shall provide system wide synchronization fully distributed throughout the telecom network and connected to all equipments. The Contractor shall submit the synchronization plan for the entire network meeting the requirement of ITU-T G.803.

The system equipment requiring “clock” shall be connected to the master clock using external clocking. For this purpose, appropriate interfaces(s) in the transmission & termination equipment being supplied and all other associated hardware shall be provided by the Contractor.

2.3 System Maintainability

To facilitate performance trending, efficient diagnosis and corrective resolution, the system shall permit in-service diagnostic testing to be executed both locally and from remote locations, manually and/or initiated under TMN control. Such testing shall not affect the functional operation of the system.

Preventive and problem oriented maintenance of the communications system shall be performed using diagnostics tools such as TMN and test equipment. They shall support complete maintenance of all system elements and shall permit the diagnosis of any fault without requiring additional test equipment. The Contractor shall provide specialized training required to operate above mentioned diagnostic tools. For all redundant systems, disconnection and repair of any failed device shall not interrupt the operation of the system.

2.4 System Upgradeability and Expandability

Equipment supplied shall be sized (though not necessarily equipped) to support system/ subsystem expansion to full capacity as provided by specified aggregate transmission rates. Equipment units provisioned for equipped subunits shall be terminated at appropriate patching facilities or termination blocks. Power supplies and TMN shall be sized for maximum equipped system capacity.

3.0 Equipment Availability

The availability requirements are as follows, which shall be demonstrated at site for the equipments being provided under this contract:

(1) The availability of each fibre optic link (E1 to E1) shall be at least

99.999%.

(2) The availability of network end to end (E1 to E1) shall be at least 99.998%.

(3) The average per link subscriber to subscriber availability shall be at least 99.97%. The per link subscriber to subscriber availability is defined as the availability between any two data or voice subscribers between RTU to reporting Control Centre.

(4) The network-wide subscriber to subscriber availability shall be at least 99.8% .The network-wide subscriber to subscriber availability is defined as the availability between any two data or voice subscribers on the wideband network.

The calculated availability is defined as the theoretical availability determined by a statistical calculation based on the mean-time-between-failure (MTBF) and the mean-time-to-repair (MTTR) of the components and subsystems comprising the FOTS. The down time of the fibre optic cable shall not be considered in the aforesaid availability calculations.

In order to ensure that the equipment & configuration proposed by the bidders shall be capable of demonstrating the specified availability figures it is required that the Bidders shall include in their proposal a calculated availability analysis for the proposed equipment/ sub system. The calculated failure rates of the units and the calculated availabilities of the equipment being offered shall be provided in the proposal. The analysis shall be based on an availability block diagram and shall include the mean-time-between failure (MTBF) and mean-time-to-repair (MTTR) of all of the components on the link. The Contractor shall indicate in the analysis the MTBF and MTTR and the resulting availability of each point-to-point link. For this analysis, an MTTR of at least 4 hours shall be assumed.

3.1 General Equipment Characteristics

All Contractor supplied equipment shall be new and of the finest production quality. The Employer will not accept modules or printed-circuit boards that are modified by appending wires or components. Wired strapping options shall be incorporated in the board design to meet the above requirement.

All applicable requirements stated in this section shall equally apply to the TMN equipment as specified in this Section.

3.2 Revision Levels and Modifications

All hardware, firmware and software delivered as part of the communications network shall be field proven and at the most of current revision level. All modifications and changes necessary to meet this requirement shall be completed prior to the start of the factory tests or

under special circumstances, on written approval by Employer, prior to the completion of SAT.

All field modifications of the hardware, firmware and software that is required to meet installation and/or performance specifications, shall be fully documented as part of the deliverables, both as a separate field modifications record and as corrected equipment/configuration documentation.

3.3 Equipment Capacities

Equipment supplied shall be sized and equipped with sufficient capacity to support BOQ and configuration requirements as identified in the BOQ.. Each subsystem supplied shall be sized (to be equipped as specified) to support full subsystem expansion.

Data communications channelization required to support the TMN subsystems specified in Technical Specifications (TS) are not identified in the appendices. Therefore, the Contractor is required to size and equip the system to include all channelization and channel cards required to support the TMN function.

3.4 Redundancy Requirements and Protection Schemes

Equipment redundancy and Automatic Protection Schemes (APS) are specified in the Table 3-1. The failure of one element shall not prevent the use of any other that has not failed.

Table 3-1
Equipment Redundancy Requirements Summary

Fiber Optic transmission Equipment :	
SDH equipment	
Power Supply & Converters ----------	1:1 APS or distributed power supply
Common Control* Cards ----------	1:1 APS
DACS (Cross Connect)	1:1 APS or distributed power supply
Power Supply ----------	1:1 APS
Common control* cards----------	1:1 APS or distributed power supply
MUX, DROP/INSERT	
Power Supply ----------	
*** = Common control cards which are essentially required for operation of the equipment.**	

The offered equipment shall support at least SNCP **as per standard ITU-T G.841**. In case the equipment offered by the Bidder does not support the above mentioned minimum protection methods, the bidder shall have to provide all additional equipment needed to provide same level of flexibility, redundancy and functionality at no additional cost to Employer. The bidders shall provide details of protection schemes supported in the Bid document.

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.

4.0 Lost Signal Recovery

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.

4.1 Equipment Lifespan

All equipment supplied shall have expected life of fifteen (15) years.

4.2 Fibre Optic Link Lengths

The fiber optic route lengths are as specified in appendices. The lengths specified in appendices are the transmission line route lengths; however the actual fiber cable length shall exceed the route lengths on account of extra cable requirement due to sag, jointing & splicing, approach cabling etc. For bidding purposes the Contractor may assume an additional cable length of 5% of given route length **+** 1Km towards approach cable for calculating the link length. The exact cable lengths shall be determined by the Contractor during the survey. The same shall be used by the Contractor for final link design during the detailed engineering of the project. In case of change in the specified BOQ, the contract price shall be adjusted accordingly.

5.0 Fibre Optic Transmission System

The Fibre Optic Transmission System (FOTS) is defined herein to include ETSI digital optical line termination equipment. The FOTS shall be based on SDH technology. Minimum aggregate bit rate shall be STM-1 and equipped with 2 nos. of minimum 16 port E1 interface(G.703) card & one no. of minimum 4 port Ethernet interface (IEEE 802.3/IEEE 802.3u) card supporting layer 2 switching as tributaries. The Ethernet interfaces shall support VLAN (IEEE 802.1P/Q), spanning tree (IEEE 802.1D) quality of service.

The Contractor shall provide (supply and install) connectorised jumpers (patch cords) for FODP-to-equipment and equipment-to-equipment connection. Two number spare jumpers shall be provided for each equipment connection. Fiber jumpers shall be of sufficient lengths as to provide at least 0.5m of service loop when connected for their intended purpose.

SDH Equipment

5.1 Functional Requirement

The BOQ is provided in the appendices. For the purpose of BOQ, the SDH Equipment is considered to be divided in three parts i.e. Optical cards (Line), Tributary Cards (Electrical tributaries such as E1 & Ethernet 10/100 Mbps) and Base Equipment (Consisting of Common Cards, Power supply cards, sub-rack, cabinet, other hardware and accessories required for installation of equipment i.e. everything besides optical cards and tributary cards).

The offered SDH equipment shall be upgradeable to STM-4 by changing optical line cards
only. Cross connection (VC4) capability of offered SDH equipment shall be provided according to STM-4 equipment. The contractor shall demonstrate the STM-4 upgradeability during FAT.

SDH ADM

The aggregate interfaces shall be (at least) STM-1 (155 Mbit/s) towards at least two directions (Protected as specified in this specifications). At present the equipment shall be equipped with a 2 nos., min.16 E-1 port electrical tributary cards & one no., min.4 port Ethernet interface card as tributaries. The Equipment shall provide access to full STM1 payload.

5.2 Redundancy and Protection

Two fibre rings shall be implemented wherever the network permits. On linear sections of the network, protected links using 4 fibres shall be implemented.

5.3 Service Channel

Service channels shall be provided as a function of the SDH equipment and shall be equipped with Service Channel Modems that shall provide at a minimum: One voice channel (order wire) with analog interface (0.3 to 3.4 kHz) and one data channel. Both omnibus and selective calling facilities shall be provided. There shall be a facility to extend the line system order-wire to any other system or exchange lines on 2W/4W basis.

5.4 Supervision and Alarms

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. Additionally, F2/Q2 interfaces for a local craftsperson terminal interface and remote equipment monitoring is required.

The Equipment shall support collection of at least four (4) external alarms for monitoring and control of station associated devices by the TMN.

5.5 Synchronisation

The equipment shall provide synchronisation as per Table 3-2. One 2MHz synchronisation output from each equipment shall be provided.

5.6 Electrical and Optical I/O Characteristics and General Parameters

Table 3-2 provides the electrical and optical characteristics as well as other general parameters for SDH equipment.

Table 3-2
Electrical and Optical I/O Characteristics and General Parameters

Optical Wavelength NOTE (1)	1310/1550nm
Optical Source NOTE (2)	Laser
Optical Source Lifespan	Better than 5 $X10^5$ hours
Optical Fibre Type	G.652 D
Optical Connectors	Type FC-PC
Transmission Quality	Per ITU-T G.821, G.823, G.826
Source Primary Power	-48 Vdc
Equipment Specifications	Per ITU-T G.783
Tributary, Electrical Interface	Per ITU-T G.703, 75 Ω
Ethernet Interface	10/100 Mbps
SDH Bit Rates	Per ITU-T G.703
Optical Interfaces	Per ITU-T G.957, G.958
Frame and Multiplexing Structure for SDH	Per ITU-T G.707
Synchronization	Per ITU-T G.813

Table 3-2
Electrical and Optical I/O Characteristics and General Parameters

Management Functions	Per ITU-T G.774, G.784
Protection Architectures	Per ITU-T G.841
Built In Testing and Alarms	Per ITU-T G.774, G.783, G.784

NOTE (1) Optical wavelength shall be selected considering the characteristics of the optical fibre and the link budget.

NOTE (2) **Eye Safety for Laser Equipment:** To avoid eye damage, when a receiver detects a line interruption, it is required that the optical power of the laser shall be reduced to safe limits on the transmitter in the opposite direction as per ITU-T G.958.

NOTE (3) 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.

5.7 Optical Link Performance Requirements

The optical fibre link performance requirements are specified as follows:

5.8 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 category of fibre optic link in the Bid.

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.

5.9 Link Performance

The Link performance for ES, SES and BER for the fibre optic links shall correspond to National Network as defined in ITU-T G.826.

5.10 FODP to SDH Equipment

The Contractor shall be responsible for connectivity between the FODP and the SDH equipment. The Contractor shall provide FC PC coupled patch cords. The location of FODP shall be finalized during detailed engineering.

The patch-cord length between the FODP & equipment rack shall be suitably protected from rodents, abrasion, crush or mechanical damage.

6.0Termination Equipment Subsystem

The Termination Equipment Subsystem is defined to include the equipment that interfaces (adapts) the subscriber (user) to the Fibre Optic Transmission System (FOTS). A Functional description of these equipments are as follows:

6.1 Functional Description

The transmission network node provides subscriber interface to the transmission network and/or switching/routing. For clarity, the basic functions accomplished at the network nodal points, are described briefly as follows:

Primary Multiplexer shall be used to accomplish subscriber connectivity to the Digital Communication Network. Subscriber Line Units shall provide analog to digital and direct digital conversion to 64 Kbps digital channel. In the CEPT standard hierarchy, thirty (30) such 64 Kbps digital channels shall be Time Division Multiplexed (TDM) resulting in a single 2.048 Mbps (E-1) digital bit stream.

Digital Drop-Insert and Branching Equipment shall be used to digitally interface a small number of channels at spur locations without requiring successive D/A and A/D conversions of the throughput channels.

Digital Cross connect Equipment (DACS) shall be used to provide software controlled dynamic routing/rerouting of the primary (E-1) bit stream as well as the 30 channels of the E1 bit stream.

The equipment shall also have an interface for external 2048 kHz synchronisation signal according to ITU-T Recommendation G.703.

6.2 First Order (Primary) Multiplexing

The Contractor shall be required to provide E-1 Drop & Insert Multiplexer and E-1 Channel Bank primary multiplexing in compliance with the electrical input-output characteristics provided in Table 3-3.

6.3 Drop & Insert Primary Multiplexing

Drop & Insert primary multiplexing in conformance with CEPT E-1 characteristics shall be required at locations where the subscriber requirement is minimal. The drop and insertion of up to thirty 64 Kbps channels supporting subscriber line units (SLU) shall be required at intermediate locations. The Drop & Insert Muxes supplied shall be performance and card compatible with the Channel Bank Equipment provided so that all Subscriber Line Interface cards are interchangeable.

Table 3-3
CEPT E-1 Standard First Order Multiplexing
Electrical Input/Output Characteristics

Applicable Standards:	CEPT per CCITT Recommendation G.702, G.703, G.711 and G.712
Number of Tributaries:	30 X 64 Kbps
Alternative Sub-rate Tributaries:	n X 64 Kbps V.36 64Kb/s V.11/V.36
Output Aggregate Rate: **Interface Code:** **Impedance:** **Peak Level @ 120 ohm:** **Peak Level @ 75 ohm:** **Maximum Insertion Loss:**	2.048 Mb/s ± 50 ppm HDB3 75 ohm unbalanced 3.0 volts ± 10% 2.37 volts ± 10% 6 dB
Signal Waveform: **Frame Structure:** **Jitter Performance:**	Per CCITT G.703 Per CCITT G.742 Per CCITT G.823
Power Supply Voltage:	-48 Vdc

6.4 Channel Banks (Mux, Drop/Insert)

User voice and data equipment interfacing requirements are defined at the subscriber line level. Primary multiplexing in conformance with CEPT E-1

characteristics shall be used to provide first order multiplexing of up to thirty 64 Kbps channels supporting Subscriber Line Units (SLUs).

6.5 Subscriber Line Units\Subscriber Line Interface Cards

The terms Subscriber Line Interface Cards and Subscriber Line Units have been used interchangeably throughout the specification. Multiple configurations of SLUs shall be required to provide subscriber to primary multiplexer Bank interfacing for a variety of voice and data communications. In case there are changes in number or type of cards because of changes in channel requirements, the contract price shall be adjusted accordingly.

The SLU interface requirements are discussed in the following subparagraphs:

(A) Voice Channels

The voice channel requirement is for (I) 4-Wire E&M trunking in support of PABX trunks & PLC VF and (II) 2-Wire telephonic interfaces. 2 wire SLUs shall be DTMF/TP optioned for 2-wire loop start or 2-wire GND start. The voice cards shall utilize ITU.T A - law companded PCM G.711, 64 kbits/s encoding. The voice card requirements are indicated in the BoQ in appendices.

(B) Sub-Channel Data Multiplexing

For this Project, the RTU data interface to the wideband telecommunications network node shall be defined at the DTE level at low-speed rates of 300, 600 and 1200 baud. The port shall be compatible with RS232C interface. The Contractor shall be required to furnish 64 Kbps SLU asynchronous dataplexing for at least 4 selectable low speed DTE interfaces whenever multiple asynchronous data circuits are required.

(C) Synchronous Data

The Contractor shall provide a direct DTE interface for synchronous communications at speed of 64Kbps and compatible with CCITT G.703 Kbit/s, V.35 and X.21 interfaces. Data rate selection shall be switch selectable or programmable.

(D) Nx64 kbps Synchronous Data

There is also a requirement for N x 64 kbps V.35, X.21 interfaces. The tentative quantities have been identified in the appendices. However the final BOQ shall be worked out during detailed design and contract price shall be adjusted accordingly.

6.6 MDF, DDF and Cabling

For the purposes of the specification, the contractor shall provide cabling, wiring, DDF patching facilities and MDFs interfacing to the wideband telecommunications system. Equipment and material components for MDF, DDF and cabling are also part of this procurement. It shall be the Contractor's responsibility to provide all cable support required for full supplied equipment interconnection with the MDF and shall be in accordance with communications industry standard practices and the requirements mentioned in the technical specifications.

6.7 MDF and DDF Patching Facilities

The Contractor shall supply and install all cabling, wiring, connectors, cross connects, Digital Distribution Frames (DDF) and Main Distribution Frames (MDF) associated with the installation and interconnection of equipments procured under this package as follows:

(i) DDF for termination of new SDH equipment E-1 ports

(ii) Cabling (including connectors) for E1 level connections from DDF to existing SDH equipments, DDF to Existing & new PDH equipments. To the extent possible, existing cable at site shall be used.

(iii) All Ethernet ports shall be terminated with RJ-45 connector. Provision for 100% expansion with connector for terminating additional Ethernet ports shall be provided.

(iv) MDF for termination of all the subscriber channels at new PDH node

(v) Cabling and connectors required to enable subscriber-to-subscriber circuits over the telecom network. The Line side of the MDF shall be cabled to the Primary Multiplex and the equipment side shall be cabled to the MDF of the assigned subscriber (PLCC, PABX, Telephone at wideband locations etc).

(vi) Any other cables, connections etc required for a fully functional, integrated telecom system.

The connections amongst various equipment such as FOTS, termination equipment and subscriber MDFs etc shall always be routed through DDF and MDF to provide maintenance access.

6.8 Digital Distribution Frame Functional Requirements

The Contractor shall provide DDF for Digital Signal Cross connect (DSX) Broadband-quality (better than 20 MHz) patching facilities configured "normally-thru" with Equipment, Line and Monitor Patch Jacks. DDFs shall provide the following basic functions:

(i) "Normally thru" circuit routing
(ii) Circuit rerouting via patch cord assemblies
(iii) Circuit disconnect and termination

All DDFs shall be sized and equipped to support the offered configuration of the provided equipment. Independent Transmit and Receive patch jack assemblies (line and equipment) shall provide for separate transmit and receive single-plug patching. Transmit and receive patch jack assemblies shall be located side-by-side such that dual-plug patch cord assemblies may be used to route both transmit and receive for the same circuit.

6.9 Main Distribution Frames

The Contractor shall make provision for cross connection of subscriber services to the subscribers utilizing Krone type or equivalent and shall provide full connectivity up to and terminated on the equipment side of the appropriate DDFs and line side of MDFs. The Contractor shall terminate on the equipment side of patching facilities provided by other contracts and shall provide DSX type patching facilities supporting aggregate bit streams (i.e. dataplexers and E-1 Channel Banks). Separate Patch panels or MDFs shall be provided for Data and Voice. All cross connects shall be accomplished utilizing one, two or three pair patch cords. Patch plugs are permissible for direct one-to-one circuit "cut-thru".

7.0 Patch Cords

The Contractor has to supply FC PC coupled Patch cords as described in BOQ. 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.

Employer/Owner in the operations and maintenance of the wideband communication resources of the including detection of degraded circuits, system performance, the diagnosis of problems, the implementation of remedial actions and the allocation or reallocation of telecommunications resources and addition/deletion of network elements.

8.0 Applicable Standards

The TMN design concept, functional and informational architecture and physical architecture, shall be in compliance with ITU-T Recommendation M.3010. The offered TMN system shall be capable of integration to other supplier's Network Management System (NMS) upwardly through North bound interfaces. The north bound interface in the EMS shall be CORBA/TMF-814 compliant.

8.1 Security Management

The TMN shall be provided with security features to limit access to monitoring and control capabilities to only authorized personnel. One access level of System Administrator and at least two levels of operator access shall be provided - read (view) only, and write (configure). The system administrator shall be able to create, define and modify operators with different access levels, network domains and perform all kind of maintenance and up gradation of the TMN system. With "read only" access level, network parameters should only be viewed. Access to database maintenance, command control and test functions shall be available with "write " access level. Means shall be provided to ensure only one authorized user has write capability for a selected domain of the network. It shall be possible to define multiple domains for purposes of monitoring and control.

Human error and conflict detection are also required. Such errors and access violations shall be reported to the offending user as error messages and warnings.

8.2 Craft Terminal

Each equipment(SDH equipment, Mux, Drop/Insert and DACS etc.) on the fibre optic communication network shall include provision for connecting a portable personal computer (PC) to be known as craft terminal to support local commissioning and maintenance activities. Through the use of this PC and local displays/controls, the operator shall be able to:

a. Change the configuration of the station & the connected NEs.
b. Perform tests
c. Get detailed fault information

The craft terminal shall be connected to the interface available in the communication equipment. Portable (laptop) computers (Craft terminals), each complete with necessary system and application software to support the functions listed above, shall be supplied to the employer as per BOQ given in the appendices.

ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

FIRE PROTECTION SYSTEM

TABLE OF CONTENTS

Drawing For (1) P&I diagram for Hydrant and HVW spray system Drawing
(2) Typical drawings for location of fire detectors and extinguishers.
(3) Typical drawings of HVW spray system for transformer and reactor.
(4) Technical data sheets.(**APPENDIX -I)**
(5) List of Approved vendors(**APPENDIX -II)**

TECHNICAL SPECIFICATION FOR

FIRE PROTECTION SYSTEM

1.00.00 **INTENT OF SPECIFICATION**

This section covers the design and performance requirements of the following types of fire protection systems;

a. Hydrant System
b. High Velocity Water (H.V.W) Spray System
c. Fire Detection and alarm System

d. Portable Fire Extinguishers

e. Wheel/ Trolley mounted Fire Extinguishers

1.00.01 It is not the intent to completely specify all details of design and construction. Nevertheless, the system design and equipment shall conform in all respects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Owner. The system design shall also conform to TAC/ NFPA norms.

1.00.02 The scope of work include complete earthwork (i.e. excavation, backfilling etc.) for the entire buried piping for the system, valve pits and pipe supports for buried, entrenched and over ground piping.

1.00.03 The equipment offered shall comply with the relevant Indian Standards. The equipment conforming to any other approved international standards shall meet the requirement called for in the latest revision of relevant Indian Standard or shall be superior. The Deluge valves, HVW spray nozzles & quartzoid bulb detectors shall have the approval of any of the following agencies;

a. UL of USA.

b. F M of USA

c. LPCB of UK or

d. VDS of Germany,

1.00.04 Ambient temperature for design of all equipment shall be considered as 50°C.

1.00.05 The piping and instruments diagram for Hydrant and HVW spray system for 400kV substations is enclosed. The successful bidder shall prepare detailed layout and piping drawing based on this drawing and other drawings such as road, drainage, cable trench, switch yard layout, etc. as furnished by the Employer during detailed engineering. The typical drawings for location of fire detectors and fire extinguishers in control cum administrative building is also enclosed and shall be followed for execution.

1.00.06 Equipment under the fire protection system should be supplied from the suppliers approved by OPTCL (A list of approved vendors is enclosed at Appendix-V). All equipment shall conform to the data sheets attached in **APPENDIX–I** and/or relevant subsections/clauses of this specification. In case

of contradiction between data specification sheets and relevant subsections/clauses, then stipulations of the data sheets will prevail.

2.00.00 DESIGN AND CONSTRUCTION

2.01.00 Hydrant System

Hydrant system of fire protection essentially consists of a large network of pipe, both under ground and over ground which feeds pressurised water to a number of hydrant valves, indoor (if applicable) as well as outdoor. These hydrant valves are located at strategic locations near buildings, Transformers and Reactors. Hose pipes of suitable length and fitted with standard accessories like branch pipes, nozzles etc., are kept in Hose boxes. In case of emergency, these hoses are coupled to the respective hydrant valves through instantaneous couplings and jet of water is directed on the equipment on fire. Hydrant protection shall be provided for the following in substations of voltage levels 400kV and above. At least one hydrant post shall be provided for every 60m of external wall measurement of buildings.

a) Control room building
b) L.T. Transformer area.
c) Fire Fighting pump House.
d) Stores
e) Transformers
f) Shunt Reactors/ Bus Reactors.

2.01.01 A warning plate shall be placed near the hydrant points for the transformers and reactors and the pump in 220kV substations to clearly indicate that water shall be sprayed only after ensuring that the power to the transformer/ reactor which is on fire is switched off and there are no live parts within 20metres of distance from the personnel using the hydrant.

2.02.00. HIGH VELOCITY WATER (H.V.W) SPRAY SYSTEM

H.V.W. spray type fire protection essentially consists of a network of projectors and an array of heat detectors around the Transformer/Reactor to be protected. On operation of one or more of heat detectors, Water under pressure is directed to the projector network through a Deluge valve from the pipe network laid for this system. This shall be provided for transformers and reactors in 765kV and 400kV substations. Wet detection initiation system shall be employed for automatic operation. The system shall be designed in such a way that the same can be extended to protect additional Transformer/ Reactor to be installed in future. However, for the purpose of design it shall be assumed that only one Transformer/ Reactor will be on fire. The main header pipe size in the yard shall

be 250mmNB and the branch to the equipment (shall not be more than 20metres length) shall be of the same size as of deluge valve.

2.02.01 The Electrical clearance between the Emulsifier system pipe work and live parts of the protected equipment shall not be less than the values given below :

1. 765 kV bushing 4900 mm
2. 420 kV bushing 3500 mm
3. 245 kV bushing 2150 mm
4. 145 kV bushing 1300 mm
5. 52 kV bushing 630 mm
6. 36 kV bushing 320 mm

2.02.02 System shall be designed in such a way that the Water pressure available at any spray nozzle shall be between 3.5bar and 5.0bar and shall be demonstrated through hydraulic calculations. Water shall be applied at a minimum rate of **10.2 LPM/M2** of the surface area of the transformer / Reactor including radiator, conservator, oil pipes, bushing turrets, etc. (including bottom surface for transformer). The nozzle arrangement shall ensure direct impingement of water on all exterior surfaces of transformer tank, bushing turrets, conservator and oil pipes, except underneath the transformer, where horizontal spray may be provided. Typical drawings of HVW spray system of a transformer and a reactor is enclosed for reference.

2.02.03 Deluge Valve

Deluge Valve shall be water pressure operated manual reset type. The Deluge valve shall be closed water tight when water pressure in the heat detector pipe work is healthy and the entire pipe work shall be charged with water under pressure upto the inlet of the Deluge valve. On fall of water pressure due to opening of one or more heat detectors, the valve shall open and water shall rush to the spray water network through the open Deluge valve. The valves shall be manually reset to initial position after completion of operation. Each Deluge Valve shall be provided with a water motor gong which shall sound an alarm when water after passing through the Deluge valve, is tapped through the water motor. Each Deluge valve shall be provided with a local panel with provision of opening of Deluge valve from local and remote from control room/ remote centre. In addition to this, each valve shall be provided with local operation latch. Deluge valves of 100mmNB size shall be used if the flow requirement is ≤ 200m3/hr and 150mmNB size shall be used for flow requirement >200m3/hr. Test valves shall simulate the operation of Deluge valves and shall be of quick opening type. The general construction shall conform to requirements under clause no.7.00.00 for piping, valves and specialties.

2.02.04 **High Velocity Spray Nozzles (Projectors)**

High velocity spray system shall be designed and installed to discharge water in the form of a conical spray consisting of droplets of water travelling at high velocity, which shall strike the burning surface with sufficient impact to ensure the formation of an emulsion. At the same time the spray shall efficiently cut off oxygen supply and provide sufficient cooling.

2.02.05 Minimum set point of the heat detectors used in the HVW spray system shall be 79^{O}C. The optimum rating shall, however, be selected by the Bidder, keeping in mind the maximum and minimum temperature attained at site.

2.03.00 Fire Detection and alarm System. This system shall be provided for control room building and Switchyard panel rooms of substations. Suitable fire detection system using smoke detectors and/or heat

2.03.01 Detectors shall be provided for the entire building, including corridor and toilets. Fire detectors shall be located at strategic locations in various rooms of the building. Each Switchyard panel room shall be considered a separate zone. Adequate number of extra zones shall be provided for Switchyard panel rooms for future bays identified in Single line diagram of the substation. The operation of any of the fire detectors/ manual call point should result in the following;

1. A visual signal exhibited in the annunciation panels indicating the area where the fire is detected.
2. An audible alarm sounded in the panel, and
3. An external audible alarm sounded in the building, location of which shall be decided during detailed engineering.

4. If the zone comprises of more than one room, a visual signal shall be exhibited on the outer wall of each room.

2.03.02 Each zone shall be provided with two zone cards in the panel so that system will remain healthy even if one of the cards becomes defective. Coverage area of each smoke detector shall not be more than 80 m2 and that of heat detectors shall not be more than 40 m2. Ionisation type smoke detectors shall be provided in all areas except pantry room where heat detectors shall be provided. If a detector is concealed, a remote visual indication of its operation shall be provided. Manual call points (Break glass Alarm Stations) shall be provided at strategic locations in the control room building. All cabling shall be done through concealed conduits.

2.03.03 Cables used should be exclusively for fire detection and alarm system and shall be 2Cx1.5sq.mm Cu. cables. Un-armoured PVC insulated FR cables conforming to IS 1554 (Part 1) shall be used.

2.04.00 Portable and Wheel/ Trolley mounted Fire Extinguishers

2.04.01 Portable Fire Extinguishers Adequate number of portable fire extinguishers of pressurised water, dry chemical powder, and Carbon dioxide type shall be provided in suitable locations in control room building and FFPH building as indicated in the drawing. In addition to this one (1) CO2 type fire extinguisher of 4.5kg capacity shall be provided for each Switchyard panel room. These extinguishers will be used during the early phases of fire to prevent its spread and costly damage. The design, construction & testing of portable fire extinguishers shall meet the requirements as per clause 10.00.00.

2.04.02 Wheel/ Trolley mounted Fire Extinguishers Wheel/Trolley mounted Mechanical foam type fire extinguishers of 50litre capacity, conforming to IS:13386, shall be provided for the protection of the following:

1. Transformers and reactors in 220kV and 132 kV substations. Two (2) nos. for each 220kV or 132kV transformer and reactor.

2. LT transformers in all substations. One (1) no. for each transformer. The design, construction & testing of Mechanical foam type 50 litre capacity shall meet the requirements of relevant IS Codes and clause 10.00.00 of this specification.

2.05.00 Water Supply System (for substations of voltage levels 400kV and above) Water for hydrant & HVW system shall be supplied by one electrical motor driven pump of rated capacity 410m3/hr. at 70MWC head, with another pump of same capacity , driven by diesel engine, shall be used as standby. Water storage tank with two compartments of adequate capacity shall be provided. Pumps shall work under positive suction head. Annunciations of the hydrant & HVW spray systems shall be provided in fire water pump house and repeated in 400 kV control room. The outdoor piping for the system in general shall be laid above ground on concrete pedestals with proper supporting arrangement. However, at road/rail crossings, in front/access of buildings, places where movement of cranes/vehicles is expected and at any other place where above ground piping is not advisable, the pipes shall be laid underground. Such locations shall be finalised during detailed engineering. The whole system will be kept pressurised

by providing combination of air vessel and jockey pump of 10.8M3/hr. capacity at 80MWC. The capacity of air vessel shall not be less than 3m3. Minor leakage will be met by Jockey pump. One additional jockey pump shall be provided as standby. All pumps shall be of horizontal centrifugal type. Pumps and air vessel with all auxiliary equipment will be located in firewater pump house. A pressure relief valve of suitable rating shall be provided in water header to release excess pressure due to atmospheric temperature variations. Operation of all the pumps shall be automatic and pumps shall be brought into operation at preset pressure. Fire pumps shall only be stopped manually. Manual start/stop provision shall be provided in local control panel.

2.05.01 The general design of the fire fighting pump sets shall meet the requirements under clauses no.5.00.00 for Horizontal centrifugal pumps, no.6.00.00 for Diesel engines and no.12.00.00 for Electrical motors.

2.05.02 Each pump shall be provided with a nameplate indicating suction lift/delivery head, capacity and number of revolutions per minute.

2.05.03 Design, construction, erection, testing and trial operation of piping, valves, strainers, hydrant valves, hoses, nozzles, branch pipes, hose boxes, expansion joints etc. shall conform to the requirements of clause no. 7.00.00.

2.06.00 Instrumentation and Control System

2.06.01 All instruments like pressure indicators, differential pressure indicators, pressure switches, level indicators, level switches, temperature indicators, alarms and all other instruments and panels as indicated in the specification and drawings and those needed for safe and efficient operation of the whole system shall be furnished according to the requirements of clause 11.00.00. Pump running/ fails to start signal shall be taken from the pressure switch immediately after the discharge of the pump.

2.06.02 Control Panel Power feeder for motors will be from switchgear board located in control building but control supply for all local control panels, annunciation panels, battery charger units, space heaters etc. shall be fed from the AC and DC distribution boards located in pump house. These AC & DC distribution boards will be fed from the switchgears and DCDBs located in control building.

a) Panel for motor driven fire water pump The panel shall be provided with the following:

1. TPN switch 1 No.

2. Auto/manual switch 1 No.
3. Start/Stop Push buttons 1 Set
with indication lamp
4. DOL starter with 1 Set
thermal O/L relay
5. Indicating lamp showing 1 Set
power ON
6. Indication lamp with drive 1 Set
ON/OF
7. Indication lamp showing 1 No.
Motor Trip

Main power cable from breaker feeder of main switchboard shall be terminated in this panel and another cable shall emanate from this panel which shall be terminated at motor terminals.

b) Panel for Two nos. Jockey Pump 1No.

The panel shall be provided with the following :

1. Fuse-switch unit for Jockey pumps 1 Set for each pump
2. Auto/manual switch for 1 No. for each pump
3. Selector switch for 1 No.
selecting either jockey pump
4. D.O.L. starter with overload 1 No. each
relay self-resetting type, for all the drives.
5. Start/stop push button for 1 Set for each pump
Jockey Pump with indication
lamp with pad-locking
arrangements in stop position
6. Indication lamp for trip 1 No. each for pump
indication

c) Panel for 2 Nos. battery charger 1 No.
& Diesel Engine driven fire water pump

The panel shall be provided with the following :

1. Auto/Manual switch for 1 No.
Diesel Engine driven pump
2. Start/Stop push buttons 1 Set
with indication lamp

3.	Indicating lamp showing drive ON/OFF	1 Set
4.	D.C. Voltmeter/Ammeter in the battery charger circuit	1 No. each
5.	Battery charger will be as per specification described	1 Set
6.	Selector switch for selecting either of battery chargers for the battery sets.	1 No.
7.	Selector switch for selecting either set of batteries for Diesel engine starting.	1No.
8.	Selector switch for boost charging/Trickle charging of battery set.	1 Set

d) Individual local control panel is to be considered for each transformer/ Reactor deluge system wherever these equipment are envisaged. This panel shall contain push buttons with indicating lamps for spray ON/OFF operation in the valve operation circuit. Push buttons shall be concealed behind glass covers, which shall be broken to operate the buttons. Provision shall be made in the panel for the field signal for the annunciations such as spray ON and fire in the Transformer/Reactor. A signal for spray ON shall also be provided in the control room fire alarm panel for employer's event logger. Remote operation facility to open the Deluge valve from control room/ remote centre shall also be provided.

2.06.03 Annunciation Panels

a) Location: Fire Water Pump House

i) Indicating lamps showing power supply "ON".

ii) Annunciation windows complete with buttons. Details are as follows:

Sl.No.	Description	Number
1.	Electric motor driven fire water pump running	1
2.	Electric motor driven fire water pump fails to start	1
3.	Diesel engine driven fire water pump running.	1
4.	Diesel engine driven water pump fails to start	1

5.	Jockey pump-1 running	1
6.	Jockey pump-1 fails to start	1
7.	Jockey pump-2 running	1
8.	Jockey pump-2 fails to start	1
9.	Fire in Transformer/ Reactor equipment	1 for each
10.	Deluge system operating for Transformer/Reactor equipment	1 for each
11.	Header pressure low	1
12.	Fire in smoke detection system zone (Common Fire Signal)	1
13.	Water storage tank water level low	2
14.	High speed diesel tank level low	1
15.	Spare	10

b) Location 400 kV Control Room

i) Indication lamp showing power supply 'ON'

ii) Provision shall be made in the panel for a signal for spray ON for each Transformer/Reactor for owner's use for event logger.

iii) Each Switchyard panel room shall be considered as separate zone for fire detection and alarm system.

iv) Following annunciations shall be provided.

Sl.No.	Description	Number
1.	Fire in Transformer/ Reactor	1 for each equipment
2.	Diesel engine driven fire water pump in operation	1
3.	Motor driven fire water pump in operation	1
4.	Jockey pump in operation	1
5.	Fire fighting Water storage tank level Low	2
6.	Fire/Fault (zone alarm module) zone as applicable	1+1(duplicate) For each
7.	Spare windows complete in all respect, with relays	10
8.	Spare zone alarm modules	Number of future A/c Kiosks required for the bays identified as per SLD

c) Each annunciation panel shall be provided with a hooter.

d) Indication for fault in respective areas shall also be provided. Each zone alarm module shall exhibit 'FIRE' and 'FAULT' conditions separately.

2.06.04 The control and interlock system for the fire protection system shall meet the following requirements:

1. Electric Motor Driven Fire water Pump. Pump should start automatically when the System header pressure is low. Pump should be stopped manually only. Pump should also be started manually if required from local control panel.

2. Diesel Engine Driven Standby Pump. The pump should automatically start under any of the following conditions:

a) System Header pressure low.

b) Electric motor operated fire water pump fails to start. Pump should be stopped manually only. Pump should also be started manually if required from the local control panel. The battery set which is connected for starting of Diesel engine shall not be subjected to boost charge.

3. Jockey Pump. It shall be possible to select any one of the Jockey pumps as main and the other as standby. Main Jockey pump shall start automatically when water pressure in header falls below the set value. If the main jockey pump fails to start then the standby should start. Jockey pump shall stop automatically when the pressure is restored to its normal value. Manual starting/stopping shall be possible from the local control panel.

3.00.00 TESTS

3.01.00 Shop Tests

3.01.01 Shop tests of all major equipment centrifugal pumps, diesel engines, electrical drive motors, piping, valves and specialties, pressure and storage vessels, MCC, electrical panels, controls, instrumentation etc. shall be conducted as specified in various clauses and as per applicable standards/codes.

3.01.02 Shop tests shall include all tests to be carried out at Contractor's works, works of his sub-contractor and at works where raw materials supplied for manufacture of equipment are fabricated. The tests to be carried out shall include but not be limited to the tests described as follows :

a) Materials analysis and testing.

b) Hydrostatic pressure test of all pressure parts, piping, etc.

c) Dimensional and visual check.

d) Balancing test of rotating components.

e) Response of heat/smoke detectors.

f) Performance characteristics of HVW spray nozzles (projectors).

g) Flow rate and operational test on Flow control valves.

h) Operational test of alarm valve (water-motor gang).

i) Calibration tests on instruments and tests on control panel.

j) Destruction/burst tests on 2% or minimum one (1) no. of hoses and portable type fire extinguishers for each type as applicable. Any fraction number shall be counted as next higher integer.

k) Performance test on fire extinguishers as required in the code.

3.01.03 In the absence of any Code/Standard, equipment shall be tested as per mutually agreed procedure between the supplier and the Employer.

3.01.04 A comprehensive visual and functional check for panels would be conducted and will include a thorough check up of panel dimensions, material of construction, panel finish, compliance with tubing and wiring specifications, quality of workmanship, proper tagging & locations of instruments/accessories. The wiring check shall be complete point to point ring out and check for agreement with installation drawings and equipment vendor prints of the complete system and an inspection of all field connection terminals and levelling.

3.01.05 All test certificates and reports shall be submitted to the Employer for approval.

3.01.06 The Employer's representative shall be given full access to all tests. The manufacturer shall inform the Employer allowing adequate time so that, if the Employer so desires, his representatives can witness the test.

3.02.00 Pre-commissioning Tests

3.02.01 General

a) All piping and valves, after installation will be tested hydraulically at a pressure of 16kg/cm2 for a period of 30 minutes to check against leak tightness.

b) All manually operated valves/gates shall be operated throughout 100% of the travel and these should function without any trouble whatsoever, to the satisfaction of the Employer.

c) All pumps shall be run with the specified fluid from shut off condition to valve wide open condition. Head developed will be checked from the discharge pressure gauge reading. During the test, the pumps and drives shall run smoothly without any undue vibration, leakage through gland, temperature rise in the bearing parts, noise, flow pulsation etc.

d) All pressure vessels should be tested hydraulically at the specified test pressure, singly or in the system.

e) Painting shall be checked by dry type thickness gauges.

f) Visual check on all structural components, welding, painting etc. and if doubt arises, these will be tested again.

g) All test instruments and equipment shall be furnished by the Contractor to the satisfaction of the Employer.

h) Automatic starting of all the fire pumps by operating the test valves.

i) Automatic operation of the Jockey pump Operation of the Deluge valve by breaking a detector as well as

j) manual and remote operation of the deluge valve.

k) Operation of entire annunciation system. Replacement of fused/damaged quartzoid bulb detectors during the test shall be responsibility of contractor.

3.02.02 After erection at site, the complete HVW spray protection and hydrant system shall be subject to tests to show satisfactory performance for which detailed procedure shall be submitted for Employer's approval. Full flow tests with water shall be done for the system piping as a means of checking the nozzle layout, discharge pattern and coverage, any obstructions and determination of relation between design criteria and actual performance, also to ensure against clogging of the smaller piping and the discharge devices by foreign matter carried by the water. Rigidity of pipe supports shall also be checked during the water flow.

3.02.03 All the detectors installed shall be tested for actuation by bringing a suitable source of heat/smoke near the detector and creating a stream of hot air/ smoke over the detector. The exact procedure of this test shall be detailed out by the Employer to the successful Bidder.

4.00.00 SPARE PARTS

The Contractor shall indicate in his scope of supply all the mandatory spares in the relevant schedules. The list of mandatory spares is indicated in 'Section - Projects'.

5.00.00 HORIZONTAL CENTRIFUGAL PUMPS

This clause covers the design, performance, manufacturing, construction features and testing of horizontal centrifugal pumps used for the purpose of fire fighting.

5.01.00 The materials of the various components shall conform to the applicable IS/BS/ASTM/DIN Standards.

5.01.01 In case of any contradiction with the aforesaid standards and the stipulations as per the technical specification as specified hereinafter, the stipulations of the technical specification shall prevail.

5.02.00 General Performance Requirements

5.02.01 The pump set shall be suitable for continuous operation at any point within the "Range of operation".

5.02.02 Pumps shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum being at shut off.

5.02.03 Pumps shall be capable of furnishing not less than 150% of rated capacity at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of rated head. Range of operation shall be 20% of rated flow to 150% of rated flow.

5.02.04 The pump-motor set shall be designed in such a way that there is no damage due to the reverse flow through the pump which may occur due to any mal-operation of the system.

5.02.05 **Drive Rating**

The drive rating shall not be less than the maximum power requirement at any point within the "Range of Operation" specified. During starting under reverse flow condition, the motor shall be capable of bringing the pump to rated speed at normal direction with 90% rated voltage at motor terminals.

5.02.06 Pump set along with its drive shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall generally be guided by Hydraulic Institute Standards.

5.02.07 The Contractor under this specification shall assume full responsibility in the operation of the pump and drive as one unit.

5.03.00 Design & Construction

5.03.01 Pump casing may be axially or radially split. The casing shall be designed to withstand the maximum pressure developed by the pump at the pumping temperature.

5.03.02 Pump casing shall be provided with adequate number of vent and priming connections with valves, unless the pump is made self-venting & priming. Casing drain, as required, shall be provided complete with drain valves.

5.03.03 Under certain conditions, the pump casing nozzles will be subjected to reactions from external piping. Pump design must ensure that the nozzles are capable of withstanding external reactions not less than those specified in API-610.

5.03.04 Pump shall preferably be of such construction that it is possible to service the internals of the pump without disturbing suction and discharge piping connections.

5.03.05 **Impeller**

The impeller shall be secured to the shaft and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft impellers shall be secured to the shaft by an additional locknut or cap screw. All screwed fasteners shall tighten in the direction of normal rotation.

5.03.06 **Wearing Rings**

Replaceable type wearing rings shall be furnished to prevent damage to impeller and casing. Suitable method of locking the wearing ring shall be used.

5.03.07 **Shaft**

Shaft size selected shall take into consideration the critical speed, which shall be at least 20% away from the operating speed. The critical speed shall also be at least 10% away from runaway speed.

5.03.08 **Shaft Sleeves**

Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing or seal and plate so as to distinguish between the leakage between shaft & shaft sleeve and that past the seals/gland.

5.03.09 Shaft sleeves shall be securely fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.

5.03.10 **Bearings**

Bearings of adequate design shall be furnished for taking the entire pump load arising from all probable conditions of continuous operation throughout its "Range of Operation" and also at the shut-off condition. The bearing shall be designed on the basis of 20,000 working hours minimum for the load corresponding to the duty point. Bearings shall be easily accessible without

disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.

5.03.11 **Stuffing Boxes**

Stuffing box design shall permit replacement of packing without removing any part other than the gland. Stuffing boxes shall be sealed/cooled by the fluid being pumped and necessary piping, fittings, valves, instruments, etc. shall form an integral part of the pump assembly.

5.03.12 **Shaft Couplings**

All shafts shall be connected with adequately sized flexible couplings of suitable design. Necessary guards shall be provided for the couplings.

5.03.13 **Base Plates & Sole Plate**

A common base plate mounting both for the pump and drive shall be furnished. The base plate shall be of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the pumping unit so mounted as to minimise misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust etc. Suitable drain taps and drip lip shall be provided.

5.03.14 **Material of Construction**

All materials used for pump construction shall be of tested quality. Material of construction of the major parts of the pumps shall be as given below :

a)	Casing	Casting Grade FG: 260 of IS 210
b)	Impeller	Bronze Grade LTB 2 of IS:318
c)	Wearing ring	Bronze Grade LTB 2 of IS:318
d)	Shaft	Grade 40C8 of IS 1570 (Part 2, section 1.): 1979.
e)	Shaft sleeve	Bronze Grade LTB 2 of IS:318 or Chrome steel 07Cr13 of IS 1570 (part 5) :1985.
f)	Stuffing box	2.5% Nickel CI Grade FG 260 of IS:210
g)	Gland	--- do ---

5.03.15 **Balancing**

All rotating components shall be statically and dynamically balanced at shop. All the components of pumps of identical parameters supplied under this

5.03.16 specification shall be interchangeable.

5.04.00 Tests and Inspection

5.04.01 The manufacturer shall conduct all routine tests required to ensure that the equipment furnished conform to the requirements of this specification and are in compliance with the requirements of applicable Codes and Standards. The particulars of the proposed tests and the procedures for the tests shall be submitted to the Employer/Engineer for approval before conducting the tests.

5.04.02 Where stage inspection is to be witnessed by Employer, in addition to above, the Bidder shall submit to the Employer/Engineer at the beginning of the contract, the detailed PERT-Chart showing the manufacturing programme and indicating the period where Employer or his authorised inspecting agency are required at the shop.

5.04.03 **Material of Construction**

All materials used for pump construction shall be of tested quality. Materials shall be tested as per the relevant standards and test certificates shall be made available to the Employer/Engineer.

5.04.04 Where stage inspection is to be witnessed by Employer, all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication, by Employer's Inspector who shall stamp the material. In case mill test certificates for the material are not available, the Contractor shall carry out physical and chemical tests at his own cost from a testing agency approved by the Employer, as per the requirements of specified material standard. The samples for physical and chemical tests shall be drawn up in presence of Employer's inspector who shall also witness the tests.

5.04.05 Shaft shall be subjected to 100% ultrasonic test and machined portion of the impeller shall be subject to 100% DP test. On finished shaft DP test will also be carried out.

5.04.06 **Hydraulic test at shop**

All pressure parts shall be subjected to hydraulic testing at a pressure of 150% of maximum pressure generated by the pump at rated speed or 200% of total dynamic head whichever is higher, for a period not less than one (1) hour.

5.04.07 **Performance test at shop**

Pumps shall be subjected to routine tests to determine the performance of the pumps. These tests shall be conducted in presence of Employer/Engineer's representative as per the requirements of the Hydraulic Institute Standards/ASME Power Test Code PTC 8.2/BS-599/I.S.S., latest edition. Routine tests shall be done on all the pumps.

5.04.08 Performance tests shall be conducted to cover the entire range of operation of the pumps. These shall be carried out to span 150% of rated capacity upto pump shut-off condition. A minimum of five combinations of head and capacity are to be achieved during testing to establish the performance curves, including the design capacity point and the two extremities of the Range of operation specified.

5.04.09 Tests shall preferably be conducted alongwith the actual drives being supplied.

5.04.10 The Bidders shall submit in his proposal the facilities available at his works to conduct performance testing. If because of limitations of available facilities, a reduced speed test or model test has to be resorted to establish pump performance, the same has to be highlighted in the offer.

5.04.11 In case of model testing, the stipulations of latest edition of Hydraulic Institute Standards shall be binding. Prototype or model tests, however, shall be conducted with the suction condition identical to the field conditions i.e. sigma values of prototype and model is to be kept same.

5.04.12 Prior to conducting model testing, calculations establishing model parameters, sizes and test procedure will be submitted to Employer/Engineer for approval.

5.04.13 All rotating components of the pumps shall be subjected to static and dynamic balancing tests.

5.04.14 The Employer or his authorised representative shall have full access to all tests. Prior to performance tests, the Contractor shall intimate the Employer allowing adequate time so that if the Employer so desires, his representative can witness the test.

5.04.15 Report and test certificates of the above tests shall be submitted to the Employer/Engineer for approval.

5.04.16 **Pre commissioning tests**.

After installation, pumps offered may be subjected to testing at field also by Employer. If the performances at field are not found to meet the requirement, then the equipment shall be rectified by the Contractor without any extra cost. Prior to performance testing, the procedure for such tests will be mutually agreed between Employer and Contractor. The Contractor shall furnish all necessary instruments, accessories and personnel for testing. Prior to testing, the calibration curves of all instruments and permissible tolerance limit of instruments shall be mutually agreed upon.

6.00.00 **DIESEL ENGINES**

This Clause covers the design, performance, manufacturing construction features and testing of compression ignition diesel engines, used primarily for driving centrifugal pumps, used for the purpose of fire fighting.

6.01.00 Design and Construction General

6.01.01 The diesel engine shall be of multicylinder type four-stroke cycle with mechanical (airless) injection, cold starting type.

6.01.02 The continuous engine brake horse power rating (after accounting for all auxiliary power consumption) at the site conditions shall be atleast 20% greater than the requirement at the duty point of pump at rated RPM and in no case, less than the maximum power requirement at any condition of operation of pump.

6.01.03 Reference conditions for rated output of engine shall be as per IS:10000, part II or ISO:3046, part I.

6.01.04 The engine shall be designed with regard to ease of maintenance, repair, cleaning and inspection.

6.01.05 All parts subjected to substantial temperature changes shall be designed and supported to permit free expansion and contraction without resulting in leakage, harmful distortion or misalignment.

6.01.06 **Starting**

The engine shall be capable of both automatic and manual start. The normal mode of starting is automatic but in the event of failure of automatic start or at the discretion of the operator, the engine can be started manually from the LCP. Since the fire pumping unit driven by the diesel engine is not required to run continuously for long periods and the operation will not be frequent, special

features shall be built into the engine to allow it to start within a very short period against full load even if it has remained idle for a considerable period.

6.01.07 If provision for manual start (cranking) is provided, all controls/ mechanisms, which have to be operated during the starting process, shall be within easy reach of the operator.

6.01.08 Automatic cranking shall be effected by a D.C. motor having high starting torque to overcome full engine compression. Starting power will be supplied from either of the two (2) sets of storage batteries. The automatic starting arrangement shall include a 'Repeat Start' feature for 3 attempts. The battery capacity shall be adequate for 3 (three) consecutive starts without recharging with a cold engine under full compression.

6.01.09 The batteries shall be used exclusively for starting the diesel engine and be kept fully charged all the time in position. Arrangement for both trickle and booster charge shall be provided. Diesel engine shall be provided with two (2) battery charger units of air-cooled design. The charger unit shall be capable of charging one (1) set of battery at a time. Provision shall, however, be made so that any one of the charger units can be utilised for charging either of the two (2) batteries.

6.01.10 For detail design of battery and battery charger, sub- section Electrical may be referred to.

6.01.11 **Governing System**:

The engine shall be fitted with a speed control device, which will control the speed under all conditions of load.

6.01.12 The governor shall offer following features:

a) Engine should be provided with an adjustable governor capable of regulating engine speed within 5% of its rated speed under any condition of load between shut-off and maximum load conditions of the pumps. The governor shall be set to maintain rated pump speed at maximum pump load.

b) Engine shall be provided with an over speed shut- down device. It shall be arranged to shut-down the engine at a speed approximately 20% above rated engine speed and for manual reset, such that the automatic engine controller will continue to show an over speed signal until the device is manually reset to normal operating position (Vol.II, NFPA, 1978).

6.01.13 The governor shall be suitable for operation without external power supply.

6.01.14 **Fuel System**

The diesel engine will run on High Speed Diesel.

6.01.15 The engine shall be provided with fuel oil tank of 250 litres capacity. The fuel oil tank shall preferably be mounted near the engine. No fuel oil tank will be provided by the Employer.

6.01.16 The fuel oil tank shall be of welded steel constructed to relevant standards for mild steel drums. The outlet of the tank shall be above the inlet of fuel injection pump of the diesel engine to ensure adequate pressure at suction of injection pump.

6.01.17 The fuel oil tank shall be designed in such a way that the sludge and sediment settles down to the tank bottom and is not carried to the injection pump. A small sump shall be provided and fitted with drain plug to take out sludge/sediment and to drain oil. Adequate hand holes (greater than 80 mm size) shall be provided to facilitate maintenance.

6.01.18 Pipeline carrying fuel oil shall be gradually sloped from the tank to the injection pump. Any valve in the fuel feed pipe between the fuel tank and the engine shall be placed adjacent to the tank and it shall be locked in the open position. A filter shall be incorporated in this pipeline, in addition to other filters in the fuel oil system. Pipe joints shall not be soldered and plastic tubing shall not be used. Reinforced flexible pipes may also be used.

6.01.19 The complete fuel oil system shall be designed to avoid any air pocket in any part of the pipe work, fuel pump, sprayers/injectors, filter system etc. No air relief cock is permitted. However, where air relief is essential, plugs may be used.

6.01.20 A manual fuel pump shall be provided for priming and releasing of air from the fuel pipelines.

6.01.21 **Lubricating Oil System**

Automatic pressure lubrication shall be provided by a pump driven by the crank shaft, taking suction from a sump and delivering pressurized oil through cooler and fine mesh filters to a main supply header fitted in the bed plate casing. High pressure oil shall be supplied to the main and big end bearings, cam-shaft bearings, cam-shaft chain and gear drives, governor, auxiliary drive gears etc.

Valve gear shall be lubricated at reduced pressure through a reducing valve and the cams by an oil bath.

6.01.22 **Cooling Water System**

Direct cooling or heat exchanger type cooling system shall be employed for the diesel engine. Water shall be tapped from the fire pump discharge. This water shall be led through duplex strainer, pressure breakdown orifice and then after passing through the engine, the water at the outlet shall be taken directly to the sump through an elevated funnel.

6.02.00 Testing & Inspection

6.02.01 The manufacturer shall conduct all tests required, to ensure that the equipment furnished conforms to the requirement of this sub-section and in compliance with requirements of applicable codes. The particulars of the proposed tests and the procedure for the tests shall be submitted to the Employer for approval before conducting the tests.

6.02.02 At manufacturer's works, tests shall be carried out during and after completion of manufacture of different component/parts and the assembly as applicable. Following tests shall be conducted.

6.02.03 Material analysis and testing.

6.02.04 Hydrostatic pressure testing of all pressure parts.

6.02.05 Static and dynamic balance tests of rotating parts at applicable over- speed and determination of vibration level.

6.02.06 MPI/DPT on machined parts of piston and cylinder.

6.02.07 Ultrasonic testing of crankshaft and connecting rod after heat treatment.

6.02.08 Dimensional check of close tolerance components like piston, cylinder bore etc.

6.02.09 Calibration tests of all fuel pumps, injectors, standard orifices, nozzles, instruments etc.

6.02.10 Over speed test of the assembly at 120% of rated speed.

6.02.11 Power run test.

6.02.12 Performance test of the diesel engine to determine its torque, power and specific fuel consumption as function of shaft speed. Performance test of the engine shall be carried for 12 hours out of which 1 hour at full load and one hour at 110% overload.

6.02.13 Measurement of vibration & noise.

(i) **Measurement of vibration**

The vibration shall be measured during full load test as well as during the overload test and limit shall be 100 microns.

(ii) **Measurement of noise level**

The equivalent 'A' weighted sound level measured at a distance of 1.5 M above floor level in elevation and 1.0 M horizontally from the base of the equipment, expressed in dB to a reference of 0.0002 microbar shall not exceed 93 dBA. Above tests for vibration shall be repeated at site as pre-commissioning tests.

6.02.14 Adjustment of speed governor as per BS:5514.

6.02.15 Diesel engine shall be subjected to routine tests as per IS:10000/BS:5514.

7.00.00 **PIPING, VALVES AND SPECIALITIES**

This clause covers the design, manufacture, shop testing, erection, testing and commissioning of piping, valves and specialities.

7.02.00 **Scope**

The piping system which shall include but not be limited to the following:

7.02.01 Plain run of piping, bends, elbows, tees, branches, laterals, crosses, reducing unions, couplings, caps, expansion joints, flanges, blank flanges, thrust blocks, anchors, hangers, supports, saddles, shoes, vibration dampeners, sampling connections, hume pipes etc.

7.02.02 Gaskets, ring joints, backing rings, jointing material etc. as required. Also all welding electrodes and welding consumables including special ones, if any.

7.02.03 Instrument tapping connections, stubs etc.

7.02.04 Gate and globe valves to start/stop and regulate flow and swing check valves for one directional flow.

7.02.05 **Basket strainers and Y-type strainers**

Bolts, nuts, fasteners as required for interconnecting piping, valves and fittings as well as for terminal points. For pipe connections into Owner's R.C.C. works, Bidder will furnish all inserts.

7.02.06 Painting, anti-corrosive coatings etc. of pipes and equipment. Adequate number of air release valves shall be provided at the highest points in the piping system to vent any trapped air in the system.

7.03.00 **Design**

7.03.01 **Material of construction of various pipes shall be as follows** :

(a) **Buried Pipes**

Mild steel black pipes as per IS:1239, Part-I medium grade (for pipes of sizes 150 NB and below) or IS:3589, Fe 410 grade (for pipes of sizes 200 NB and above) suitably lagged on the outside to prevent soil corrosion, as specified elsewhere.

(b) **Overground Pipes normally full of water**

Mild steel black pipes as per IS:1239, Part-I medium grade (for pipes for sizes 150 NB and below) or IS:3589, Fe 410 grade (for pipes of sizes 200 NB and above).

(c) Overground pipes normally empty, but periodic charge of water and for detector line for HVW System. Mild steel galvanised pipes as per IS:1239, Part-I medium grade (for pipes of sizes 150 NB and below) or IS:3589, Fe 410 grade (for pipes of sizes 200 NB and above).

7.03.02 All fittings to be used in connection with steel pipe lines upto a size of 80 mm shall be as per IS:1239. Part-II Mild steel tubulars and other wrought steel pipe fittings, Heavy grade. Fittings with sizes above 80 mm upto 150 mm shall be fabricated from IS:1239 Heavy grade pipes or steel plates having thickness not less than those of IS:1239 Part-I Heavy grade pipes. Fittings with sizes above 150 mm shall be fabricated from IS:3589 Class-2 pipes. All fitting used in GI piping shall be threaded type. Welding shall not be permitted on GI piping.

7.03.03 Pipe sizes shall not be less than the sizes indicated in the attached drawings.

7.03.04 For steel pipeline, welded construction should be adopted unless specified otherwise.

7.03.06 All piping system shall be capable of withstanding the maximum pressure arising from any condition of operation and testing including water hammer effects.

7.03.09 Gate/sluice valve shall be used for isolation of flow in pipe lines and shall be as per 778 (for size upto 40 mm) and IS:14846 (for sizes above 40 mm). Valves shall be of rising spindle type and of PN 1.6 class

7.03.10 **Gate Valves shall be provided with the following** :

(a) Hand wheel.

(b) Position indicator.

(c) Locking facility (where necessary).

7.03.11 Gate valves shall be provided with back seating bush to facilitate gland removal during full open condition.

7.03.12 Globe valves shall be provided with contoured plug to facilitate regulation and control of flow. All other requirements should generally follow those of gate valve.

7.03.13 Non-return valves shall be swing check type. Valves will have a permanent "arrow" inscription on its body to indicate direction of flow of the fluid. These valves shall generally conform to IS:5312.

7.03.14 Whenever any valve is found to be so located that it cannot be approached manually from the nearest floor/gallery/platform hand wheel with floor stand or chain operator shall be provided for the same.

7.03.15 Valves below 50 mm size shall have screwed ends while those of 50 mm and higher sizes shall have flanged connections.

7.03.14 **Basket Strainer**

a) Basket strainers shall be of 30mesh and have the following materials of construction :

Body: Fabricated mild steel as per IS:2062 (Tested Quality).

Strainer Wires: stainless steel (AISI : 316), 30 SWG, suitably reinforced.

b) Inside of basket body shall be protected by two (2) coats of heavy duty bitumastic paint.

c) Strainers shall be Simplex design. Suitable vent and drain connections with valves shall be provided.

d) Screen open area shall be at least 4 times pipe cross sectional area at inlet.

e) Pressure drop across strainer in clean condition shall not exceed 1.5 MWC at 410 M3/hr flow. Pressure drop test report of strainer of same design shall be furnished.

7.03.15 **Y-type On-line Strainer**

Body shall be constructed of mild steel as per IS:2062 (tested quality). Strainer wires shall be of stainless steel AISI:316, 30 SWG, 30 mesh. Blowing arrangement shall be provided with removable plug at the outlet. Screen open area shall be atleast 4 times pipe cross-sectional area at inlet. Pressure drop test report of strainer of same design shall be furnished.

7.03.16 **Hydrant Valve (Outdoor) and Indoor Hydrant Valves (Internal Landing Valves).**

The general arrangement of outdoor stand post assembly, consisting of a column pipe and a hydrant valve with a quick coupling end shall be as per TAC requirement.

Materials of construction shall be as follows :

a)	Column pipe	M.S. IS:1239 med. grade.
b)	Hydrant Valve	
	i) Body	Gun metal.
	ii) Trim	Leaded tin bronze as per IS:318, Grade-LTB 2.
	iii) Hand Wheel	Cast Iron as per IS:210, Grade FG:200.
	iv) Washer, gasket, etc.	Rubber as per IS:638.
	v) Quick coupling connection	Leaded tin bronze as per IS:318, Grade-LTB 2.
	vi) Spring	Phosphor Bronze as per IS:7608.
	vii) Cap and chain	Leaded tin bronze as per IS:318, Grade-LTB etc.2.

The general design of hydrant valve shall conform to IS:5290.

7.03.17 **Hoses, Nozzles, Branch pipes and Hose boxes**

(a) Hose pipes shall be of reinforced rubber-lined canvas construction as per type A of IS:636 with nominal size of 63 MM (2 1/2") and lengths of 15 metre or 7.5 metre, as indicated elsewhere. All hoses shall be ISI marked.

(b) Hosepipes shall be capable of withstanding an internal water pressure of not less than 35.7 kg/cm2 without bursting. It must also withstand a working pressure of 8.5 kg/cm2 without undue leakage or sweating.

(c) Each hose shall be fitted with instantaneous spring lock type couplings at both ends. Hose shall be fixed to the coupling ends by copper rivets and the joint shall be reinforced by 1.5 mm galvanized mild steel wires and leather bands.

(d) Branch pipes shall be constructed of copper and have rings of leaded tin bronze (as per IS:318 Grade-2) at both ends. One end of the branch pipe will receive the quick coupling while the nozzles will be fixed to the other end.

(e) Nozzles shall be constructed of leaded tin bronze as per IS:318, Grade-2.

(f) Suitable spanners of approved design shall be provided in adequate numbers for easy assembly and dismantling of various components like branch pipes, nozzles, quick coupling ends etc.

(g) Hose pipes fitted with quick coupling ends, branch pipes, nozzles spanner etc. will be kept in a hose box, which will be located near point of use. The furnished design must meet the approval of Tariff Advisory Committee.

(h) All instantaneous couplings, as mentioned under clause Nos.3.03.19, 3.03.20 and 3.03.21 above shall be of identical design (both male and female) so that any one can be interchanged with another. One male, female combination shall get locked in by mere pushing of the two halves together but will provide leak tightness at a pressure of 8 kg/cm2 of water. Designs employing screwing or turning to have engagement shall not be accepted.

7.04.00 Fabrication & Erection

7.04.01 The contractor shall fabricate all the pipe work strictly in accordance with the related approved drawings.

7.04.02 **End Preparation**

(a) For steel pipes, end preparation for butt welding shall be done by machining.

(b) Socket weld end preparation shall be sawing/machining.

(c) For tees, laterals, mitre bends, and other irregular details cutting templates shall be used for accurate cut.

7.04.03 **Pipe Joints**

(a) In general, pipes having sizes over 25 mm shall be joined by butt welding. Pipes having 25 mm size or less shall be joined by socket welding/screwed connections. Galvanised pipes of all sizes shall have screwed joints. No welding shall be permitted on GI pipes. Screwed joints shall have tapered threads and shall be assured of leak tightness without using any sealing compound.

(b) Flanged joints shall be used for connections to vessels, equipment, flanged valves and also on suitable straight lengths of pipe line of strategic points to facilitate erection and subsequent maintenance work.

7.04.04 **Overground Piping**

(a) Piping to be laid overground shall be supported on pipe rack/supports. Rack/supports details shall have to be approved by Employer/Engineer.

(b) Surface of overground pipes shall be thoroughly cleaned of mill scale, rust etc. by wire brushing. Thereafter one (1) coat of red lead primer shall be applied. Finally two (2) coats of synthetic enamel paint of approved colour shall be applied.

7.04.05 **Buried Pipe Lines**

(a) Pipes to be buried underground shall be provided with protection against soil corrosion by coating and wrapping with two coats of coal tar hot enamel paint and two wraps of reinforced fibre glass tissue. The total thickness of coating and wrapping shall not be less than 3 mm. Alternatively corrosion resistant tapes can also be used for protection of pipes against corrosion.

(b) Coating and wrapping and holiday testing shall be in line with IS:10221.

(c) Buried pipelines shall be laid with the top of pipe one meter below ground level.

(d) At site, during erection, all coated and wrapped pipes shall be tested with an approved Holiday detector equipment with a positive signalling device to indicate any fault hole breaks or conductive particle in the protective coating.

7.05.00 General Instruction for Piping Design and Construction

7.05.01 While erecting field run pipes, the contractor shall check, the accessibility of valves, instrument tapping points, and maintain minimum headroom requirement and other necessary clearance from the adjoining work areas.

7.05.02 Modification of prefabricated pipes, if any, shall have to be carried out by the contractor at no extra charge to the Employer.

7.05.03 **Welding**

(i) Welding shall be done by qualified welders only.

(ii) Before welding, the ends shall be cleaned by wire brushing, filing or machine grinding. Each weld-run shall be cleaned of slag before the next run is deposited.

(iii) Welding at any joint shall be completed uninterrupted. If this Employer/ Consultant.

(iv) As far as possible welding shall be carried out in flat position. If not possible, welding shall be done in a position as close to flat position as possible.

(v) No backing ring shall be used for circumferential butt welds.

(vi) Welding carried out in ambient temperature of 5°C or below shall be heat-treated.

(vii) Tack welding for the alignment of pipe joints shall be done only by qualified welders. Since tack welds form part of final welding, they shall be executed carefully and shall be free from defects. Defective welds shall be removed prior to the welding of joints. Electrodes size for tack welding shall be selected depending upon the root opening.

(viii) Tacks should be equally spaced as follows :
for 65 NB and smaller pipes : 2 tacks
for 80 NB to 300 NB pipes : 4 tacks

for 350 NB and larger pipes : 6 tacks

(ix) Root run shall be made with respective electrodes/filler wires. The size of the electrodes/filler wires. The size of the electrodes shall not be greater than 3.25 mm (10 SWG) and should preferably be 2.3 mm (12 SWG). Welding shall be done with direct current values recommended by the electrode manufacturers.

(x) Upward technique shall be adopted for welding pipes in horizontally fixed position. For pipes with wall thickness less than 3 mm, oxyacetylene welding is recommended.

(xi) The root run of butt joints shall be such as to achieve full penetration with the complete fusion of root edges. The weld projection shall not exceed 3 mm inside the pipe.

(xiii) On completion of each run craters, weld irregularities, slag etc. shall be removed by grinding or chipping.

(xiv) Fillet welds shall be made by shielded metal arc process regardless of thickness and class of piping. Electrode size shall not exceed 10 SWG. (3.25 mm). At least two runs shall be made on socket weld joints.

7.06.00 **Tests at Works**

7.06.01 **Pipes**

(i) Mechanical and chemical tests shall be performed as required in the codes/standards.

(ii) All pipes shall be subjected to hydrostatic tests as required in the codes/standards.

(iii) 10% spot Radiography test on welds of buried pipes shall be carried out as per ASME VIII.

7.06.02 **Valves**

(i) Mechanical and chemical tests shall be conducted on materials of the valve as required in the codes/standards.

(ii) All valves shall be tested hydrostatically for the seat as well as required in the code/standards for a period of ten minutes.

(iii) Air test shall be conducted to detect seat leakage.

(iv) Visual check on the valve and simple operational test in which the valve will be operated thrice from full open to full close condition.

(v) No repair work on CI valve body, bonnet or wedge shall be allowed.

7.06.03 **Strainers**

(i) Mechanical and chemical tests shall be conducted on materials of the strainer.

(ii) Strainers shall be subjected to a hydrostatic test pressure of 1.5 times the design pressure or 10 kg/cm2g whichever is higher for a period of one hour.

7.06.04 **Hydrant valves and Indoor Hydrant Valves (Internal Landing Valves)**

(i) The stand post assembly along with the hydrant valve (valve being open and outlet closed) shall be pressure tested at a hydrostatic pressure of 21 kg/cm2g to detect any leakage through defects of casting.

(ii) Flow test shall be conducted on the hydrant valves at a pressure of 7 kg/cm^2g and the flow through the valve shall not be less than 900 litres/min.

(iii) Leak tightness test of the valve seat shall be conducted at a hydrostatic test pressure of 14 kg/cm^2g.

7.06.05 **Hoses, Nozzles, Branch Pipes and Hose Boxes**

Reinforced rubber-lined canvas hoses shall be tested hydro statically.

Following tests shall be included as per IS:636.

a)Hydrostatic proof pressure test at 21.4 kgf/cm^2g

b) **Internal diameter**

The branch pipe, coupling and nozzles shall be subjected to a hydrostatic test pressure of 21 kg/cm^2g for a period of 21/2 minutes and shall not show any sign of leakage or sweating. Dimensional checks shall be made on the hose boxes and nozzle spanners.

8.00.00 **AIR VESSELS**

8.01.00 Air vessels shall be designed and fabricated of mild steel as class-II vessels as per IS:2825 for a pressure of 14kg/cm^2 and shall be minimum 3 m3 capacity.

8.02.00 Inside surface of the tank shall be protected by anti-corrosive paints/coatings/linings as required.

8.03.00 Outside surfaces of the vessels shall be provided with one (1) coat of red lead primer with two (2) coats of synthetic enamel paint of approved colour and characteristics.

8.04.00 Tests & Inspection

8.04.01 Air vessels shall be hydraulically tested at 21kg/cm^2 for a period not less than one (1) hour.

8.04.02 All materials used for fabrication shall be of tested quality and test certificates shall be made available to the Owner.

8.04.03 Welding procedure and Welder's qualification tests will be carried out as per relevant IS Standard.

8.04.04 NDE tests, which will include 100% Radiography on longitudinal seams and spot Radiography for circumferential seams, for pressure vessel will be carried out.

9.00.00 **HEAT DETECTORS/FIRE DETECTORS AND SPRAY NOZZLES**

9.00.01 **Intent of Specification**

This specification lays down the requirements of the smoke detectors, heat detectors and spray nozzles for use in various sub-systems of the fire protection system.

9.00.02 **Codes and Standards**

All equipment supplied shall conform to internationally accepted codes and standards. All equipment offered by Bidders should be TAC approved or have been in use in installations which have been approved by TAC.

9.01.00 **Heat Detectors, Quartzoid bulb type. (Used in HVW spray system)**

a) Heat detectors shall be of any approved and tested type. Fusible chemical pellet type heat detectors are however not acceptable.

b) Temperature rating of the heat detector shall be selected by the Bidder taking into consideration the environment in which the detectors shall operate. Minimum set point shall, however, be 79^{o}C.

c) Heat detectors shall be guaranteed to function properly without any maintenance work for a period of not less than twenty five (25) years.

d) The heat detectors shall be mounted on a pipe network charged with water at suitable pressure. On receipt of heat from fire, the heat detector will release the water pressure from the network. This drop in water pressure will actuate the Deluge valve.

9.02.00 **HVW Spray Nozzles (Projectors)**

High velocity water spray system shall be designed and installed to discharge water in the form of a conical spray consisting of droplets of water travelling at high velocity which shall strike the burning surface with sufficient impact to ensure the formation of an emulsion. At the same time the spray shall efficiently cut off oxygen supply and provide sufficient cooling. Integral non-ferrous strainers shall be provided in the projectors ahead of the orifice to arrest higher size particle, which are not allowed to pass through the projectors.

9.03.00 Fire Detectors (Used in fire detection and alarm system)

9.03.01 Fire detectors shall be approved by FOC-London or similar international authorities.

9.03.02 Both smoke and heat type fire detectors shall be used. Bidder shall clearly indicate the mode of operation of detectors in his proposal.

9.03.03 The set point shall be selected after giving due consideration for ventilating air velocity and cable insulation.

9.03.04 Fire detectors shall be equipped with an integral L.E.D. so that it shall be possible to know which of the detectors has been operated. The detectors, which are to be placed in the space above the false ceiling or in the floor void shall not have the response indicators on the body but shall be provided with remote response indicators.

9.03.05 Approval from Department of Atomic Energy (DAE), Government of India shall be made available for ionisation type smoke detectors. All accessories required to satisfy DAE shall also be included in the scope of supply.

9.03.06 Fire detectors shall be guaranteed to function properly without any maintenance work for a period of not less than ten (10) years.

10.00.00 **PORTABLE AND WHEEL/ TROLLEY MOUNTED FIRE EXTINGUISHERS**

10.00.01 This specification lays down the requirement regarding fire extinguishers of following types :

Portable fire extinguishers.

a) Pressurised water type.
b) Dry chemical powder type
c) Carbon Dioxide type

Wheel/ Trolley mounted fire extinguishers.

a) Mechanical foam type

10.00.02 All the extinguishers offered by the Bidder shall be of reputed make and shall be ISI marked.

10.01.00 Design and Construction

10.01.01 All the portable extinguishers shall be of freestanding type and shall be capable of discharging freely and completely in upright position.

10.01.02 Each extinguisher shall have the instructions for operating the extinguishers on its body itself.

10.01.03 All extinguishers shall be supplied with initial charge and accessories as required.

10.01.04 Portable type extinguishers shall be provided with suitable clamps for mounting on walls or columns.

10.01.05 All extinguishers shall be painted with durable enamel paint of fire red colour conforming to relevant Indian Standards.

10.01.06 Pressurisation of water type fire extinguishers shall either be done by compressed air or by using gas cartridge. The constant air pressure type shall conform to IS:6234 and the gas pressure type shall conform to IS:940. Both these extinguishers shall be ISI marked.

10.01.07 Dry chemical powder type portable extinguisher shall conform to IS: 2171.

10.01.08 Carbon Dioxide type portable extinguisher shall conform to IS:2878.

10.01.09 Wheel/ trolley mounted fire extinguishers of 50 litre capacity Mechanical foam type shall conform to IS:13386

10.02.00 Tests and Inspection

10.02.01 A performance demonstration test at site of five (5) percent or one (1) number whichever is higher, of the extinguishers shall be carried out by the Contractor. All consumable and replaceable items require for this test would be supplied by the Contractor without any extra cost to Employer.

10.02.02 Performance testing of extinguisher shall be in line of applicable Indian Standards. In case where no Indian Standard is applicable for a particular type of extinguisher, the method of testing shall be mutually discussed and agreed to before placement of order for the extinguishers.

10.03.00 **Painting**

Each fire extinguisher shall be painted with durable enamel paint of fire red colour conforming to relevant Indian Standards.

11.00.00 **INSTRUMENTS**

11.00.01 **Intent of Specification**

The requirements given in the sub-section shall be applicable to all the instruments being furnished under this specification.

11.00.02 All field mounted instruments shall be weather and dust tight, suitable for use under ambient conditions prevalent in the subject plant. All field mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance can be achieved.

11.01.00 **Local Instruments**

Pressure/ Differential Gauges & Switches.

11.01.01 The pressure sensing elements shall be continuous 'C' bourdon type.

11.01.02 The sensing elements for all gauges/switches shall be properly aged and factory tested to remove all residual stresses. They shall be able to withstand at least twice the full scale pressure/vacuum without any damage or permanent deformation.

11.01.03 For all instruments, connection between the pressure sensing element and socket shall be braced or hard soldered.

11.01.04 Gauges shall be of 150 mm diameter dial with die-cast aluminium, stoved enamel black finish case, aluminium screwed ring and clear plastic crystal cover glass. Upper range pointer limit stop for all gauges shall be provided.

11.01.05 All gauges shall be with stainless steel bourdon having rotary geared stainless steel movements.

11.01.06 Weatherproof type construction shall be provided for all gauges. This type of construction shall be fully dust tight, drip tight, weather resistant and splash proof with anti-corrosive painting conforming to **NEMA- 4**.

11.01.07 All gauges shall have micrometer type zero adjuster.

11.01.08 Neoprene safety diaphragm shall be provided on the back of the instruments casing for pressure gauges of ranges 0-10 Kg/cm2 and above.

11.01.09 Scales shall be concentric, white with black lettering and shall be in metric units.

11.01.10 Accuracy shall be + 1.0 percent of full range or better.

11.01.11 Scale range shall be selected so that normal process pressure is approximately 75 percent of full scale reading. For pressure gauges and pressure switches, the range shall not be less than 0 -16 Kg/cm2

11.01.12 All gauges shall have 1/2 inch NPT bottom connection.

11.01.13 All instruments shall conform to IS: 3624 - 1966.

11.01.14 All instruments shall be provided with 3 way gauge isolation valve or cock. Union nut, nipple and tail pipe shall be provided wherever required.

11.01.15 Switch element contact shall have two (2) NO and two (2) NC contacts rated for 240 Volts, 10 Amperes A.C. or 220 Volts, 5 Amperes D.C. Actuation set point shall be adjustable throughout the range. ON-OFF differential (difference between switch actuation and de-actuation pressures) shall be adjustable. Adjustable range shall be suitable for switch application.

11.01.16 Switches shall be sealed diaphragm, piston actuated type with snap action switch element. Diaphragm shall be of 316 SS.

11.01.18 Necessary accessories shall be furnished.

11.02.00 Timers

11.02.01 The timers shall be elector-mechanical type with adjustable delay on pick-up or reset as required.

11.02.02 Each timer shall have two pairs of contacts in required combination of NO and NC.

11.03.00 Level Gauges/Indicator/Switches

11.03.01 **Level Gauges**

i) Gauge glasses shall be used for local level indication wherever shown in the flow diagram.

ii) Gauge glasses, in general, shall be flag glass type with bolted cover. Body and cover material shall be of carbon steel with rubber lining.

iii) Level coverage shall be in accordance with operating requirements. Maximum length of a single gauge glass shall not exceed 1.4 M. Should a larger gauge glass be required, multiple gauges of preferably equal length shall be used with 50 mm overlap in visibility.

iv) Reflex type gauge glasses shall be used for colourless liquids and transparent type gauge glasses shall be used for all liquids having colour.

v) Each gauge glass shall be complete with a pair of offset valves. Valves shall have union bonnet, female union level connection, flanged tank connection, and vent and drain plug.

vi) Offset valves shall have corrosion resistant ball-check to prevent fluid loss in the event of gauge glass breakage. Valve body shall have a working pressure of 200 percent of the maximum static pressure at the maximum process fluid temperature. Valve body materials shall be of carbon steel with rubber lining.

11.03.02 **Level Indicators**

i) Float type mechanical level gauges with linear scale type indicator shall be offered for measuring level of tanks wherever shown in the flow diagram.

ii) AISI-316 stainless steel float, guide rope and tape shall be used. Housing shall be of mild steel painted with anti-corrosive painting.

iii) The scale indicator shall be provided at a suitable height for ease of reading.

iv) Accuracy shall be + 1% of scale range or better.

11.03.03 **Level Switches**

i) Level switches shall be of ball float operated magnetic type complete with cage.

ii) Materials of construction shall be suitable for process and ambient conditions. The float material shall be AISI-316 stainless steel.

iii) Actuating switches shall be either hermetically sealed mercury type or snap acting micro-switches. Actuation set point shall be adjustable. ON-OFF differential (difference between switch actuation and de-actuation levels) shall be adjustable. Adjustable range shall be suitable for switch application. All switches shall be repeatable within + 1.0 percent of liquid level change required to activate switch. Contacts shall be rated for 50 watts resistive at 240 V A.C. Number of contacts shall be two NO and two NC for each level switch.

11.04.00 Solenoid Valves

11.04.01 The body of the valves shall be Forged brass or stainless steel.

11.04.02 The coil shall be continuous duty, epoxy moulded type Class-F, suitable for high temperature operation.

11.04.03 The enclosure shall be watertight, dust-tight and shall conform to NEMA-4 Standard.

11.04.04 The valves shall be suitable for mounting in any position.

11.05.00 **Switches, Lamps, Meters Etc.**

All electrical components on the panel namely push buttons, switches, lamps, meters etc. shall meet the requirements of sub-section Electrical enclosed with the specification.

11.06.00 All local instruments shall be inspected by Employer/Consultant as per the agreed quality plan.

11.07.00 Makes of control panel and local instruments, accessories shall be as per Employer's approval.

12.00.00 **ELECTRIC MOTORS**

12.01.00 **General**

12.01.01 This clause covers the requirements of three phase squirrel cage induction motors and single-phase induction motors.

12.01.02 The motors to be furnished, erected and commissioned as covered under this specification shall be engineered, designed, manufactured, erected, tested as per the requirements specified herein. These requirements shall however be read along with the requirements of the respective driven equipment being supplied under the specification of which this specification forms a part.

12.01.03 The motor supplied under this specification shall conform to the standards specified in GTR.

12.01.04 Terminal point for all motors supplied under this specification shall be at the respective terminal boxes.

12.01.05 Materials and components not specifically stated in this specification but are necessary for satisfactory operation of the motor shall be deemed to be included in the scope of supply of this specification.

12.01.06 Notwithstanding anything stated in this motor specification, the motor has to satisfy the requirement of the mechanical system during normal and abnormal conditions. For this the motor manufacturer has to co-ordinate with the mechanical equipment supplier and shall ensure that the motor being offered meets the requirements.

12.02.00 **Codes & Standards**

12.02.21 The design, manufacture, installation and performance of motors shall conform to the provisions of latest Indian Electricity Act and Indian Electricity Rules. Nothing in these specifications shall be construed to relieve the Contractor of his responsibility.

12.02.22 In case of contradiction between this specifications and IS or IEC, the stipulations of this specification shall be treated as applicable.

12.02.23 National Electrical code for hazardous location and relevant NEMA standard shall also be applicable for motors located in hazardous location.

12.03.00 **Design Features**

12.03.01 **Rating and type**

(i) The induction motors shall be of squirrel cage type unless specified otherwise.

(ii) The motors shall be suitable for continuous duty in the specified ambient temperature.

(iii) The MCR KW rating of the motors for 50oC ambient shall not be less than the power requirement imposed at the motor shaft by the driven equipment under the most onerous operation conditions as defined elsewhere, when the supply frequency is 51.5 Hz (and the motor is running at 103% of its rated speed).

(iv) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously in the system having the following particulars :

a) Rated terminal voltage

From 0.2 to 200, KW 415V (3 Phase, solidly earthed)

Below 0.2 KW ,240 V (1 Phase, solidly earthed)

Variation in voltage + 6%.

b) Frequency 50 Hz + 3%.

c) Any combination of (a) & (b)

12.03.02 **Enclosure**

Motors to be installed outdoor and semi-outdoor shall have hose proof enclosure equivalent to IP-55 as per IS: 4691. For motors to be installed indoor, the enclosure shall be dust proof equivalent to IP-54 as per IS: 4691.

12.03.03 **Cooling method**

Motors shall be TEFC (totally enclosed fan cooled) type.

12.03.04 **Starting requirements**

(i) Induction motor

a) All induction motors shall be suitable for full voltage direct on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.

b) Motors shall be capable of withstanding the electro-dynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

c) The starting current of the motor at rated voltage shall not exceed six (6) times the rated full load current subject to tolerance as given in IS : 325.

d) Motors when started with the driven equipment imposing full starting torque under the supply voltage condition specified under Clause 12.03.01 (iv) (a) shall be capable of withstanding at least two successive starts with coasting to rest between starts and motor initially at the rated load operating temperature. The motors shall also be suitable for three equally spread starts per hour, the motor initially at a temperature not exceeding the rated operating temperature.

e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than the starting time with the driven equipment at minimum permissible voltage (clause 12.03.04 (i) (a) by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

12.03.05 **Running requirements**

(i) When the motors are operating at extreme condition of voltage and frequency given under clause no.12.03.01 (iv) the maximum permissible temperature rise over the ambient temperature of 50oC shall be within the limits specified in IS : 325 after adjustment due to increase ambient temperature specified herein.

(ii) The double amplitude of motor vibration shall be within the limits specified in IS: 4729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

(iii) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

(iv) Induction motors shall be so designed as to be capable of withstanding the voltage and torque stresses developed due to the difference between the motor residual voltage and incoming supply voltage during fast changeover of buses. The necessary feature incorporated in the design to comply with this requirement shall be clearly indicated in the proposal.

(v) Motors shall be capable of developing the rated full load torque even when the supply voltage drops to 70% of rated voltage. Such operation is envisaged for a

period of one second. The pull out torque of the induction motors to meet this requirement shall not be less than 205% of full load torque.

(vi) The motors shall be capable of withstanding for 10 seconds without stalling or abrupt change in speed (under gradual increase of torque) an excess torque of 60 percent of their rated torque, the voltage and frequency being maintained at their rated value.

(vii) Guaranteed performance of the motors shall be met with tolerances specified in respective standards.

12.04.00 **Construction Features**

12.04.01 **Stator**

(i) **Stator frame**

The stator frames and all external parts of the motors shall be rigid fabricated steel or of casting. They shall be suitably annealed to eliminate any residual stresses introduced during the process of fabrication and machining.

(ii) **Stator core**

The stator laminations shall be made from suitable grade magnetic sheet steel varnished on both sides. They shall be pressed and clamped adequately to reduce the core and teeth vibration to minimum.

(iii) **Insulation and winding**

All insulated winding conductor shall be of copper. The overall motor winding insulation for all 415 volts motors shall be of epoxy thermosetting type i.e., class 'F' but limited to class-B operating from temperature rise consideration. Other motors may be of conventional class-B type. The windings shall be suitable for successful operation in hot, humid, tropical climate with the ambient temperature of 50oC.

12.04.02 **Rotor**

(i) Rotors shall be so designed as to keep the combined critical speed with the driven equipment away from the running speed by atleast 20%.

(ii) Rotors shall also be designed to withstand 120% of the rated speed for 2 minutes in either direction of rotation.

12.04.03 **Terminal box leads**

(i) For motors of 415 Volts and below a single terminal box may be provided for power and accessories leads.

(ii) Terminal boxes shall be of weatherproof construction designed for outdoor service. To eliminate entry of dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame.

(iii) Terminal box shall be suitable for top and bottom entry of cables.

(iv) Unless otherwise approved, the terminal box shall be capable of being turned through 360o in steps in 90o.

(v) The terminals shall be complete with all accessories for connecting external cables. They shall be designed for the current carrying capacity and shall ensure ample phase to phase to ground clearances.

(vi) Suitable tinned brass compression type cable glands and cable lugs shall be supplied by the Contractor to match Employer's cable.

(vii) Terminal box for single core cable shall be of non- magnetic material.

(viii) Marking of all terminals shall be in accordance with IS : 4728.

12.04.04 **Rating Plates**

(i) Rating plates shall be provided for all motors giving the details as called for in IS:325 (for three phase squirrel cage induction motors).

(ii) In addition to above, the rating plate shall indicate the following :

a) Temperature rise in ^{o}C under normal working conditions.

b) Phase sequence corresponding to the direction of rotation for the application.

c) Bearing identification number (in case of ball/ roller bearing) and recommended lubricants.

12.04.05 **Other Constructional Features**

(i) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of Employer's earthing conductor to be specified to the successful Bidder.

(ii) Motor weighing more than 25 kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

12.05.00 **Paint and Finish**

12.05.01 Motor external parts shall be finished and painted to produce a neat and durable surface, which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all sharp edges and scales removed and treated with one coat of primer and two coats of grey enamel paint.

12.05.02 Motor fans shall also be painted to withstand corrosion.

12.05.03 All fasteners used in the construction of the equipment shall be either of corrosion resistant material or heavy cadmium plated.

12.05.04 Current carrying fasteners shall be either of stainless steel or high tensile brass.

12.06.00 Tests at Manufacturers Works

12.06.01 Motors shall be subject to routine tests in accordance with IS : 325 & IS : 4029 standards.

12.06.02 In addition, the following tests shall also be carried out :

a) 20% over speed test for 2 minutes on all rotors.
b) Measurement of vibration.
c) Measurement of noise level.
d) Phase sequence and polarity checks relative to mechanical rotation.

12.06.03 **Tests after installation at site**

(i) After installation and commissioning at site, the motors alongwith the driven equipment shall be subject to tests to ascertain their conformity with the requirement of this specification and those of the driven equipment specification and the performance data quoted by the Bidder.

(ii) In case of non-conformity of the motor with these specifications and performance requirement, the Engineer may at his discretion reject or ask for necessary rectification/replacement as detailed in general Terms and Conditions of Contract (GCC) Volume-I.

13.00.00 **BATTERY & BATTERY CHARGERS**

This clause covers the design, performance, manufacturing, construction features and testing of Battery and Battery charger used primarily for starting the diesel engine driving the fire water pumps. Battery Chargers shall be housed in Diesel Engine Panel.

13.01.00 **General Information**

13.01.01 The equipment specified hereinafter are required for starting the diesel engines and other operation of the plant as required.

13.01.02 For each diesel engine there shall be two (2) sets of Battery and two (2) sets of Battery Charger.

13.01.03 The D.C. voltage shall be obtained normally after necessary rectification by battery charger. The Battery Charging system shall be capable of meeting the following requirements :

13.01.04 Float charging the Battery.

13.01.05 Boost Charging the Battery.

13.01.06 The battery shall be large enough to crank the engine 3 times without charging in between and without getting drained to an extent which will affect its life.

13.01.07 The Bidder shall indicate the battery voltage and battery capacity in Ampere-Hour at ten (10) hour discharge rate. The battery voltage at any time during operation shall not be less than the minimum voltage required for operation of the D.C. loads.

13.02.00 **General Design**

The Battery shall be located indoor

13.02.01 **Battery**

(i) The cells shall be lead-acid type. The Battery shall be automotive type.

(ii) The cells shall be sealed in type with anti-splash type vent plug.

(iii) The cell terminal posts shall be provided with connector bolts and nuts, effectively coated with lead to prevent corrosion. Lead or lead coated copper connectors shall be furnished to connect up cells of battery set.

(iv) Positive and Negative terminal posts shall be clearly and indelibly marked for easy identification.

(v) The electrolyte shall be of battery grade Sulphuric Acid conforming to IS : 226-2962. Water for storage batteries conforming to IS : 1069 shall be used in the preparation of the electrolyte.

13.02.02 **Battery Charger**

(i) The Bidder shall furnish the battery charging scheme complete with all necessary accessories such as transformers, switches, fuses, starters, contactors, diodes, ammeters, voltmeters and other devices as required for trouble free operation. All devices and equipment shall conform to relevant Indian Standard or shall be Superior to it.

(ii) The scheme of the battery charger shall be such that the battery can be charged automatically as well as manually.

(iii) The boost charger shall have sufficient capacity to restore a fully discharged Battery to a state of full charge in eight (8) hours with some spare margin over maximum charging rate. Suitable provision shall be kept so that, for a particular engine, any of the two (2) charger units can be used for charging any of the two (2) batteries.

(iv) The instruments, switches and lamps shall be flush/semi-flush mounted on the front panel. Name plate of approved type shall be provided for each of these equipment.

(v) The panel shall be complete with internal wiring and input-output terminal block. Terminal blocks shall be clip on type of suitable rating. All equipment and wire terminals shall be identified by symbols corresponding to applicable schematic/wiring diagram.

(vi) Space heaters of adequate capacity shall be provided to prevent moisture condensation in the panel.

13.03.00 **Testing**

13.03.01 The Battery Charger shall also be subjected to the following tests at manufacturer's works as per IS - 4540

13.03.02 Insulation test.

13.03.03 Connection checking.

13.03.04 Measurement of voltage regulation.

13.03.05 Auxiliary of devices.

13.03.06 Alternating current measurement.

13.03.07 Performance test.

13.03.08 Temperature rise test.

13.03.09 Following acceptance tests shall be carried out in batteries as per IS:1651.

a) Marking and packing
b) Verification of dimensions
c) Test for capacity
d) Test for voltage during discharge

Battery and battery charger shall be checked for auto charging and providing sufficient power for three consecutive starting kicks to diesel engine within five minutes with A.C. supply switched off.

14.00.00 **CONTROL & ANNUNCIATION PANELS**

14.01.00 **Intent of Specification**

The following requirement shall be applicable to the control and annunciation panels furnished under these specifications.

14.02.00 General Information

14.02.01 The equipment specified herein are required for controlling, metering, monitoring and indication of electrical systems of the plant offered.

14.02.02 The selection and design of all the equipment shall be so as to ensure reliable and safe operation of the plant and shall be subjected to approval by the Employer.

14.02.03 The reference ambient temperature outside the panel shall be taken as 50oC and relative humidity 100%.

14.03.00 **Equipment to be Furnished**

Control & annunciation panels shall be furnished complete with all accessories and wiring for safe and trouble free operation of the plant. Details are included in sub-section General.

14.04.00 **Constructional Details**

14.04.01 The panel frames shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 2.5 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary.

14.04.02 Panels shall be of free standing type and shall be provided with hinged door with locking arrangement. The access doors, cutest and covers shall be equipped with neoprene/synthetic rubber gaskets (conforming to IS 11149-1984) all around and the latches sufficiently strong to hold them in alignment when closed. The panels to be installed outdoor or semi outdoor shall have a degree of protection of IP:55 and those installed indoor shall have a degree of protection of IP:52 as per IS:13947 Part-1.

14.04.03 If a panel consists of a number of panels, each panel should be mounted side by side and bolted together to form a compact unit, when two panels meet, the joints shall be smooth, close fittings and un-obstructive.

14.04.04 Removable eye bolt or lifting lugs shall be provided on all panels to facilitate easy lifting.

14.04.05 The heights of all operating equipment on the panel shall be between 800 mm to 1600 mm from the finished floor level. The proper supporting arrangement shall be provided by the Contractor.

14.04.06 Cable entries to the panel may be from bottom or top. The cable entry required will be intimated to the successful Bidder. A suitable removable gland plate of 3 mm thick shall be mounted not less than 200 mm above the floor level.

14.04.07 All equipment mounted on the front face of the panels shall be flush or semi-flush type. All equipment shall be so located that their terminal **and adjustment are readily accessible for inspection or maintenance and** their removal and replacement can be done without interruption of service to other equipment. The contractor shall submit the panel general arrangement drawings clearly bringing out internal mounting details, dimensions of equipment, clearance between the equipment and the edges of the panel, for approval.

14.05.00 **Name Plates and Labels**

14.05.01 Each panel shall be provided with prominent, engraved identification plates for all front mounted equipment. Panel identification name plate shall be provided at front and rear as required.

14.05.02 All name plates shall be of non-rusting metal or 3 ply lamicold, with white engraved lettering on black background. Inscription and lettering sizes shall be subjected to Employer's approval.

14.05.03 Suitable plastic sticker labels shall be provided for easy identification of all equipment located inside the panel. These labels shall be positioned so as to be clearly visible and shall give the device number, as mentioned in the wiring drawings.

14.06.00 **AC/DC Power Supply**

14.06.02 The Employer will provide one feeder each for AC and DC to the panel. The Contractor shall make for his own arrangements for providing these power supplies to different panels.

14.06.02 The Contractor shall provide suitable isolating switch fuse unit in the control panel for receiving the above incoming AC and DC supplies. Fuse and link shall be provided for isolating of individual circuit without disturbing other circuits.

14.07.00 **Wiring**

14.07.01 All inter panel wiring and connections between panels (if there is group of panels) including all bus wiring for AC & DC supplies shall be provided by the Contractor.

14.07.02 All internal wiring shall be carried out with 1100 V grade, single core, 1.5 square mm or larger stranded copper wires having colour-coded PVC insulation. CT circuits shall be wired with 2.5 square mm copper wires, otherwise similar to the above.

14.07.03 Extra-flexible wire shall be used for wiring to devices mounted on moving parts such as doors.

14.07.04 Spare contacts of auxiliary relays, timers and switches shall be wired out to the terminal blocks as required by the Employer/Engineer at the time of detailed engineering.

14.08.00 **Terminal Blocks**

14.08.01 Terminal Blocks shall be of 650V grade, rated for 10 Amps and in one- piece moulding. It shall be complete with insulating barriers, clip-on-type terminals, and identification strips. Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. It shall be similar to 'Elmex-Standard' type terminals.

14.08.02 Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal block.

14.08.03 The terminal blocks shall have at least 20% spare terminals.

14.09.00 **Grounding**

A continuous copper bus 25 x 3 mm size shall be provided along the bottom of the panel structure. It shall run continuously throughout the length of the panel and shall have provision at both ends for connection to the station grounding grid (25 x 6 mm MS Flat).

14.10.00 **Space Heater and Lighting**

14.10.01 Space heaters shall be provided in the panels for preventing harmful moisture condensation.

14.10.02 The space heaters shall be suitable for continuous operation on 240V AC, 50 Hz, single phase supply and shall be automatically controlled by thermostat. Necessary isolating switches and fuses shall also be provided.

14.10.03 Free standing panel shall have a 240V AC, plug point and a fluorescent light operated by door switch.

14.11.00 **Control and Selector Switches**

14.11.01 Control and selector switches shall be of rotary type, with escutcheon plates clearly marked to show the function and positions.

14.11.02 Control/selector switches shall be spring return or stay put type as per the requirements. Handles of control/selector switches shall be black in colour. Shape and type of handles shall be to the approval of the Employer.

14.11.03 **The contact ratings shall be at least the following :**

i) Make and carry continuously 10 Amp.
ii) Breaking current at 240V DC 1Amp. (Inductive)

iii) Breaking current at 240V DC 5 Amp. at 0.3 p.f. lagging

14.12.00 **Push Buttons**

14.12.01 Push buttons shall be spring return, push to actuate type and rated to continuously carry and break 10A at 240V AC and 0.5A (Inductive) at 220V DC. The push buttons shall have at least 1 NO and 1 NC contact. All contact faces shall be of silver or silver alloy.

14.12.02 All push buttons shall be provided with integral escutcheon plates marked with its function.

14.12.03 **The colour of buttons shall be as follows :**

Green For motor START, Breaker CLOSE, Valve/ damper OPEN.

Red For motor TRIP, Breaker OPEN, Valve/ damper CLOSE.

Black For all annunciation functions, overload reset and miscellaneous.

14.12.04 Red push buttons shall always be located to the left of green push buttons. In case of clinker grinder etc. the push buttons would be black-red-green from left to right.

14.13.00 **Indicating Lamps**

14.13.01 Indicating lamps shall be of the panel mounting, filament type and of low-watt consumption. Lamps shall be provided with series resistors preferably built-in-the lamps assembly. The lamps shall have escutcheon plates marked with its function, wherever necessary.

14.13.02 Lamp shall have translucent lamp covers of the following colours :

Red for motor OFF, Valve/damper OPEN, Breaker CLOSED.

Green for motor ON, Valve/damper CLOSED, Breaker OPEN.

White for motor AUTO-TRIP.

Blue for all healthy conditions (e.g. control supply, lub oil pressure and also for spring charged).

Amber for all ALARM conditions (e.g. pressure low, over load and also for 'service' and 'Test' position indication).

14.13.03 Bulbs and lamps covers shall be easily replaceable from the front of the panel.

14.13.04 Indicating lamps should be located directly above the associated push button/control switches. Red lamps shall variably be located to the right of the

green lamp. In case a white lamp is also provided, it shall be placed between the red and green lamps. Blue and amber lamps should normally be located above the red and green lamps.

14.14.00 **Fuses**

14.14.01 All fuses shall be of HRC cartridge plug-in-type and shall be of suitable rating, depending upon circuit requirements.

14.14.02 All fuses shall be mounted on fuse carriers, which shall be mounted on fuse-bases.

14.15.00 **Contactors**

14.15.01 Contactors shall be of air break, electromagnetic type rated as per requirement. These shall be of utilisation category AC 3 as per IS:2959.

14.15.02 Operating coils of AC contactors shall be of 240V AC or 220V DC as required. AC contactors shall operate satisfactorily between 85% to 110% of the rated voltage. The Contactor shall not drop out at 70% of the rated voltage.

14.15.03 DC contactors shall have a coil voltage of 220V DC and shall be suitable for satisfactory continuous operation at 80% to 110% of the rated voltage.

14.16.00 Relays and Timers

14.16.01 All auxiliary relays & timers shall be of proven design and of reputed make. Contacts of relays and timers shall be of solid silver or silver cadmium oxide or solid silver faced. Timers shall have the provision to adjust the delay on pick-up or reset as required.

14.16.02 All relays and timers shall have at least two NO and two NC contacts.

14.16.03 All relays and timers shall be suitable for 240V AC and 220V DC as required. DC relays shall operate satisfactorily between 70% to 110% and AC relays shall be suitable for voltage variation between 80% to 110%.

14.17.00 Indication Instruments

14.17.01 All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96 mm square size with 90 degree scales and shall have an accuracy class of 2.0 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.

14.17.02 All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustment removing or dismantling the instruments.

14.17.03 All instruments shall have white dials with black numerals and lettering. Black knife edge pointer with parallax free dials will be preferred.

14.17.04 Ammeters provided on motor feeders shall have a compressed scale at the upper current region to cover the starting current.

14.18.00 Annunciation System

14.18.01 The annunciation system shall be complete with all necessary relays, flashers and other accessories required for the proper operation of the equipment and shall be completely solid state. The control circuit shall be mounted on plug-in type glass epoxy printed circuit boards. Audible alarms for the system shall be mounted inside the panel. One set of acknowledge, test and reset push buttons shall be mounted on the panel.

14.18.02 Indications shall be engraved on Acrylic inscription plate window and shall be visible clearly when the indication lamp is lighted (black letters on white background). Each window shall be provided with two lamps.

14.18.03 Audible hooter shall sound when a trouble contact operates and shall continue to sound until the acknowledge button is pressed. In addition to the hooters provided on annunciation panels, a hooter shall be provided outside FFPH which shall sound in any fire alarm condition.

14.18.04 Indication lamps shall flash when trouble contact operates and shall continue flashing until acknowledge button is pressed.

14.18.05 After acknowledge button is pressed, the hooter and flashing shall stop but the indication lamp shall remain lighted.

14.18.06 After trouble is cleared indication lamps shall be ready and shall go off only when reset.

14.18.07 Silencing the hooter in conjunction with one trouble contact shall not stop and hooter sounding if another trouble contact operates.

14.18.08 When test button is pressed, all lamps shall flash and hooter shall sound.

14.18.09 Annunciator systems shall operate on 220V DC Systems.

14.18.10 The annunciation system shall include alarm for AC control system failure (working on DC supply), DC supply failure (working on AC supply) and test facilities for these alarms.

14.18.11 List of annunciations required on the panels has been listed elsewhere. The Contractor shall also provide additional annunciations if desired by the Employer/Engineer during Vendor drawing review stage and for such additional annunciations no extra charges shall be claimed by the Contractor, if the number of such additions are within 10% of the number stipulated in this specification.

14.18.12 20% spare windows shall be provided on the panel.

14.19.00 **Painting**

14.19.01 All sheet steel work shall be pre-treated, in tanks, in accordance with IS:6005, Degreasing shall be done by alkaline cleaning. Dust and scale shall be removed by pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "Class-C" as specified in IS:6005. The phosphated surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint on panels shall be applied. Electrostatic painting shall also be acceptable. Finishing paint on panels shall be shade 692 (smoke grey) of IS:5 unless required otherwise by the Employer. The inside of the panels shall be glossy white. Each coat of finishing shall be properly stoved. The paint thickness shall not be less than 50 microns. Finished parts shall be coated by peelable compound by spraying method to protect the finished surface from scratches, grease, dirt and oily spots during testing, transportation handling and erection.

14.20.00 **Tests**

14.20.01 Following tests/inspection shall be carried out by the Contractor in the presence of Employer's representative :

(A) **Factory Tests**

1. Compliance with approved drawings, data and specification.
2. Visual check for workmanship.

3. Wiring continuity and functional checks.
4. Calibration of instruments, relays and metres wherever required by inspector.
5. HV test
6. Insulation resistance measurement before and after HV test.

(B) **Inspection/Testing at site :**

1. IR test before and after HV test
2. HV Test
3. Functional Testing.

(C)

1. The Fire detection and annunciation panel shall be subjected to functional tests.
2. The Annunciation System shall be routine tested

APPENDIX–I

TECHNICAL DATA SHEETS

(A) DATA SHEET FOR DELUGE VALVE

1.0	Manufacturer	OPTCL Approved make
2.0	Number & size	As per approved system drawings.
3.0	Type	Differential Diaphragm type.
4.0	Rating	
4.1	Flow in M3/hr.	
	1. 150 mm ø	170 to 650
	2. 100 mm ø	50 to 225
		Working Pressure – 12.3 kg/cm^2
4.2	Pressure	
		- 25 kg/cm^2.

	Test Pressure
4.3 Pressure drop in equivalent length	
1. 150 mm ø	19M
2. 100 mm ø	11M
5.0 Material of construction	
5.1 Body	CI IS:210 Gr. FG 260
5.2 Valve internal	Cast Bronze – IS:318-LTB 2
5.3 Seat Seal	Neoprene Rubber
5.4 Diaphragm	Neoprene Rubber
6.0 Differential pressure required for operation	Differential Ratio – 50%
7.0 Water Motor Gong provided	Yes
7.1 Type	Hydraulic type
7.2 Material of Construction:	
7.2.1 Housing	Al. Alloy-IS:617
7.2.2 Cover/Rotor./Gong	Aluminium to IS:737
7.2.3 Manual actuation lever provided?	Yes
8.0 Remote actuation with Solenoid Valve provided?	Yes
9.0 Resetting type	Manual resetting type
10.0 Deluge valve complete with test and drain valves, manual operation arrangement, supporting structures and all necessary accessories.	Yes
11.0 Approval of Deluge Valve.	FM of USA, UL of USA, LPCB of U.K. or VDS of Germany

(B) DATASHEET FOR HVW SPRAY NOZZLE

1.0	Make	OPTCL Approved make
2.0	Type	High velocity water spray type
3.0	Working pressure	3.5 bar to 5 bar
4.0	Material	Brass
5.0	K factor	As per approved design & drawings
6.0	Quantity	As per approved design & drawings
7.0	Integral non-ferrous strainer provide	Yes
8.0	Approval of HVW spray Nozzle.	FM of USA, UL of USA, LPCB of U.K. or VDS of Germany

(C) DATA SHEET FOR QUARTZOID BULB DETECTORS

1.0	Make	OPTCL Approved make
2.0	Type	Quartzoid bulb type
3.0	Rated pressure	12.3 kg/ cm^2 (175 PSI).
4.0	Hydrotest pressure	30kg/cm^2
5.0	Material of construction	
5.1	Frame	Bronze
5.2	Bulb	Glass
5.3	Deflector	Copper
6.0	Temperature rating	79^oC
7.0	Quantity	As per approved drawings
8.0	Approval of Detector	FM of USA, UL of USA, LPCB of U.K. or VDS of Germany

DATA SHEET FOR OPTICAL SMOKE DECTECTOR

1.0	Manufacturer	OPTCL Approved make
2.0	Principle of operation	Light scattering by smoke particles.
3.0	Max. recommended spacing	9 m.

4.0	Normal operating temperature	-10°C to 60°C
5.0	Guaranteed to function properly	Yes. Accumulated dust to be removed without any maintenance work for periodically by blowing air a period of not less than ten (10) years
6.0	Approval of detector	FM of USA, UL of USA, LPCB of U.K. or VDS of Germany
7.0	Cabling.	2C x 1.5 sq.mm.
8.0	cables	Un-armoured PVC insulated FR conforming to IS 1554 (Part 1).

(D) DATA SHEET FOR HEAT DECTECTOR

1.0	Manufacturer	OPTCL Approved make
2.0	Principle of operation	Rate of rise-cum-fixed temperature type.
3.0	Set point of operation	5°C per minute / 55°C
4.0	Max. recommended spacing	6 m.
5.0	Normal operating temperature	-20°C to 70°C
6.0	Guaranteed to function properly without	Yes. Accumulated dust to be removed any maintenance work for a period of not less than ten (10) years periodically by blowing air.
7.0	Approval of detector	FM of USA, UL of USA, LPCB of U.K. or VDS of Germany
8.0	Cabling.	2C x 1.5 sq.mm. Un-armoured PVC insulated FR cables conforming to IS 1554 (Part 1).

(E) DATA SHEET FOR IONISATION SMOKE DECTECTOR

1.0	Manufacturer	OPTCL Approved make

3.0	Principle of operation	Ionisation of air by Radio-active source.
4.0	Radio-active source	Americium - 241
5.0	Max. recommended spacing	9 m.
6.0	Normal operating temperature	-10^{o}C to 60^{o}C
8.0	Guaranteed to function properly	Yes. Accumulated dust to be removed without any maintenance work for a periodically by blowing air. period of not less than ten (10) years
9.0	Approval of detector	FM of USA, UL of USA, LPCB of U.K**.** or VDS of Germany
10.0	Cabling.	2C x 1.5 sq.mm. Un-armoured PVC insulated FR cables conforming to IS 1554 (Part 1).

(F) DATA SHEET FOR 2C x 1.5sq.mm Un-armoured cable.

1	Make	OPTCL approved make
2	Type	Control Cable
3.	Number of cores	Two (2)
4.	Size	1.5 sq. mm.
5.	Voltage Grade	1.1 kV
6.	Applicable standard	IS:1554 Part 1
7.	Conductor Material	Plain annealed electrolytic copper
8.	Conductor construction Stranded	12.1 Ohms/kM at 20^{o}C
9	Conductor resistance.	
10	Insulation material	PVC insulation Type A as per

		IS:5831
11	Insulation thickness	0.8 mm Nominal
12	Identification	Red & Black
13	Inner sheath material	PVC compound Type ST1 as per IS:5831
14	Inner sheath thickness	0.3 mm Minimum
15	Outer sheath material	PVC compound Type ST2 as per IS:5381,FR.
16	Outer sheath thickness	1.8 mm Nominal.
17	outer sheath colour	Grey
18	Overall Diameter	As per manufacturer design data

(G) DATA SHEET FOR MANUAL CALL POINT

1.0	Manufacturer	OPTCL Approved make
2.0	Construction	Deep drawn sheet steel
3.0	Type	Break glass with push button.
4.0	Operating Voltage	24V DC ± 10%
5.0	Type of control	Pole- NO/NC
6.0	Degree of protection	IP 52
7.0	Material of housing.	M.S. 18 Gauge
8.0	Colour	FIRE RED
9.0	Accessories	Hammer & Chain assembly

(H) DATA SHEET FOR FIRE ALARM SOUNDER (HOOTER)

1.0	Manufacturer	OPTCL Approved make
2.0	Construction	Deep drawn sheet steel

3.0	Type	Dual tone/ Single tone
4.0	Operating Voltage	24V DC ± 10%
5.0	Output	Not less than 80dB(A) but not more than 120dB(A) at 1.5m distance.
6.0	Output frequency range	500Hz. to 1000 Hz.
7.0	Operating time	50 minutes (Minimum)
8.0	Material of housing.	M.S. 18 Gauge
9.0	Colour	FIRE RED
10.0	Marking	FIRE ALARM.

(I) DATA SHEET FOR GLOBE VALVE.

1.0	Nominal size in mm.	15 TO 40
2.0	Make	OPTCL approved make
3.0	Type	Globe
4.0	Number	As per approved system drawings.
5.0	Material of construction	
5.1	Body	Bronze to IS 318 Grade LTB 2
5.2	Hand wheel	Grey cast iron, grade FG200 of IS 210.
5.3	Bonnet & Bonnet Wedge	Bronze to IS 318 Grade LTB 2
5.4	Trim	Bronze to IS 318 Grade LTB 2
6.0	End connection	Screwed

7.0	Standard	IS:778	
8.0	Rating	PN 1.6	
9.0	Hydrostatic test pressure	24 kg/cm2	
9.1	Body	16 kg/cm2	
9.2	Seat		

(J) DATA SHEET FOR GUN METAL GATE/ SLUICE VALVE.

1.0	Nominal size in mm.	15 to 40	50 to 300
2.0	Make	OPTCL	Approved make
3.0	Type	Gate/Sluice	
4.0	Number	As per approved system drawings.	
5.0	Material of construction		
5.1	Body	Bronze to IS 318 Grade LTB 2	Grey cast iron, grade FG200 of IS 210.
5.2	Hand wheel	Grey cast iron, grade FG200 of IS 210.	
5.3	Bonnet & Wedge	Bronze to IS 318 Gr.LTB 2	Grey cast iron, grade FG200 of IS 210.
5.4	Stem	High tensile brass, grade HT1 or HT2 of IS:320	Stainless steel
6.0	End connection	Screwed	Flanged
7.0	Standard	IS:778	IS:14846
8.0	Rating	PN 1.6	

9.0	Hydrostatic test pressure	24 kg/cm2
9.1	Body	16 kg/cm2
9.2	Seat	

(K) DATA SHEET FOR FLOAT OPERATED VALVE

1.0	Manufacturer	OPTCL Approved make
2.0	Type	Float operated valve
3.0	Size	100 MM
4.0	Quantity	2 nos.
5.0	Material of construction	
5.1	Body	Cast Iron (IS:210 FG:200)
5.2	Seat Ring	Gun Metal (IS:318, LTB-2)
5.3	Disc Ring	Gun Metal (IS:318, LTB-2)
5.4.	Spindle	13% Cr. Stainless steel
5.5	Piston	Cast Iron (IS:210, FG:200)
5.6	Lever	Mild Steel (IS:226)
5.7	Float	Tin Coated Copper
5.8	Fulcrum	Mild Steel (IS:226)
5.9	Pilot Valve	Stainless Steel (AISI-304)
5.10	Gland Packing	Graphited Asbestos Rope
5.11	Bonnet	Cast Iron (IS:210, FG:200)
6.0	Hydrostatic test pressure	
6.1	Body	15 kg / cm2

6.2	Seat	10 kg / cm2
7.0	End connection	Flanged connection

(L) DATA SHEET FOR CHECK VALVES (NON-RETURN VALVES)

1.0.0	Make	OPTCL Approved make
1.1.0	Type	Swing Check Type
1.2.0	Standard followed	IS;5312
1.3.0	Rating	PN 1.6
1.4.0	Material of construction,	Dimensions. As per IS;5312
1.5.0	Inlet Outlet details	Flanged Hydraulic test pressure, kg/cm2
1.6.0		
1.6.1	Body	24
1.6.2	Seat	16

APPENDIX -II

VENDOR LIST FOR FIRE PROTECTION PACKAGE

S.No.	Equipment/Material	Make
1.	Pumps (Horizontal Centrifugal)	KBL/M&P/B&C
2.	Motors (L.T.)	RAJENDRA ELECT.IND./GEC SIEMENS/ ABB/CROMPTON
3.	Diesel Engine	Ruston & Hornsby (Greaves)/ KIRLOSKAR OIL ENGINE LTD
4.	Air Compressor	KGK/ELGI/INGERSOL RAND
5.	Batteries	EXIDE/AMCO/AMARA RAJA
6.	M.S./G.I Pipes	JINDAL/PRAKASH/ SAIL/ LLOYD METALS & ENGINEERS LTD.
7.	C. I. Valves (Gate & Check)	H. Sarkar/Venus/Kalpana
8.	Gun Metal Valves (Globe)	Leader
9.	Float operated Gate Valve	Levcon/Sigma
10.	Deluge Valve	ACE Turnkey/H.D. Fire

11.	Strainer (Y-Type & Basket Type)	Grandprix/Jaypee/Multitex/ Gujarat Otofilt
12.	Hume pipe	Indian Hume Pipe/Pargate Concrete Udyog Delhi
13.	H. V. Spray Nozzles	H.D. Fire/ACE Turnkey
14.	Q. B. Detectors	H.D Fire/ACE Turnkey
15.	Pressure Gauge	H. Guru/General Instrument
16.	Pressure Switches	Indfos/Switzer/Verma Trafag
17.	Level Switches	Levcon/Sigma
18.	Level Indicator	Levcon/Sigma
19.	Level Gauge	Levcon/Sigma
20.	Hydrant Valves & Accessories	Sukan/Shah Bhogilal
21.	Hoses (Flax Canvas)	Jayshree Calcutta/Newage
22.	Solenoid Valves	AVCON/ROTEX
23.	Heat & Smoke Detectors	Apollo, U.K. /Pyrotonics / System Sensor/ Nittan
24.	Cables	Polycab/PRWE/GEMSCAB/ KEI/PARAMOUNT
25.	Fire Extinguishers	Nitin/Vijay Fire/Lightex/ Zenith/ Minimax
26.	Fire alarm Panels	ECD
27.	Annunciators	Peacon/Piri/Procon
28.	Dished Ends	Anoop Engg./Motilal/Kanara
29.	Local control panels & Annunciation panels.	Suchitra/Vikas Engg./UNILEC/JASPER/ MIKA/ Bose corporation.

30.	Response Indicators/Hooters	M.C. Engineering Delhi/
	Break Glass Units	Maths, Bombay/ Mehta & Associates, Ahmedabad.

ODISHA POWER TRANSMISSION CORPORATION LIMITED

Technical Specification
For
400 / 220/132/33KV Gas Insulated Switchgear (GIS)

CONTENTS

400 / 220 / 132 KV GIS SUB-STATION SYSTEM

GENERAL DESCRIPTION OF GAS INSULATED SWITCHGEAR .

STANDARD SPECIFICATIONS

The switchgear conforms to the following IEC standards:

SWITCHGEAR, GENERAL:

IEC 62271-1 : High-voltage switchgear and control gear Part 1: Common specifications

IEC 62271-203 : High-voltage switchgear and control gear Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV Circuit-breakers:

IEC 62271-100 : High-voltage switchgear and control gear Part 100: Alternating-current circuit-breakers

IEC 62271-101 : High-voltage switchgear and control gear Part 101: Synthetic testing Disconnectors, earthing switches.

IEC 62271-102 : High-voltage switchgear and control gear Part 102: Alternating-current dis connectors and earthing switches Instrument transformers:

IEC 62271-303: High-voltage switchgear and control gear – Use and handling of sulphur hexafluoride (SF_6)

IEC 61000 Electromagnetic compatibility (EMC)

IEC 60060 High voltage test techniques

IEC 60071 Insulation co-ordination

IEC 60255 Electrical relays

IEC 60265 High voltage switches

IEC 60270 High-voltage test techniques - Partial discharge measurements

IEC 60376 Specification and acceptance of new sulphur hexafluoride

IEC 60480 Guide to checking of sulphur hexafluoride (SF_6)

IEC 60529 Degrees of protection provided by enclosures (IP Code)

IEC 60815 Guide for the selection of insulators in respect of polluted conditions

IEC 61869 Instrument transformers

IEC 60364 / 60479 / 60621 / IEEE std. 80 Standards for station grounding.

CENELEC/SVDB Pressure vessel codes

CABLE CONNECTIONS:

IEC 62271-209: High-voltage switchgear and control gear Part 209: Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52 kV – Fluid-filled and dry- type cable-terminations

OUTDOOR BUSHINGS:

IEC 60137 : Insulated bushings for alternating voltages above 1000 V Transformer direct connection:
IEC 61639 : Direct connection between power transformers and gas-insulated metal-enclosed switchgear for rated voltages of 72.5 kV and above.

SURGE ARRESTERS:
IEC 60099-4: Surge arresters Part 4: Metal-oxide surge arresters without gaps for A.C. Systems SF6-Gas:
IEC 60480: Guidelines for the checking and treatment of sulphur hexafluoride (SF6) taken from electrical equipment and specification for its re-use
IEC/TR 62271-303: High-voltage switchgear and control gear Part 303: Use and handling of sulphur hexafluoride (SF6)

LOCAL CONTROL CUBICLES:
IEC 61439 -1: Low-voltage switchgear and control gear assemblies Part 1: General rules EMC.
IEC 62271-1: High-voltage switchgear and control gear Part 1: Common specifications The enclosures of the switchgear conform to the following EN standards:

ENCLOSURE

CENELEC standard mentioned above.

MODULAR DESIGN
Housings and expansion joints together form the pressure-resistant enclosure of the switchgear. The housings are made of cast or welded aluminium, the expansion joints of high-grade steel and the covers of steel or aluminium. The switchgear modules are single-phase or three-phase encapsulated.

The manufacturing and testing of the housings are state-of-the-art technology. Each, housing is subject to a pressure and gas tightness test and complies with the requirements of the relevant CENELEC standard.

SURFACE TREATMENT
Steel (covers):
Indoor structure: Hot galvanised or painted
Outdoor structure: Hot galvanised and painted
High-Grade Steel (expansion joints):
Indoor Pre-treatment: none
Paint work: none
Outdoor Pre-treatment: degrease
Paint work: same as housings of cast aluminium

CAST-ALUMINIUM:
Pre-treatment (indoor and outdoor): Sand-blast or degrease alkaline
Internal surfaces (cast-aluminium): Seevenax protective paint **RAL 7038** (grey)
Internal surfaces (aluminium wrought alloy): without surface treatment
External surfaces: material description: high-resistant 2-component polyurethane paint
Shade: RAL 9010 (white)

GAS

Gas compartments, monitoring of gas compartments:

• SF6 serves as insulation for the enclosure of several separately-sealed gas compartments

• static filters in all gas compartments – with single-phase encapsulation for each phase for single phase encapsulation design - absorb moisture and decomposition products; the filter material is placed in filter bags which are supplied in airtight cans

• all gas compartments are equipped with rupture diaphragms and, if necessary, with gas diverter nozzles; these nozzles are arranged in a way that, if the rupture diaphragm bursts, the gas flow is guided away in a direction not unnecessary hazardous to either personnel or equipment

• the modules of circuit-breakers, voltage transformers, cable connection module and surge arresters form separate gas compartments.

• the disconnector gas compartment can contain other device earthing switch

• the switch operating shafts are supported and provided with lip seals against pressure and vacuum loss in such a way that during the evacuation process before commissioning no air can penetrate and no SF6 can escape during operation; the leakage rate is less than 0.5 % SF6 per year and gas compartment.

• the gas pressure is monitored by density monitors with indication; density monitors are installed directly at the gas compartment they monitor.

1. GENERAL SPECIFICATION

The intent of this specification is to provide the work enumerated to be fully complete in every detail for the function designated. It is hereby required that the BIDDER, in accepting the contract, agrees to furnish all apparatus, appliances, material not herein specifically mentioned or included, but which may be found necessary to complete, perfect or test any portion of the apparatus or equipment herein specified in a substantial manner, and in compliance with the requirements implied in this specification and without extra cost to the PURCHASER/OWNER. The GIS manufacturer should have (1) prompt after sale service support having based in India (2) having HV testing kit & (3) provide supporting documents for the same.

NOTE: The Bus of the 400kV, 220 KV, 132kV & 33 KV GIS System shall be of **Aluminum** of adequate size and should be capable of withstanding the short circuit current level of 50kA, 50kA, 40 KA & 31.5 KA respectively for 3 sec. Care should be taken while designing the GIS system.

The tender work shall be carried out in accordance with the requirements of this specification and shall include design, manufacture, supply, testing at the factory, shipping to site, installation and testing at site and commissioning of the GIS and associated equipment.

Remarks: The type of exit termination shall be as defined in the Single Line Diagram.

EQUIPMENTS TO BE SUPPLIED BY THE BIDDER:

The apparatus shall include but not be limited to the following:

(A): To be used in GIS.

1. Circuit breakers
2. Dis connector switches (Bus / Line)
3. Maintenance earthing switches
4. Fast acting line earth switches
5. Bus Pts in 400/220 / 132/33kV side
6. SF6 Bus – duct

7. Current transformers
8. Surge arrester
9. Bus and elbow sections
10. Cable end enclosures.
11. SF6 to air bushings / cable terminations
12. Ground connection to the station ground grid
13. Auxiliary material to complete the GIS installation (like density switches, auxiliary power/control cable and bolts)
14. Support structures for the GIS
15. Insulating SF6 gas
16. Local Control Cubicle
17. Special tools for installation, monitoring, testing & maintenance
18. Commissioning spares
19. Protection control and sub-station automation system with IEC 61850.

(B) Following equipment to be used in AIS:
1. Surge Arrester. (400 KV, 220KV & 33 KV side)
2. Line Capacitor Voltage Transformer: 400/220/132 KV side.
3. 33/0.43 KV,250 KVA Station Transformers

(C) Following auxiliary system also to be supplied.
1. ACDB, DCDB, other Switch Boards to be installed in the Switch yard and in other areas etc.
2. Fire Fighting, smoke detection facilities as per requirement.
3. Station Batteries, PLCC Batteries, Battery Chargers.
4. Control & Power Cable as per requirement.
5. XLPE Power Cables for 33 KV Side (From Transformer to 33 KV side GIS & from 33 KV GIS to Station Transformers).

SERVICES TO BE SUPPLIED BY TENDERER:

1. All equipment and material shall be prefabricated, factory assembled, tested and shipped in the largest practical assemblies dependent on the mode of transport.
2. The Tenderer shall provide documentation as required in this specification.
3. The Tenderer shall provide the services of operation & maintenance for the purpose of installation, testing & commissioning and on-site training.
4. Construction of GIS Building for 420kV, 220 KV and 33 KV sides, Power Transformer foundations, Foundations for switch yard columns & equipment etc.
5. Construction of concrete & bitumen roads, drainage system, Site surfacing, Fencing etc.
6. Construction of Control room Building & Quarters.
7. Sub-station earthing & Illumination for switchyard and other buildings.

All additional apparatus and services, listed below, which are required to successfully complete the GIS installation shall be supplied by the purchaser.

1. All detailed engineering for civil works for foundations of equipment/ tower gantry, embedded steel, cable ducts. The erection of GIS & auxiliaries building shall be done by purchaser based on the detailed engineering done & civil drawings issued for erection by purchaser.
2. Sealing ends
3. High Voltage cable
4. Overhead line connection
5. Auxiliary voltage supply
6. Station earthing

2. ELECTRICAL RATINGS:

The GIS equipment shall be provided with one enclosure per phase for all gas compartments. The apparatus shall have the following basic electrical and design characteristics**:**

			420kV / 220 KV / 132kV
i)	Phase design		1-ph (420kV), 1-ph or 3-ph (for 220 & 132 kV)
ii)	Rated voltage	KV	420 / 245 / 145

	A	Rated lightning impulse withstand voltage (peak) phase to earth Across open contacts	KV KV	1425 / 1050 / 650 1425+240 / 1050+206 / 650+100
	B	Power frequency 1 minute (r.m.s.) phase to earth Across open contacts	 KV KV	 650 / 460 / 275 815 / 460+145 / 315
iii)	Rated frequency		Hz	50
iv)	Rated current (bus bars) [At 40°C]		A	4000A for 400kV & 3150A for 220kV & 132kV
v)	Rated short-time current (r.m.s) (3s)		KA	50 / 50 / 40
vi)	Rated making current (peak)		KA	135 / 135 / 108
vii)	Rated short circuit breaking current		KA	50 / 50 / 40
viii)	Partial discharge level, complete bay 1.5 x U//3		pC	< 5
ix)	SF6 gas pressure at 68 ºF / 20 ºC, for reference		kPa	Shall be submitted by the manufacturer.
x)	Enclosure			*Aluminium alloy

***Aluminum alloy: All external enclosure shall be of Aluminium alloy.**

3. EQUIPMENT SPECIFICATION

It is understood that each manufacturer has their own particular GIS design concept and it is not the purpose of this specification to impose any unreasonable restrictions. However, in the interest of safety, reliability and maintainability, the switchgear offered shall meet the following minimum requirements stipulated herein.

3.1 General

The GIS shall be made of tubular Aluminum alloy and filled with SF6 gas for insulation. Enclosures shall be of single phase for 400kV & 1-ph / 3- phase encapsulation for 245kV and 145kV for both the bus bars and the feeder section bays.

The switchgear shall be modular in design. Future extensions shall be easily accomplished by adding extra feeders without dismantling any major parts of the equipment. As much as possible the parts shall be of standard manufacture with similar parts and assemblies being interchangeable. The tenderer is encouraged to offer an optimized physical layout regarding minimized space requirements and maintainability.

Shipping sections which are tested in the factory shall be jointed in the field by using bolted and sealed flange connections only. Field welding of enclosures is not acceptable. The size of the per-assembled shipping sections shall be as big as practical for transportation. Complete station assembly in the factory for testing purpose and dis assembly for shipping is not preferred.

The flanged connections shall have gas seals between the flange surfaces. For outdoor application, suitable means shall be used to protect the gas seal from the external environment. Connections including bolts and nuts shall be adequately protected from corrosion and easy accessible with the proper tools.

Tenderer shall confirm the nominal rating of GIS components at **50°C**

Bus Potential Transformer (PT) shall be provided with additional disconnector as shown in the Single Line diagram.

3.1.1 SECTIONALIZATION

The switchgear must be sectionalized, with gas tight barriers between sections or compartments. The sections shall be designed

i) To minimize operational shut down when the gas pressure is reduced due to Leakage or for maintenance purposes.
ii) To minimize the quantity of gas that has to be evacuated and recharged before and after maintaining any item of equipment.

Continuous bus lengths without gas segregation shall not be acceptable.

Each section shall be provided with necessary valves to allow evacuation and refill of gas without evacuation of any other section.

The gas system proposed shall be submitted with the proposal. External fixtures shall be of non-corrosive material and be capped wherever required.

For the purpose of gas monitoring and maintenance, the GIS shall be provided with gas density monitoring device along with temperature compensated gas density switch having two stage contacts in each gas compartment.

Pressure relief devices shall be used where ever required.

3.1.2 CONDUCTOR TYPE AND CONTACTS

Conductors shall be made of **Aluminum** suitable for the specified voltage and current ratings. The electrical connections between the various gas sections shall be made by means of multiple contact connectors (plug-in type) so that electrical connection is automatically achieved when bolting one section to another. Field welding of the conductor is not acceptable. The surface of the connector fingers and conductor tubes on such connections shall be silver plated.

3.1.3 SUPPORT INSULATORS AND SECTION BARRIERS

Support insulators shall be used to maintain the conductors and enclosure in proper relation.
Barrier insulators which are employed to isolate gas compartments as well as support insulators shall be manufactured from high quality epoxy resin, free of all voids and be designed to reduce the electrical stress on the insulators to a minimum. The support insulator shall have holes on both sides for proper flow of gas.

The mechanical strength must be sufficient to ensure the conductor's space requirements and clearances when short circuit faults occur. In addition, the gas barrier insulators sealing to the conductors and the enclosure wall shall be designed to withstand the maximum gas pressure differential under normal operating condition and maximum pressure differential with one of the adjacent enclosures at three times operating gas pressure and the other at atmospheric pressure for five minutes. Its safety factor shall be no less than 4.5.

Tests shall be carried out during the manufacturing of the switchgear to ensure that all insulators are free of partial discharge at a voltage which is at least 10% higher than the rated voltage.

3.1.4 GAS SYSTEM

The GIS shall be furnished with sufficient sulfur hexa-fluoride (SF6) gas to pressurize the complete system in a sequential approach, one zone or compartment at a time to the rated nominal density. During commissioning the dew point of SF6 gas shall be measured and documented. Maximum water content of SF6 -gas in GIS, within guarantee period:

CB **≤ 1**50 PPM (volume)

Others **≤** 500 PPM (volume)

The Gas loss of the switchgear shall be in no case higher than 0.5% per year (as per IEC62271-203) .

3.1.5 GAS SEALS

All gas seals shall be designed to ensure that leakage rates are kept to an absolute minimum under all normal pressure, temperature, electrical load and fault conditions. All gas seals located in the flanges of the equipment enclosures shall be of the O-ring type. The material and method of sealing used shall be stated in the tender.

3.1.6 GAS FILTERS / TREATMENT

Each gas compartment shall be fitted with gas filters, driers or desiccants for the absorption of moisture and the gaseous products of switching. The filter shall be effective for the duration of time between major overhaul. It shall be possible to replace the active material of the filter without extensive dismantling. The absorbent shall be located in an easy accessible location. The tenderer shall indicate the detail and type of filters used in the various gas sections

3.1.7 SF6 GAS QUALITY

The GIS shall be designed for use with SF6. All SF6 gas supplied as part of the tender shall comply with the requirements of IEC 60376 at a minimum.

3.1.8 GAS MONITORING DEVICES

Temperature-compensated gas density monitoring devices shall be provided for each gas compartment. The devices shall provide continuous and automatic monitoring of the density of the gas. The monitoring device shall have two alarm settings. These shall be set so that:

First stage: Advanced warning can be given that the gas density is approaching an unacceptably low level

Second stage: The relevant GCB can be locked for tripping/ closing.

3.1.9 GAS LOSS

Maximum guaranteed gas leakage loss of the switchgear shall be in no case be more than **0.5%** per year.

3.1.10 SF6 GAS TREATMENT

Under normal operating conditions it shall not be necessary to treat the insulating SF6 gas between major overhauls. Normally closed valve shall be provided to facilitate filling and recharging. In all gas compartments permanent efficient filters and drying agent shall be at least effective for the duration of time between major overhauls. The filters shall be capable of absorbing the by-products of SF6 gas during interruption.

3.1.11 SUPPLY OF SF6 GAS

The tender shall include the supply of all SF6 gas necessary for filling and putting in commercial operation the complete switchgear installation with recommended extra quantity (minimum 10% extra).

3.1.12 PRESSURE RELIEF

Automatic external pressure relief devices shall be incorporated in the basic design as a precaution against bursting of enclosure. Internal pressure relief devices shall not be acceptable. The bursting pressure of the relief device shall be effectively coordinated with the rated gas pressure and the pressure rise due to arcing to avoid any mal-operation in normal operating conditions. Deflection devices shall be installed to ensure that personnel will not be endangered. Pressure relief shall be by means of a metallic bursting disc system with a preset opening pressure. For better gas tightness, bursting discs made of graphite or non-metallic material shall be avoided.

3.1.13 SWITCHGEAR ENCLOSURES

The metal enclosures for the GIS equipment modules shall be made from Aluminum alloy and tubular in construction. The tenderer shall state the material used for his particular design. All flanges shall be directly bolted together with good metallic contact to make enclosures equipotential.

Enclosures shall withstand normal and transient pressure in operation. They shall be designed and manufactured according to the related standards to guarantee safety and reliability of material, construction, welding technology and testing.

Enclosures shall be designed to withstand any internal arc specified in IEC 62271-203.

The gas-filled enclosures shall comply to the pressure vessel code applied in the country of manufacturer and shall be suitable for purchaser's environmental condition.

3.1.14 EXPANSION JOINTS AND FLEXIBLE CONNECTION

Expansion and installation alignment shall be considered in the design of the bus and enclosure. The continuity of service during thermal expansion / contraction and vibrations shall be ensured. The switchgear shall be fixed to the floor with minimum requirement on floor preparation. If required, expansion joints shall be provided with compensator for the enclosure and sliding plug-in contacts for the conductors. Expansion joints and flexible connections shall be considered in the design of the bus and enclosure to take care of thermal expansion / contraction and vibrations during service and to absorb the relative movement between the switchgear equipment and its fixing structure / floor. The position of expansion joints or flexible connections are to be considered by the manufacturer to ensure that the complete installation will not be subject to expansion stresses which could lead to distortion or failure of any piece of the SF6 equipment, support structures or foundations. These expansion joints shall be provided with each bay, which will provide maximum tolerance and the flexibility during the installation & maintenance.

Also, expansion joints, flexible connections and adjustable mountings shall be provided to compensate for reasonable manufacturing and construction tolerances in the associated equipment to which the GIS may be connected. This is to ensure that unreasonably excessive accuracy is not required when installing such equipment and constructing the associated foundations or support structures, e.g. transformers or the interconnection of isolated sections of switchgear by means of long GIS bus bar or duct installations. Flexible joints may also be provided to allow more efficient maintenance and future extensions of the GIS.

3.1.15 FINISH OF SURFACE AND CLEANING

The finish of interior surfaces of the GIS enclosures shall facilitate cleaning and inspection. Any paints or other coatings that may be used shall not deteriorate when exposed to the SF6 gas and arc products, etc., that may be present in the enclosures. They shall not contain any substances which could contaminate the enclosed SF6 gas or affect its insulating properties over a period of time.

The equipment shall be manufactured and assembled at the manufacturer's works under conditions of the utmost cleanliness. Before factory tests and packing for shipment, interior surfaces, insulators, barriers etc., must be thoroughly cleaned.

3.1.16 SUPPORTING STRUCTURES

All supporting structures necessary for the support of the GIS equipment including associated parts such as anchor bolts, beams etc. shall be supplied.

Access has to be considered in the design of the structures to all equipment of the GIS. It has to be possible to surround the GIS with the gas cart.

The specified stresses for outdoor equipment like wind, earthquake, snow, ice and thermal expansion due to current and sun radiation have to be considered.

Proper surface treatment for all parts especially in outdoor situation has to be considered. All steel members have to be hot-dipped galvanized according to DIN standards for heavily polluted environment.

3.1.17 FUTURE EXTENSION

For any type of bus bar configuration, it shall be possible to extend the switchgear by adding future feeders as decided by the owner with at least one of the bus bar systems service continuously and the existing feeders remaining in service continuously. The Vendor is required to demonstrate clearly in his submitted documents the suitability of the switchgear design in this respect.

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3.1.18 REPAIR

In case of any internal fault in the bus bar or bus bar dis - connector, circuit breaker, repair works must be possible with at least one busbar in service

Any failure shall be immediately signaled by the systems inherent self-supervision with clear description of the nature and the location of this failure. Generally any failure shall have impact only on the direct related devices and the rest of the substation shall remain in normal operation.

3.1.19 REMOVAL OF COMPONENTS

The GIS shall be designed so that any component of the GIS can be easily removed. As minimum flexibility in the layout arrangement, it shall be possible to remove the circuit breaker with both bus bar remaining in service and it shall be possible to remove the dis connector of the bus bars, with one bus bar remaining in service.

3.1.20 EARTHING OF THE SWITCHGEAR

(a) EARTHING OF MAIN CIRCUITS

To ensure safety during maintenance work all parts of the main circuit, to which access is required, shall be provided with facilities for connecting removable earthing device, after opening the enclosure, on the circuit element which is previously earthed via main earth switch.

(b) EARTHING OF ENCLOSURE

The enclosure shall be connected to earth. All metal parts other than main and auxiliary circuits shall be earthed.

Separate earthing strips to short circuit flanges and earth switches are not allowed. Earthing switches shall be connected to earth through enclosures. Individual earth leads for the earth Switches are not recommended.

The continuity of the earthing circuits shall be ensured taking into account thermal and electrical stresses caused by the current they have to carry.

Each of the earthing strips shall be connected to the main earthing mesh installed below the GIS, at two ends.

(c) EARTHING OF GIS

The earthing system shall be based on a multi-point design ensuring the protection in case of indirect contact (Touch or step voltages, in case of system fault) and transient phenomena in case of lightning or switching operations.

Earthing conductors shall allow fault with short circuit current for at least 1 sec. Separate ground strips to short circuit flanges and earthing switches are not allowed. Grounding switches shall be connected to ground through the enclosure. Individual ground leads for the ground switches are not allowed.

3.1.21 AUXILIARY CONTACTS

Each equipment shall be furnished with adequate number of electrically independent contacts at user's disposal. They shall be wired to terminals located in the local control cabinet of the circuit breaker bay. Installation of auxiliary relays (contact multiplication) may be used to meet the overall control and protection requirements.

3.1.22 SPECIAL TOOLS

Any special tools needed for installation, operation and inspection shall be included in the quotation. **These special tools shall be supplied along with the GIS and shall not be taken back by the bidder.** For gas handling purpose following tools shall be quoted as a minimum:

i) Dew point meter
ii) Leakage detector
iii) Precision pressure gauge

3.2 TECHNICAL SPECIFICATION OF THE HIGH VOLTAGE COMPONENTS OF GIS

3.2.1 CIRCUIT BREAKER

1. General

The GIS circuit breakers shall comply with the following general requirements for circuit breakers and the latest revisions of the relevant IEC specifications.

Circuit-breakers shall be the SF6 gas insulated type of single phase for 400kV or single phase insulated & three phase encapsulated for 220kV & 132kV design with the specified ratings. The breaker shall be Self-Blast / auto Puffer type principle and consist of one interrupting arcing chambers.

Each circuit-breaker including the drive mechanism shall be completely factory assembled, adjusted and tested. The breaker shall include a suitable operating mechanism to assure proper opening and closing, and shall permit checking adjustments and opening characteristics. Each mechanism shall include dual trip coils in redundant design. The mechanism shall be capable of re-closing within the range specified in the applicable standards. The breakers are to be re-strike-free. The Circuit breaker shall be C2 class type and 400 kV, 'k' should be 1.4 times.

Breaker disposition must be horizontal horizontal to provide higher mechanical stability and ease in maintenance. The operating principle of the breaker shall ensure minimized dynamic floor loading. Low reaction forces on foundations especially dynamically, are favorable and considered in the evaluation.

2. Technical Particulars

		420kV / 220 KV / 132kV
Nominal operating Voltage	kV	400 / 220 / 132
Highest system Voltage	kV	420 / 245 / 145
Nominal operating current(at 40°C)	A	4000A (400kV) 3150 (220 & 132kV)
System earthing		Solidly earthed
Rated withstand voltage with respect to earth		
Lightning	kV	1425+240 / 1050 / 650
Power frequency	kV	815 / 460 / 275

Rated short-circuit breaking current (r.m.s.), 3s:	kA	50 / 50 / 40
Rated making current (peak):	kA	135 / 135 / 108
Rated break time	ms	< 2 cycle
Rated opening time	ms	As per IEC-62271-100
Rated closing time	ms	< 5 cycle
Close-open time	ms	As per IEC-62271-100
Rated cable and line charging breaking current	A	400 (400kV), 250 & 125 (220kV)
Number of breaks per pole	Nos.	1
First pole to clear factor		1.3 minimum
Operating mechanism :		Spring-Hydraulic/Spring
Rated operating sequence		O-0.3s-CO-3 min-CO / CO-15sec-CO
Time for recharging CO cycle		
Type		Spring-Hydraulic/Spring
Number of trip coils		2 in each pole
Number of closing coils		1 in each pole
Rated control voltage (DC)	V	220 DC
Number of operations permissible without maintenance: At no load At rated current At 40/50 kA	 CO CO CO	 10'000 2000 20

Auxiliary electrical equipment shall be suitable for operation on the following supply system.

(a)	Power Devices like drive Motors of rating maximum 1 KW	415 V, 3 phase 4 wire/230V 50Hz, neutral grounded AC supply.
(b)	Lighting, space heaters and Fractional KW motors.	240 V, single phase, 50 Hz neutral grounded AC supply.
(c)	Alarm, control and Protective devices.	220 V DC, 2 wire

Each of the foregoing supplies shall be made available by the Purchaser at the terminal point for each circuit breaker for operation of accessories and auxiliary equipment. Supplier's scope include supply of interconnecting cables, terminal boxes etc. The above supply voltage may vary as below and all devices shall be suitable for continuous operation over entire range of voltages.

I) AC supply : voltage ± 10% frequency ± 5%

II) DC supply : - 15% to + 10%

3. Constructional features

All making and breaking contacts shall be designed to have adequate thermal and current carrying capacity for the duty specified and to have a life expectancy so that frequent replacements due to excessive burning will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.

Main contacts shall be first to open and last to close so that there is little contact burning and wear. Contacts shall be kept permanently under pressure of SF6 gas.

Arcing contacts shall be first to close and last to open. These shall be easily accessible for inspection & replacements.

Any devices provided for voltage grading to damp oscillations or to prevent re-strike prior to the complete interruption of the circuit or to limit over voltage on closing shall have a life expectancy comparable to that of the beaker as a whole.

Breaker shall be so designed that when operated within its specified rating, the temperature of each part is limited to the values consistent with a long life or the material used. The temperature shall not exceed the values indicated in IEC60694 under specified ambient conditions.

The material used in the construction of the circuit breaker shall be such as to be fully compatible with SF6 gas decomposition products.

All gasket surfaces shall be smooth, straight and reinforced.

4. Breaking capacity

The total breaking time from energizing of the trip coil at rated control voltage to final arc extinction shall be as short as possible.

The circuit breaker shall be capable of breaking all currents from zero up to the specified maximum fault current in accordance with the relevant IEC publications. Official test reports shall be submitted with the tender as evidence that the offered circuit breaker meets the specific rating.

5. Interrupting Duty:

Circuit breakers must be capable of coping with the interrupting duties produced by the switching of transformer magnetizing currents, line charging currents, cable charging currents, capacitor banks, short-line faults and out-of-phase switching duties.

6. Auto-reclosing

The circuit-breakers shall be capable of tripping and re closing according to the specified duty cycle.

7. Closing devices

All electrically operated closing devices and any mechanism charging motors or devices shall be suitable for operation at any voltage between 110% and 85% of the nominal control voltage measured at the device terminals.

The breaker shall close correctly when an electrical closing pulse of 50 ms duration is applied to the closing coil.

Closing coil rating shall be as per GIS manufacturers standard.

8. Tripping devices

All electrical tripping devices shall be suitable for operation at any voltage between 110% and 70% of the nominal voltage, measured at the device terminals. Tripping device tolerance shall be as per IEC/ANSI.

An emergency hand tripping (mechanical) device shall be provided in the operating mechanism.
Trip coil rating shall be as per GIS manufacturers standard

9. Operating mechanism

Spring-Hydraulic operating mechanism/spring operating mechanism shall be supplied for each circuit-breaker. The operating mechanism should be spring loaded for single and three pole operation in any type of mechanism. Electric motor for the mechanism shall be DC operated. In case of failure of auxiliary supply, the mechanism shall have sufficient energy stored to perform at least a O-CO cycle. Additionally, it should also be possible to operate the mechanism manually as a safety requirement (e.g. to ensure that the stored energy has been released in case of any assembly, maintenance or replacement work)

In order to reduce maintenance work and outage time, pneumatic operating mechanisms or pure hydraulic mechanism is not be accepted.

The mechanism shall be strong and rigid and shall be suitable for high speed auto re-closing and other duties specified.

The mechanism shall be anti-pumping and trip free under every method of closing.
Spring operated mechanisms shall be complete with all control equipment. The only external requirement for operation shall be electrical supply.

Spring-Hydraulic operated mechanisms/spring operating mechanism shall be complete with all control equipment. The only external requirement for operation shall be electrical supply. Hydraulic pipe working on site or common system for substation shall not be acceptable.

Low stored operating energy shall be detected as per following operations:

1. start pump motor/spring charge motor
2. block auto-reclosing if stored operating energy is insufficient to complete a break-make-break operation
3. block closing if stored operating energy is insufficient to complete a make-break operation
4. block tripping if stored operating energy is insufficient to complete a break operation

Charging of the operating mechanism shall be possible in the event of failure of the motor drive.

The mechanism shall be in a dust and vermin proof box for indoor installation or in a weatherproof box for outdoor installation.

Each breaker shall have sufficient auxiliary switches all wired to terminals located in the local control cubicle.
Position indicating devices: Position indicators shall be provided to clearly indicate whether a circuit-breaker is open or closed.

Operation counter: Each circuit -breaker shall be provided with an operation counter per mechanism to record the number of tripping operations performed.

Discrepancy circuit shall be provided which shall detect pole position discrepancy.

Design of circuit breaker shall ensure that the contacts will not ‘close’ / ‘open’ automatically upon loss of gas pressure. The circuit breaker shall retain and continue to remain in the position prior to the loss of pressure.

10. Anti pumping
All circuit-breaker mechanisms shall be provided with means to prevent pumping while the closing circuit remains energized, should the circuit breaker either fail to latch, or be tripped during closing due to the operation of the protective relays.

11. Position indicating devices
Position indicators shall be provided to clearly indicate whether a circuit-breaker is open or closed. Each circuit-breaker shall be provided with an operation counter per mechanism to record the number of tripping operations performed.

3.2.2 DISCONNECTOR

1 General
The GIS dis connectors shall comply with the following general and the latest revision of the relevant IEC standards. Dis connectors shall be three pole, group operated, no-load break, with one motor operated mechanism per three-pole. They shall also have facilities for emergency manual

operation and the necessary operating handles or hand cranks shall be supplied. Dis connector shall be interlocked to prevent the earthing switch from closing on a energized bus section.
All main contacts shall either be silver plated or shall have silver inserts. Each dis connector shall open or close only due to motor-driven or manual operation. The switch contact shall not move due to gravity or other means, even if a part fails. Once initiated, the motor mechanism shall complete an open or close operation without requiring the initiating contact to be held closed. The dis connectors shall be located as shown in single line diagram.

2 Technical Particulars

		400kV / 220 KV / 132kV
Rated Voltage	kV	420kV / 245 / 145
- Lightning	kV	1425+240 / 1050+206 / 750
- Power frequency	kV	815 / 460+145 / 315
Nominal operating current(at 40°C)	A	3150 / 2000
Rated short-circuit withstand current (r.m.s.), 3s	kA	50 / 50 / 40
Type of operating mechanism		Motor
Number of drives per 3 phase		1
Control voltage (DC)	V	220 DC
Number of CO permissible without maintenance	No.	As per latest IEC standard or equivalent.

Electric motor for the driving mechanism shall be DC operated. Mechanisms shall be arranged (mechanically ganged) so that all three phases of any particular disconnect switch operate simultaneously. All mechanisms shall be suitable for electrical motor operation to achieve a fully automatic operation in an unmanned substation.

For emergency situations manual operation shall be possible. Handles or hand cranks shall be provided. Manual operation shall be prevented if the interlocking conditions have not been satisfied. The auxiliary energy shall be electrically uncoupled from the motor when the switch is operated manually.

The mechanisms shall be arranged for locking in the open and in the closed position. Facilities shall be available to allow the switch to be padlocked in any position.

3. Position indicating
External mechanically connected position indicators shall be provided showing either open or close position.

3.2.3 MAINTENANCE EARTHING SWITCH
1. General
The GIS earthing switches shall comply with the following general requirements and the latest revision of the relevant IEC standards. Maintenance earthing switches shall be three pole, group operated, no-load break, with one motor operated mechanism per three-pole. They shall also have facilities for emergency manual operation and the necessary operating handles or hand cranks shall be supplied.
Maintenance earthing switches shall be electrically interlocked to prevent the earthing switch from closing on an energized bus section. The common point of the two bus bars along with earth switch shall be designed and housed in a separate compartment so as to avoid complete shutdown of the system in case of maintenance required in any disconnector.
All main contacts shall either be silver plated or shall have silver inserts. Each earthing switch shall open or close only due to motor-driven or manual operation. The switch contact shall not move due to gravity or other means, even if a part fails. Once initiated, the motor mechanism shall complete an open or close operation without requiring the initiating contact to be held closed.
The maintenance earthing switches shall be located as shown in the single line diagram.
2. Technical Particulars

		400kV / 220 KV / 132kV
Rated Voltage	KV	420kV / 245 / 145
- Lightning	kV	1425+240 / 1050+206 / 750
- Power frequency	kV	815 / 460+145 / 315
Rated current	A	NA
Rated short-circuit withstand current (r.m.s.), 3s:	kA	50 / 50 / 40
Type of operating mechanism		Motor
Number of drives per 3 phase	Nos.	1
Control voltage (DC)	V	220 DC
Number of CO permissible without maintenance	Nos.	As per latest IEC standard or equivalent.

3. Operating mechanism

Electric motor for the driving mechanism shall be DC operated. Mechanisms shall be arranged (mechanically ganged) so that all three phases of any particular earthing switch operate simultaneously.

All mechanisms shall be suitable for electrical motor operation to achieve a fully automatic operation in an unmanned substation. For emergency situations manual operation shall be possible. Handles or hand cranks shall be provided.

Manual operation shall be prevented if the interlocking system does not allow the operation of the switch.
The auxiliary energy shall be electrically uncoupled from the motor when the switch is operated manually.

The mechanisms shall be arranged for locking in the open and in the closed position. Facilities shall be available to allow the switch to be padlocked in any position.

4. Position indicating devices

External mechanically connected position indicators shall be provided showing either open or close position.

3.2.5 FAST ACTING EARTHING SWITCH

1. General

Fast acting earthing switches shall be located at the busbar and at all external HV connections of feeders (like HV cable or overhead line). The switching capability shall be class B (Earthing switches designated to be used in circuits having relatively long lines or high coupling to adjacent energized circuits) as per IEC 62271-102 Annex C standard. Furthermore it shall withstand the full making capability.

The fast acting earthing switches shall comply with the following general requirements of fast acting earthing switches and the latest revision of the relevant IEC specifications.

Fast acting earthing switches shall be three pole group operated, with one motor operated mechanism for three phase. They shall also have facilities for emergency manual operation and the necessary operating handles or hand cranks shall be supplied.

Fast acting earthing switches shall be electrically interlocked to prevent the fast acting earthing switch from closing on an energized bus section.

All main contacts, male and female, shall either be silver plated or shall have silver inserts.

Each fast acting earthing switch shall open or close only due to motor-driven or manual operation. The switch contact shall not move due to gravity or other means, even if a part fails. Once initiated,

the motor mechanism shall complete an open or close operation without requiring the initiating contact to be held closed.

2. Technical Particulars

		400kV / 220 KV / 132kV
Rated Voltage	kV	420kV / 245 / 145
Rated short-circuit withstand current 3s, (r.m.s.):	kA	50 / 50 / 40
Inductive current switching capability	A , kV	As per IE C standard
Capacitive current switching capability	A , kV	As per IEC standard
Type of Mechanism		Motor
No. of drives per three phase	Nos.	1
Closing time	ms	As per manufacturer standard
Control voltage	V	220 DC
Number of permissible CO without maintenance	Nos.	As per IEC
Short-circuit making 40/50kA:	Class	E1

3. Operating mechanism
Electric motor for the driving mechanism shall be DC operated. Mechanisms shall be arranged (mechanically ganged) so that all three phases of any particular fast acting earthing switch operate simultaneously.

All mechanisms shall be equipped with a motor suitable for operation from the auxiliary supply, and a set of springs for energy storage and closing. Motors shall be suitable for operation at any voltage between 85% and 110% of the rated auxiliary voltage.

For emergency situations manual operation shall be possible. Handles or hand cranks shall be provided, together with all necessary operation rods and rod guides.

The auxiliary energy shall be electrically uncoupled from the motor when the switch is operated manually. The mechanisms shall be arranged for locking in the open and in the closed position.

4. Auxiliary switches
Each fast acting earthing switch shall be furnished with adequate number of electrically independent contacts at user's disposal. The auxiliary switches shall indicate the position of the switch contacts, and shall be independent of the motor operation.

5. Position indicating devices
External mechanically connected position indicators shall also be provided.

3.2.6 CURRENT TRANSFORMERS

1. General
The current transformers shall be supplied in accordance with the following general requirements and the latest revisions of the relevant IEC.

Each current transformer shall be arranged so that the enclosure current does not affect the accuracy or the ratio of the device or the conductor current being measured.

Current transformer secondary cores shall be terminated to shorting terminal blocks.

It shall be possible to test each current transformer without the removal of gas through the insulated grounding switches.

2. Position of the Current Transformers and Cores, Ratios and Characteristics.
The number and position of the current transformers relative to the circuit-breakers, disconnectors and earthing switches shall be as detailed in the attached single line diagram. However, there must have possibility of provision of CT on either side of CB.

The rating, ratio, accuracy class etc. for the individual current transformer secondary cores shall be as specified. Where multi-ratio current transformers are required, the various ratios shall be obtained by changing the effective number of turns on the secondary winding.

However, CT ratio shall be finalized during detailed engineering.

3. Rating and Diagram Plates
Rating and diagram plates shall be as specified in the IEC specification incorporating the year of manufacture.

The rated extended current rating voltage and rated thermal current shall also be marked on the name plate.

The diagram plates shall show the terminal markings and the relative physical arrangement of the current transformer cores with respect to the primary terminals (P1 & P2). The position of each primary terminal in the current transformer SF6 gas section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer.

4. Constructional Details:
The current transformers incorporated into the GIS will be used for protective relaying and metering and shall be of metal enclosed type. The secondary windings shall be air insulated/Gas insulated with terminals brought out for secondary connection.

All the current transformers shall have effective electromagnetic shields to protect against high frequency transients.

Each current transformer shall be equipped with a marshalling box with terminals for the secondary circuits, which are connected to the local control cubicle or CT secondary terminals shall be directly terminated to the local control cubicle to avoid open circuiting in marshalling box. The star/ delta configuration and the inter connection to the line protection panels will be done at the CT terminal block located in the local control cubicle.

Current transformers guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.
The wiring diagram, for the interconnections of the three single phase CTs shall be provided inside the marshalling box.
The current transformers shall be suitable for high speed auto re-closing.
Provisions shall be made for primary injection testing either within CT or outside.
Technical Particulars

		400kV / 220 KV / 132kV
Core number per phase	Nos.	05 cores *
Accuracy - Metering - Protection		**Metering 0.2s & protection PS class ***
Rating Primary	A	2000-100-500/1200-600-300/800-400-200 *
Rated secondary current	A	1
Continuous Thermal rating	%	120

*The details will be finalized later, based on the protection relay study.

3.2.7 POTENTIAL TRANSFORMERS (PT): Bus PT.

1. General
The voltage transformers shall be supplied in accordance with the following general requirements and the latest revisions of the relevant IEC.

Each voltage transformer shall be an electromagnetic, dry type SF6 –enclosed single phase unit with the specified ratings.

The voltage transformers are to be connected as shown in the attached single line diagram.

Voltage transformers shall be attached to the gas-insulated system in such a manner that they can be readily disconnected from the system if required for dielectric testing. The metal housing of the voltage transformer shall be connected to the metal enclosure of the GIS with a flanged, bolted and gasketed joint so that the transformer housing is thoroughly grounded to the GIS enclosure. Adequate measures shall be provided to prevent any unacceptable impact on the secondary control and protection circuits which might result from very fast transients (VFT) or ferro-resonance.

2. Ratios and Characteristics
The rating, ratio, accuracy class, connection, etc. for the voltage transformers shall be as specified below.
This shall be (400kV), (220kV), (132kV) / (sqrt3)/110V/(sqrt(3)/110V(sqrt(3) accuracy class 0.2/3P, connection Y/Y-Y. The voltage transformers shall have 2 secondary windings, each winding with one tap.

3. Rating and diagram plates
Rating and diagram plate shall be provided complying with the requirements of the IEC specification incorporating the year of manufacture and including turns ratio, voltage ratio, burden, connection diagram etc.

4. Secondary Terminals, Earthing,MCB's and Fuses
The beginning and end of each secondary winding and all secondary taps shall be wired to suitable terminals accommodated in the local control cabinet for the feeder bay. Fuses / MCBs shall be also located in the local control cabinet.

All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Secondary terminals shall have permanent marking as identification of polarity, in accordance with IEC. Provision shall be made for earthing of the secondary windings inside the terminal box.

The transformer shall be able to sustain full line to line voltage without saturation of transformer.

The accuracy class will be at maximum tap.

5. Constructional Details of Potential Transformers:
The potential transformers shall be located in a separate bay module on the bus and will be connected phase to ground and shall be used for protection, metering and synchronization.

The potential transformers shall be of inductive type, nonresistant and shall be contained in their own-SF6 compartment, separated from other parts of installation. The potential transformers shall be effectively shielded against high frequency electromagnetic transients. The voltage transformers shall have two secondary windings

Potential transformer’s secondary shall be protected by fuses for all the windings. In addition fuses shall be provided for the protection and metering windings for fuse monitoring scheme. The secondary terminals of the PT’s shall be terminated to the stud type non-disconnecting terminal blocks in the secondary boxes via the fuse.

The potential transformer should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens.

The diagram for the interconnection of the VTs shall be provided inside the marshalling box.

6. Technical Particulars

		400kV / 220 KV / 132kV
Rated voltage	KV	420 / 245 / 145
Primary winding	kV	(400), (220), (132)/√3
Secondary winding	V	110/√3
No of secondary win dings	Nos.	2
Accuracy of secondary winding		
class		0.2 /3P
Burden		50 / 50
Partial discharge level at 1.5 U//3	pC	As per IEC

3.2.8 SURGE ARRESTERS:

When necessary, AIS surge arresters shall be placed at the line exits in close proximity to the line entrance.

GIS Surge Arresters shall be "Zinc Oxide" resistors type without spark gaps and with impulse characteristics suitable for use with SF6 gas insulated equipments. It shall be single phase SF6 insulated, self cooled suitable for installation as integrated part of GIS switchgear. Surge arresters shall be designed and tested in accordance with the requirements of IEC 60099-4/5 or latest.

The surge arresters form part of the overall GIS switchgear therefore they shall be positioned as near to the equipment to be protected and must be connected with as short connectors as possible to both line and earth; so that surge arresters can provide maximum protection in accordance with IEC 60099. All surge arresters shall be fitted with a pressure relief diaphragm which shall prevent explosive shattering of the housing in the event of an arrester failure and the arrester shall be tested accordingly to the high and low current tests specified in IEC 60099-1.

Each surge arrester shall be identified by a rating plate in accordance with the requirements of IEC 60099-4. Surge counters shall be provided as one per phase. The leakage current meters shall be for installation in the earth connection of the surge arresters and shall be designed for continuous operation and shall be placed in an accessible and visible location to be read from ground level with the arrester

Technical Particulars

		400kV / 220kV / 132kV
Rated voltage	KV	390 / 192 / 102
Line discharge class		3
Nominal discharge current (8/20µs)	kAp	10
Max. Lighting Impulse Residual Voltage with 8/20µs	kVp	As per IEC

Note: The detailed parameters of surge arrestors will be finalized during detailed engineering.

3.2.9 SF6/AIR BUSHINGS

1. General

Outdoor SF6 to air bushings, for the connection between the GIS and overhead lines or conventional air insulated equipment shall be furnished where specified.

Bushings shall comply with the relevant IEC standards.

Bushings with porcelain insulators is not acceptable

The internal insulation of the bushings can be a resin impregnated paper winding (RIP body) or compressed SF_6-gas. The internal and external electrical field of the bushings can be controlled by a capacitive grading body or by grading shields.

The RIP body must consist of resin impregnated paper insulation with concentric aluminium layers. The space between the RIP body and the insulator must be filled with insulating foam compound or compressed SF_6-gas.

Bushings with composite insulators (fiber-reinforced resin tubes with silicon rubber sheds) can be pressurized with the normal service gas-pressure of the GIS.

Insulation levels and creepage distances:

2. Insulation levels and creep age distances:
The insulation levels are applicable to normal sea level atmospheric conditions. The creep age distance over the external surface of outdoor bushings shall not be less than 25 mm/kV.

3. Mechanical forces on bushing terminals:
Outdoor bushings must be capable of withstanding a cantilever force as per IEC standard

4. Interface definition
The flange and conductor connection between bushing and GIS component shall be the standard of the GIS supplier.

3.2.10 GAS INSULATED BUS DUCT

The components of the GIS shall be connected by a single phase bus ducts for 400kV & 220kV. The enclosure shall be connected by use of bolted and gasketed joints. The bus conductor shall be connected with plug in contacts with silver plated contact surface. The bus system shall be capable of withstand the mechanical and thermal stresses due to short circuit currents, as well as thermal expansion and contraction created by temperature cycling.

3.2.10 EHV-POWER CABLE CONNECTION

1. General
The design of the cable end box shall fully comply with the IEC 62271-209 standard. The Extra high voltage power cables, shall be supplied by the tenderer. The type and size of cables shall be as per requirement. The final connection of the high voltage cable circuits in the GIS will be by means of individual single-phase cables, with one cable per phase.

The cable end unit design shall include a facility for high voltage AC testing of the connected power cable on site. Removable bolted links or similar connections will be accepted. The design of the link and connections shall ensure that when removed the resulting gap can withstand the impulse and power frequency test voltages applicable to the switchgear and the cable high voltage AC test voltage.

2. Interface definition
Dimensions and division of work shall fully comply with IEC 62271-209 standard.

Note: The details of the XLPE cable to be estimated based on the layout during detailed engineering.

3.2.11 LOCAL CONTROL CUBICLE

1. General

One local control cabinet (LCC) shall be supplied for the local control and operation of each circuit breaker bay. Each LCC shall contain the local control, interlocking, operation and indication devices for the associated GIS feeder bay.

The LCC shall operate as a link between GIS and Control, protection and substation automation system (SAS) in Control Room LCC shall generally include:

- mimic showing the single line diagram showing the position of CB, Dis, FAES, MES etc.
- Position indicators of CB, Dis, FAES, MES etc.
- Discrepancy type control switches for breaker, disconnector and earthing switch
- Local / remote selections
- Alarm and indication devices.
- Aux. relays or other devices as required by the design.

For easy overview, the LCC's should be integrated in the switchgear in front of the related circuit breaker bay. A general arrangement drawing showing the installation position shall be submitted with the quotation.

The LCC's shall be installed indoors. The LCC's shall also be dust and vermin proof and shall be located near GIS modules.

The control and operation circuits shall be well shielded and with safety measures to protect operator from touching energized parts. Power frequency withstand of control circuits shall be 2 kV for 1 minute. The LCC shall be factory tested and shipped together with the bay as one transport unit.

2. DC Supplies and Circuits

DC supplies shall be provided by the tenderer for all control, interlocking, alarm, indication and power supply circuits. The normal maximum and minimum voltage levels that will occur on the supply are specified.

At least one single MCB outlet from the substation DC distribution board will be provided for each local control cabinet.

The design of all circuits must be such that separately fused or sub fused circuits are always kept electrically separate.

3. A.C. Supplies and Circuits

A.C. power for heaters and other auxiliary loads will be provided by the tenderer by two 240 V, 50 Hz, 3-phase circuits.

The normal maximum and minimum voltages that will occur in the supply are as specified. All equipment supplied shall be capable of running continuously or switching the AC current within the range of the normal maximum and minimum voltages specified.

4. Cable connections within the GIS and their LCC's

All cable connections between the various GIS modules and the LCC's shall be made by prefabricated multi-core cables with multi-point plug-in connections on both ends. PT's and CT's shall be hard wired.

All cables shall be shielded and adequate for their application (indoor / outdoor).

Space Heater: Each panel shall be provided with a space heater rated for 240V, single phase, 50 Hz Ac supply for the internal heating of the panel.

3.2.12 TOOLS

The Tenderer shall include in his proposal the recommended tools required for installation, commissioning, operation and maintenance.

The following tools shall be supplied as a minimum:

Tools for gas handling plant (Cl No. 3.2.18(a)	1 set
Gas Leakage detector	1 piece
SF6 filling device	1 set

These tools shall be supplied along with the GIS and shall not be taken back by the bidder.

3.2.13 SPARE PARTS (Refer to the price schedule)

The Tenderer shall include in his proposal the recommended spare parts for installation, commissioning, operation and maintenance.

The following spare parts shall be supplied at a minimum:

(a) Maintenance earthing switch	*1 unit*
(b) Fast acting earthing switch	*1 unit*
(c) Disconnector	*1 unit*
(d) Density monitors for circuit breaker	*1 unit*
(e) Density monitors for other gas compartments	*1 unit*
(f) Drive for circuit breaker	*1 unit*
(g) Drive for dis connector & Maintenance earthing switch	*1 unit*
(h) Drive for fast acting earthing switch	*1 unit*

3.2.14 OTHER SERVICES

The following services shall be included in the proposal or quoted as optional items.

a) Training sessions on installation, commissioning, operation and maintenance of GIS shall be held by an experienced, English speaking instructor.

One week training for installation and commissioning shall be held prior to installation at site or at the owners' premises/at the factory.

One week training for operation and maintenance shall be held after the installation at the site.

b)Factory inspection/acceptance test: at the factory

c) Installation Supervision

The estimated time period for installation supervision shall be shown in the proposal.

d) Commissioning / High voltage test

The estimated time period shall be shown in the proposal.

3.2.15: INTERLOCKS

Electrical interlock shall be provided between :

1. Circuit breakers and disconnector.
2. Dis connectors and earthing switches.

The principles of electrical interlocks are the following:

On each bay:

- The disconnector from the bus bar may not be closed if the associated circuit breaker is closed.

  The bus bar disconnector may not be closed if the earthing switch located between itself and the circuit breaker is closed.

- The earthing switch located between the bus bar disconnector and circuit breaker may not be closed if the bus bar disconnector is closed.

- The circuit breaker may not be closed if the ear thing switch of the associated section of bus bar is closed.

- The feeder disconnector may not be closed or opened if the associated circuit breaker is closed.

- The feeder disconnector may not be closed if the earthing switch is closed.

On the bus bar:

- cable disconnector can be opened and earthing switch can be closed only if the voltage transformer reads zero.
- Cable earth switch can be closed only if cable disconnector is opened.
- Cable disconnector can be opened only if the associated circuit breaker is opened.
- The feeder disconnector cannot be closed if the switchgear is closed and bus bar disconnector is closed.
- The earthing switch of each bus bar may be closed only if all the bus bar disconnections are opened.

3.2.16: ARRANGEMENTS

Wiring

The wiring must be carried out with stranded copper conductors of at least 7 strands. The size of the conductors shall be suitable enough for the expected usage, but it must not be less than 2.5 sq.mm. All precautions should be taken to minimize the inductive and capacity coupling between circuits of especially with the wiring of the AC and DC circuits. The cable trays shall be designed in such a way that it has at least 20% space for future usage.

Terminal Blocks

The design of the terminal shall be as per the relevant standards in vogue. The terminals permitting the direct control of SF 6 surveillance from pressure monitoring devices must be fitted with test point.

The outgoing terminal connection must be unique and comprises of 2 distinct parts:

- an arrangement for auxiliary voltage supply (alternating or direct current)
- an arrangement for control common.

Worker Safety

All precautions must be taken to ensure an efficient protection against accidental contact with the live elements.

Degree of protection

The required level of protection shall be established for the enclosures of boxes and cubicles as per the relevant standards in vogue.

Frame work

The boxes and cubicles shall have metallic enclosures to ensure effective protection against radio interference. If these enclosures are of non-metallic materials, the screen shall be connected to the earth to ensure efficient protection.

Cable entrance

Cable glands or grommets shall be provided for cable entry through the lower side. These cable glands should avoid electrolytic corrosion at the lower side of the box.

Closing devices

A simple handle will be suffice at the door of the cubicles.

The door must open at at least 120 deg.

Lighting and socket :

Lighting facility at the cubicles shall be activated by opening the door.

In each local control cubicle a single phase 3 pin socket with switch shall also be provided. The lighting points and sockets should be connected by a circuit separate from other circuits.

Space heaters

In each box and local control cubicle a space heater is required to prevent condensation. It should be connected by the same separate A.C. circuit as above.

The manufacturer shall indicate the electrical power of each heater.

Earthing of boxes and cubicles

Depending upon the location of boxes and cubicles, the earthing terminal is either linked to the metal enclosure, or linked directly to the general earth mat by an earthing conductor of reduced cross – section.
Equipotential connections between boxes, cubicles and doors shall be provided to ensure that no movable part of the enclosure can, once it is in place, be isolated from the part to which the earthing terminal is connected.

Voltage transformer

The cable from voltage transformers shall be terminated in the cubicles with removable fuses and shall be padlocked.
The fuses are connected in such a way that the locking devices forbids access to the cells corresponding to the conductors from the voltage transformers.
The fuse units shall be of 25 amp rating with a 6amp fuse cartridge.

Boxes and cubicles.

Other than stainless steel, all the boxes and cubicles shall be painted with a minimum one primer coat and one top coat.

Bolts, screws and nuts.

In case of stainless steel a diameter of 16mm and above shall be provided.
If the diameter is below 16mm hot galvanized will be allowed and in such case the thickness of zinc plating shall be 375 g /sq.m.
All precautions shall be taken:
- to ensure that contacting materials do not cause electrolytic corrosion.
- to avoid water stagnation.

The manufacturer shall specify the measures adopted to ensure the above conditions.

3.2.17: LOW VOLTAGE CABLES & CONTROL CABLES

The Low voltage cables & control cables shall be of 1.1 kV XLPE/PVC insulated copper tape shielded control cables shall be complied with IEC 60502 and flame retardant to IEC 60332-1. The size of the above cables is more than 2.5 sqmm.

3.2.18: ACCESSORIES:

SF6 GAS SERVICE CART

The SF6 gas service cart shall be adequate to:
- refill each compartment between the first or second level of SF6 gas pressure to the rated pressure.
- check the SF6 monitoring.

(a) **SF6 HANDLING PLANT**

The SF6 handling plant shall contain compressors and vacuum pump necessary for recovering vacuum and filling SF6 gas. It shall be movable with wheels.
It shall allow the storage of SF6 in liquid state in a built – in tank having capacity sufficient to empty any three adjacent compartment of 400kV / 220 KV / 132kV GIS.
The capacity of compressors and vacuum pumps shall be selected in such a way for
-filling a compartment to the rated pressure within one hour.
-recovering SF6 gas from any compartment to the built in tank from the rated pressure to 50mb pressure within three hours.
-evacuating a compartment from 50 mb pressure to less than 1 mb pressure within one hour.
The cart shall have the following provisions:
-accessories for connections and operation (valves and coupling)
-dry type filters, dust and oil traps,
-tools and spares for operation and Maintenance,
-hand-book for description, commissioning, operation, and Maintenance.

(b) **400kV / 220 KV /132 kV SF 6 TEST BUSHINGS: Required for HV testing at the time of commissioning to be considered by the supplier (Supplier scope but will be taken back by the supplier after commissioning).**

These bushings shall conform to IEC 60137 standard.
The design shall meet the following requirements:
- Minimum creep age distance : 31mm / KV for heavy pollution level according to the IEC60815 standard.
-The terminal clamp shall be supplied by the GIS manufacturer

3.2.19: EARTHING

CONNECTION TO THE GENERAL EARTH MAT:
All metal parts intended which does not belong to a main or an auxiliary circuit, shall be connected to earth.
The general **HDG MS earth flat** earth circuit of the substation shall be formed by an uninterrupted loop which originates form the buried **HDG MS earth flat** conductor of a cross section of **750 sq.mm (75X10) for 220 & 132 KV & 40 mm dia MS Rod for 400 KV**. These loops shall be fixed to the base of the chassis with the help of an earth riser connection bolted into a hole in the chassis or frame by the manufacturer of the metal-clad equipment, and situated at 0.30 m above the floor level of the switchgear. The general earth mat design, the connection device and the bimetallic plate shall be supplied by the GIS manufacturer. The earth connection from earth pad of equipment to the general earth mat near shall be provided by the supplier. The continuity of the earthing circuits shall be ensured taking into account the thermal and electrical stress by the current they may have to carry. The riser shall be of **copper flat size of 50X6 mm** with bi-metallic arrangement to connect from the ground earth mat to enclosure of the GIS equipment.

EQUIPOTENTIAL EARTHMAT:
When a fault current flows through the earthing connections into the soil, the enclosures, linked to the earthing circuits, are carried at the same potential as the earthing mat conductors but this potential is generally different from that on the soil surface.
In order to ensure the security of personnel, it is necessary to install an equipotential mat linked to the general earthing mat in the zones where metal enclosures and fixed accessories are accessible from the floor.
It is also necessary to provide an equipotential earthing mat in the zones where an emergency mechanical operation or a locking system is accessible from the floor. It is therefore possible to extend the equipotential mat to allow the operator to carry out his manoeuvres.
In order to ensure a good equipotential surface, each element of the equipotential mat must be connected to the general earthing network by the manufacturer.
This mat will be placed on the floor, all around the switch gears. It is not required in front of the control cubicles.
If it is an oxidizing material, it should be hot dip galvanized.

The manufacturer must provide and specify this equipotential earthing mat. The location of the equipotential mat should be defined by the supplier for all the GIS and at places where :
- the enclosures are accessible for the floor.
- Manual operation of apparatus or locking system is located.

Five copies of equipotential earth mat drawings along with design calculations may be submitted for approval by the successful Bidder.

3.2.20: TESTING & COMMISSIONING:

(a) TYPE TEST:
Type tests shall be according to the **IEC 62271-203** and other relevant IEC standards. Copies of the type tests conducted shall be furnished along with the BID failing which the Bid is liable for rejection. These type tests should have been conducted in a Recognized independent institution / Laboratory. The type test reports of the manufacturer or its principal (holding company) shall be acceptable, if the manufacturer is of international repute.

(b) ROUTINE TESTS :
Routine tests shall be as per the IEC 62271-203 and other relevant standards. The manufacturer shall provide all the testing equipment required for the site tests.

(c) COMMISSIONING TESTS/ON SITE TESTS AFTER ERECTION :

After erection, and before putting into service, the gas-insulated metal enclosed Switchgear shall be tested for the correct operation and dielectric strength of the equipment.

These tests and verifications shall comprise:

(1) Tests to be conducted on the circuit breaker at site

At all required operating sequences

- Measurement of operating time

Checking of wiring and connections and dielectric checks
Indications, alarms and interlocks, auxiliary contacts
Operation at minimum and maximum control supply voltage/pressure
Operation of anti-pumping device.

(2) Test to be conducted on the Disconnectors at site

Checking of wiring and connections and dielectric checks
Indications, alarms and interlocks, auxiliary contacts
Operation at minimum and maximum control supply voltage/pressure

(3) Other Tests at Site

- Dielectric tests on auxiliary circuits
- Measurement of the resistance of the main circuit
- Measurement of gas condition
- Gas tightness tests
- General verifications

(4) POWER FREQUENCY TEST: ON SITE TESTING OF GIS

Power frequency tests for the completed GIS at site shall be complied as per **IEC 60270.**

Power frequency tests for the completed GIS at site shall be possible without removing the voltage transformers. The power frequency test voltage at site shall be **80%** of the factory test voltage for 1 min at 100Hz.

The Supplier is responsible to furnish the test equipment for conducting following performance tests at site.

• Voltage tests on main circuits at reduced voltage (80% p.f.) comprising:
- 50 Hz A.C. voltage test for 1 min
- Partial Discharge test

The manufacturer shall provide :
-The test voltage source.
-All connections between the switchgear and the test voltage source.

The procedure to be implemented following a discharge during dielectric tests is as follows :

- if a disruptive discharge occurs at the first test while increasing of test voltage, a second test is performed.
- If a second disruptive discharge occurs in the same compartment before reaching the highest level, there are two possibilities :
- If the second disruptive discharge is higher than the first voltage again the voltage is immediately increased. If a new discharge occurs the value of which is again higher, a new test is carried out.
- If the second disruptive discharge is lower than or equal to the first, the test is stopped and the compartment dismantled.

The process is continued in order to reach the test voltage. If a disruptive discharge occurs at this voltage, there are two possibilities:
-if it is the first disruptive discharge in the compartment since the test was begun, voltage is again increased. If there is no other discharge, the test has been successful. The test is stopped and the compartment dismantled.
-if some discharge have previously occurred in this compartment during the increase in voltage, the test is stopped and the compartment dismantled.

3.2.21: SCHEDULE OF EQUIPMENT/MATERIALS

Item No	Description of Equipment/Materials	Quantity
1	**ACCESSORIES**	
	SF6 Gas handling plant of adequate capacity	1 Set
	SF6 gas service cart with all accessories	1 Set
2	**TESTING EQUIPMENT**	
	GIS testing equipment(Bidder should include all such testing equipment ,which are required for detail testing of GIS system)	1set

3.2.22: SCHEDULE FOR ESSENTIAL TOOLS AND SPARES

Item No	Description	Quantity
1	Single phase voltage transformer	1 Set
2	Single phase set of 5 cores current transformer including enclosure	1 Set
3	Enclosure insulators and main circuit of bus bar	1 Set
4	Tripping and closing coils	3 Sets
5	SF6 Pressure gauges	2 Sets
6	SF6 Pressure relief devices	2 Sets
7	Auxiliary contacts for circuit breaker	1 Set
8	Auxiliary contacts for DS and ES	1 Set
9	SF6 gas in steel bottle 52 Kg / bottle	2 Nos.
10	spring charge motor for circuit breakers	1 unit
11	Complete drive mechanism for disconnect switches and grounding switches	1 unit
12	Motor for disconnect switches and grounding switches	1 unit
13	Complete drive mechanism for fast acting grounding switches	1 unit
14	Motor for fast acting grounding switches	1 unit
15	Rupture disc for circuit breakers / potential transformer	1 no
16	Set of spares for local control cabinet including M.C.B., fuses, time relays, auxiliary relay and terminals	1set
17	Rupture disc for other compartments	2 nos
18	**SPECIAL TOOLS**	
i)	SF6 gas leak detector	1 Set
ii)	Hygrometer	1 Set
iv)	Milli volt drop measurement appliance	1 Set
v)	One set of Box Spanner	1 Set
vi)	One set of adjustable Spanner	1 Set
vii)	Sf6 gas bottle locking, measuring and filling assembly with all hose	2 Set
viii)	One set of pipe grooving tools for the hydraulic operating mechanism	1 Set
ix)	Infra red camera	1 set

Guaranteed Technical particulars
400/220/132KV GAS INSULATED SWITCHGEAR

SNO.	DESCTRIPTION	400 KV GIS	220 KV GIS	132KV GIS
A	**General**			
1	Installation			
2	Model			
3	Make			
4	Reference standard			
5	Enclosure design code			
6	Type of material of enclosure			
7	Type of material of air bushings			
8	Ambient temperature (design value)			
9	Nominal Operating Voltage			
10	Highest System Voltage			
11	Phase Design Encapsulation			
	a) Busbars			
	b) Feeders			
12	Rated insulation level (withstand voltages, to ground)			
	a) At power freq 1 min			
	b) At impulse (1.2/50)			
13	Rated current of			
	a) Busbars			
	b) Other Bays			
14	Rated current at 50 °C			
15	Rated 1 sec withstand current			
16	Rated peak withstand current			
17	Internal fault withstand time without burn through			
18	Temp rise at rated service current-			
	a) Joint			
	b) Conductor			
	c) Enclosure			
19	Design pressure of enclosures:			
	a) Circuit Breakers			
	b) Other Compartments			
20	SF6 gas pressure at 20 °C (actual value shall be submitted by the manufacturer)			

	a) Filling Pressure			
	b) Alarm Pressure			
	c) Blocking Pressure			
21	Operating pressure of the pressure relief devices			
	a) Circuit Breakers			
	b) Other Compartments			
	c) Type of device			
	d) Material			
22	Type test pressure of enclosures			
	a) Circuit Breakers			
	b) Other Compartments			
23	Routine test pressure of enclosures			
	a) Circuit Breakers			
	b) Other Compartments			
24	Alarm Pressure			
	a) Circuit Breakers			
	b) Other Compartments			
25	Blocking pressure			
	a) Circuit Breakers			
	b) Other Compartments			
26	Is each gas compartment equipped with			
	a) Pressure relief valve			
	b) Absorber of moisture			
	c) Density switch			
27	Weight of each bay of GIS -			
	A) Line bays			
	b) I/C Trans bays			
	c) O/G Trans bays			
	d) B/C bays			
	e) B/B earthing & measuring bay			
28	Total weight of the offered GIS			
29	Total weight of the SF6 in the offered GIS			
30	Anticipated loss of SF6 per year			
31	Maximum PD at 1.2 times rated voltage in factory			

32	Conductor : Material			
	a) Ends / plating			
	b) Contacts			
	c) Contact type			
33	No of operations w/o maintenance at No load / at full load / at S/C current			
	a) CB			
	b) Disconnector with integrated earth switch			
	c) Fast acting Earth Switch			
34	Gas Barriers			
	a)Material			
	b)pressure withstand			
35	PD test			
36	Support Insulators Material			
37	PD test			
38	Sealing :			
	a) Material of rings			
	b) method of sealing			
39	Feeder Connection Type			
	a) for Line Bay			
	b) for ICT Bay			
	c) for GT Bay			
	c) for Bus Reactor Bay			
40	Local Control Cabinet Integral/ Non integral			
B	**400 KV GIS CIRCUIT BREAKER**	**UNIT**	**DATA**	
1	Make			
2	Model			
3	Nominal Operating Voltage			
4	Highest System Voltage			
5	Phase Design (1 OR 3 phase)			
6	BIL (across open contacts)			
7	Rated current			
8	Rated current at 50 °C			
9	Rated short time(1 sec) current			
10	Rated making current (rms)			

11	Rated making current (peak)			
12	Rated break current			
13	Rated closing time			
14	Rated opening time			
15	Rated break time			
16	Close-open time			
17	Out of phase breaking current, voltage factor 2.5			
18	Rated cable & line charging breaking current			
19	Number of breaks per pole			
20	Auto reclose			
21	Operating mechanism : (No per single phase CB)			
22	Rated Operating sequence			
23	Type of operating mechanism			
24	Number of trip coils			
25	Number of closing coils			
26	Rated Control Voltage			
27	Closing voltage range			
28	Trip device voltage range			
29	Charging without motor drive			
C	**400/220/132 KV GIS DISCONNECTING SWITCH**	**UNIT**	**DATA**	
1	Make			
2	Type			
3	Withstand voltages, (P to E / P to P)			
	a) At power freq, 1 min			
	b) At impulse (1.2 / 50)			
4	Rated cont current			
5	Rated 1 sec withstand current			
6	Peak withstand current			
7	Type of operating mechanism			
8	Number of drives per 3 phase			
9	Number of CO operations without maintenance			
10	Facility for emergency manual operation			
11	Interlocking with earthing switch			

12	Plating of main contacts			
13	Ganged operation			
14	Facility for padlock			
15	Modes			
D	**400/220/132 KV GIS MAINTENANCE EARTHING SWITCH**	**UNIT**	**DATA**	
1	Type			
2	Rated insulation level(withstand voltages, to ground)			
	a) At power freq, 1 min			
	b) At impulse (1.2 / 50)			
3	Rated 1 sec withstand current			
4	Peak withstand current			
5	Type of operating mechanism			
6	Number of drives per 3 phase			
7	Number of CO operations without maintenance			
8	Interlocking with isolator switch			
9	Plating of main contacts			
10	Ganged operation			
11	Facility for padlock			
12	View ports for inspection			
13	Mechanical position indicator			
E	**400/220/132 KV GIS FAST ACTING EARTH SWITCH**	**UNIT**	**DATA**	
1	Type			
2	Rated insulation level(withstand voltages, to ground)			
	a) At power freq, 1 min			
	b) At impulse (1.2 / 50)			
3	Rated 1 sec withstand current			
4	Peak withstand current			
5	Inductive Current switching capability.			
6	Capacitive Current switching capability.			
7	Closing time			
8	Type of operating mechanism			
9	Number of drives per 3 phase			
10	Number of CO operations without maintenance			

11	Energy storage springs			
12	Motor operation range			
13	Interlocking with isolator switch			
14	Plating of main contacts			
15	Ganged operation			
16	Facility for locking			
17	View ports for inspection			
18	Mechanical position indicator			
F	**400/220/132 KV GIS CURRENT TRANSFORMER**	**UNIT**	**DATA**	
1	Type			
2	Polarity			
3	RATIO / Class / Burden			
	a) Core-1			
	b) Core-2			
	c) Core-3			
	d) Core-4			
	e) Core-5			
4	Rated insulation level			
	a) At power freq, 1 min (main / sec)			
	b) At impulse (1.2 / 50)			
5	Rated 1 sec withstand current			
G	**400/220/132 kV GIS Voltage Transformer**			
1	Type			
2	Applying Standard			
3	Primary voltage			
4	Secondary voltage			
5	No of secondaries			
6	Accuracy & burden :			
	a) Core-1			
	b) Core-2			
	c) Core-3			
7	Voltage factor			
8	Rated insulation level			
	a) At power freq, 1 min (main / sec)			
	b) At impulse (1.2 / 50)			

TECHNICAL SPECIFICATIONS FOR CUBICLE INDOOR TYPE

33KV SF6 GAS INSULATED SWITCHGEAR (GIS)

DESIGN, CONSTRUCTION, PERFORMANCE TESTING, INSPECTION, PACKING AND DELIVERY OF 33kV CUBICLE GIS

1. **SCOPE**

1.1 This specification calls for supply of 33kV CUBICLE TYPE GAS INSULATED SWITCHGEAR (33kV GIS) and associated accessories as specified herein, for OPTCL.. The scope covers design, manufacture, inspection and testing at the VENDOR's and/or his SUB-VENDOR's works; packing for shipment and delivery to OPTCL site including complete erection, testing & commissioning. GIS Manufacturer shall undertake Supervision activity for erection, site testing and commissioning of 33 kV Gas Insulated cubicle type switchgear and accessories, including the associated main bus bars and cable termination assemblies and associated platforms, supports and internal wiring etc.

1.2 **The intent of this specification is to provide the work enumerated to be fully complete in every detail for the function designated. It is hereby required that the BIDDER, in accepting the contract, agrees to furnish all apparatus, appliances, material not herein specifically mentioned or included, but which may be found necessary to complete, perfect or test any portion of the apparatus or equipment herein specified in a substantial manner, and in compliance with the requirements implied in this specification and without extra cost to the PURCHASER.**

1.3 It is not the intent to specify completely herein, all details of design and construction of the equipment. However, the equipment shall conform in all respects to high standards of engineering design and workmanship and be capable of performing in continuous commercial operation up to the VENDOR's guarantees in a manner acceptable to the purchaser, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work / material which in his judgment is not in full accordance therewith.

1.4 Whether called for specifically or not, all accessories required for normal operation of equipment are deemed to be a part of VENDOR's scope of supply.

2. **STANDARDS**

2.1 The design, material, construction, manufacture, inspection, testing and performance of 33kV GIS shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The GIS equipment shall also conform to the IEC 62271-200.

3. TYPE & RATING: The 33kV GIS shall be of cubicle type and shall comprise three phase copper main bus bars, circuit breakers, isolators, earth switches, CTs, VTs, Surge Arresters and other accessories with rating and electrical characteristics as given in the specific requirements.

4. **FREQUENCY**

The 33kV GIS shall be suitable for continuous operation with a frequency variation of 5% from normal of 50 Hz.

5. Availability Requirements:

5.1 The gas insulated switchgear and accessories shall be designed for maximum reliability and availability.

5.2 The design ambient temperature considered for continuous rating of the equipment shall be 40^0C.

5.3 It shall be possible to interchange various cubicles. Bidders shall clearly bring out the modifications required to be carried out for interchanging/converting incomer/transformer bays and outgoing feeder bays.

5.4 Gas compartments shall be segregated from each other and the panels shall also be physically segregated from each other. Unified (continuous) busbar compartment is not acceptable.

5.5 Each gas compartment shall be internal arc tested. In the event of an internal arc the plasma shall be carried through a duct outside the switchgear room.

5.6 Cable compartment shall also be internal arc tested. In the event of an internal arc the plasma shall be carried through a rear duct outside the switchgear room. Release of plasma in the cable basement is not acceptable.

5.7 Entry of the power cable shall be from bottom. The access to the cable compartment shall be from rear side of the switchgear. Front cable access is not acceptable in view of personnel safety.

5.8 Panel to panel connection shall be fully enclosed and shall not remain open. Gas handling shall not be required during coupling of panels or during future etension of switchboard.

6. **Layout Requirements:**

6.1 It is intended that the GIS shall be located indoors.

6.2 The GIS will be mounted on concrete foundations. Any necessary supporting framework and base plates shall be provided by the BIDDER.

6.3 Bidder shall indicate recommended clearance from the top of panel to the ceiling and also material handling facility. The BIDDER shall specifically review the area indicated and confirm suitability of the equipment offered to fit into the space shown including area required for future extensions. Deviations, if any, shall be highlighted in the bid

6.4 The bidder shall ensure that dimensions and weight of the largest package shipping/transport do not exceed the permissible values imposed by Transporting Authorities.

The 33KV Cubicle type GIS shall be with Double Bus bar(Both the bus shall be as Main Bus) as mentioned in the tender

7.0 SWITCHGEAR ASSEMBLY

The switchgear assembly shall essentially consist of following items:

a. Circuit breakers
b. Disconnect Switches (Isolators) and earth switches
c. Voltage transformers, Current transformers and Surge Arresters
d. Cable chamber for termination of Power cables along with termination arrangement
e. Isolated or 3-phase main bus enclosures and accessories.
f. Local control cubicle.
g. SF6 gas sufficient for the entire switchgear including loss during installation + 10% extra SF6 gas.
h. Dummy panels wherever necessary.

8.1 **CIRCUIT BREAKERS**

8.1.1 General

1 The circuit breakers shall be vacuum type isolated phase, for independent pole operation and shall have duplicate trip coils. They shall be electrically and mechanically trip free where

applicable and anti-pumping with either or both of the duplicate trip circuits connected. A manual emergency trip facility is required to be provided.

2 The circuit breaker shall normally be suitable for remote electrical operation at DC voltage as specified in the "Specific Requirements" with either or both of the duplicate trip circuits connected. Pole discrepancy tripping shall be provided, if applicable.

3 The breaker enclosure shall have provision for easy with drawl of the interrupter assemblies. Checking the contact condition of the interrupter elements must be possible without disturbing any other gas compartment.

4 The name plate shall display the actual site rating of the equipment.

8.1.2 Circuit Breaker Performances

1 Duty Cycle: Open-0.3 seconds-Close-Open-3.0 minutes-Close-Open.

2 Breaking time : The maximum breaking time at the minimum operating pressure of the mechanism shall be 3.0 cycles.

8.1.3 Circuit Breaker Construction Features

The vacuum circuit breakers, vacuum monitor device shall be supplied to aid maintenance personnel to estimate whether vacuum levels are within acceptable/ permissible limits. This device can be portable and shall be designed to permit easy connection/ disconnection with any breaker without in any manner influencing the integrity of sealing of the vacuum interrupter.

It shall be possible to quickly isolate mechanically the interrupter unit of a vacuum circuit breaker from the breaker operating mechanism for checking loss of vacuum inside the interrupter.

Vacuum circuit breaker shall be provided with a suitable metal shield for protecting the testing/ maintenance engineer from X-ray radiations emitted during high voltage testing of interrupter unit.

8.1.5 Operating Mechanism

1 Circuit breakers shall be power operated by a motor charged spring operated mechanism. Main poles of the breaker shall be such that the design shall ensure a close pole spread with timings as per GIS manufacturers' standard.

2 Circuit breakers shall feature high repeatability of absolute closing time over a wide range of parameters (ambient temperature, control voltages, etc.).

3 Main poles shall operate simultaneously. There shall be no objectionable rebound and the mechanism shall not require any critical adjustment. It shall be strong, rigid, positive and fast in operation.

4 Trip coil shall be rating shall be specified by the bidder for continuous rating.

5 A mechanical indicator shall be provided to indicate open and closed positions at a location from where it will be visible to a man standing on the ground. An operation counter shall also be provided.

6 A closing release shall operate correctly at all values of control voltage between 80% and 110% of the rated voltage. A shunt trip shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker and at all values of control supply voltage between 70% and 110% of rated voltage.

7 Working parts of the mechanism shall be of corrosion resisting material. Bearings which

require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing of adjustment with repeated operation of the breaker.

8.1.6 Spring Operated Mechanism

1) Spring operated mechanism shall be complete with motor, opening spring, closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.

2) As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible.

3) After failure of power supply to the motor, at least one close-open (CO) operations of the circuit breaker shall be possible.

4) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring.

5) Closing action of the circuit breaker shall compress the opening spring ready for tripping.

6) When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation.

8.1.8 Contacts

1 Main contacts shall have ample area and contact pressure for carrying the rated current and the short time rated current of the breaker without excessive temperature rise which may cause pitting or welding. Contacts shall be easily replaceable and shall have a minimum of movable parts and adjustments to accomplish these results. Main contacts shall be the first to open and the last to close so that there will be little contact burning and wear.

2 Arcing contacts, if provided, shall be the first to close and the last to open and shall be easily accessible for inspection and replacement. Tips of arcing and main contacts shall be silver faced or have tungsten alloy tipping.

8.2 DISCONNECT SWITCHES (ISOLATORS) AND EARTH SWITCHES

8.2.1 Construction Features

1 The Isolators, earth switches and maintenance earth switches, as applicable, shall be complete with all parts that are necessary or essential for efficient and safe operation. Such parts shall be deemed to be within the scope of supply, whether specifically mentioned or not.

2 All similar parts shall be interchangeable.

3 The design shall be such that no lubrication of any part is required except at very infrequent intervals.

4 The isolator and earthing switch shall be provided with high current carrying contacts on the hinge and jaw ends and all contact surfaces shall be of silver/tinned faced copper, if required.

5 Arrangement shall be provided to enable manual operation of Isolators and earth switches. Whenever the emergency manual handle is inserted into the drive mechanism, it shall not be possible to control the device electrically.

8.2.2 Accessories

1 Position Indicator: A mechanical position indicating device shall be provided for each isolator/earthing switch which shall be clearly visible from ground.

2 Name Plate: A weather-proof and corrosion-proof name plate shall be provided on each isolator, earthing switch and operating devices etc. The name plates shall conform to applicable standards.

8.2.3 Earthing Switch

1 Earthing switch shall be designed in a manner to prevent transmitting of impact to earth switch bushing during high speed closing operation of the earth switch.

2 The earth switches shall have fault current rating as specified.

3 Earth switches shall be either be motor driven or stored energy operated and controlled from the local control panel as specified. After removal of the ground initiated by a fault making ground switch, it must be possible to re-energize the system without first carrying out maintenance. The BIDDER shall state what precautions are taken to minimize the accidental discharge of the stored energy operating mechanisms. This will not be applicable for hand operated earth switches.

4 A positive interlock shall be provided such that the circuit breaker shall be closed only when all three phases reach end position of “Earth” during earthing operation. Bidder shall clearly explain this interlock in the technical offer.

8.2.4 Interlocks among circuit breaker, earthing switches and doors shall be as per the recommendations of the GIS manufacturer.

8.2.5 Operating Mechanism and Controls

1. Isolators shall be motor operated and controlled from the local control panel and from a remote point. Connections, interlocking requirements and auxiliary switches shall be in accordance with the PURCHASER's requirements.

2. The operating mechanism shall provide a quick, simple and effective operation. One man shall be able to operate the isolator/earthing switch (when manually operated) without undue effort.

3. The isolator shall be provided with positive continuous control throughout the entire cycle of operation. The operating pipes and rods shall be sufficiently rigid to maintain positive control under most adverse conditions and when operated in tension or compression for isolator closing. They shall also be capable of withstanding all torsion and bending stresses due to operation of the isolator.

4. In addition to the limit switch contacts required for control of power operated isolators, the number of auxiliary contacts shall be provided. These switch contacts shall be positive acting type and shall be directly driven from the isolator shaft through minimum linkages. The auxiliary contacts shall be of silver faced copper. When make before break contacts are specified, they shall be wiping type. The contacts (including limit switch contacts) shall be designed to carry 10A continuously without undue temperature rise. All contacts (including limit switch contacts) shall be suitable for breaking an inductive current of 2A at specified DC voltage.

5. A local isolating switch fuse unit for disconnection of power supply, a local/remote selector switch and a set of open/close push buttons shall be provided in the associated local control panel for motor operated isolators.

6. The control shall be arranged such that the desired operation shall be completed when corresponding push button is pressed even momentarily. The control circuit shall be so designed

that necessary interlocks with associated breakers and earthing switch shall be incorporated in it.

7. Arrangement shall be provided to permit manual operation of isolators. The arrangements shall be such that when manual operating handle is in the engaged position, the power operation shall be made inoperative.

8. Disconnector and earthing switch mechanisms shall be able to store energy to always assure completed operations.

9. If the power supply to Isolator/ earthing switch is initially off and open/close command is given to isolator/earth switch which cannot be carried out due to non-availability of power at that moment, the operation of Isolator/Earth switch shall not take place when power supply is restored subsequently.

8.2.6 Short Circuit Requirements (except for Disconnector for VT in incoming panel)

1. The rated peak short-circuit current or the rated short time current carried by an isolator or earthing switch for the rated maximum duration of short circuit shall not cause:

   a) Mechanical damage to any part of the isolator or earthing switch.

   b) Separation of the contacts or contact welding.

   c) A temperature rise likely to damage insulation.

2 After the passage of these currents, the isolator shall be able to carry its rated current under specified conditions and the operation of the operating device shall not be impaired.

3 If earthing switch is combined with an isolator as a single unit, the rated peak short circuit current and the rated short time current of the earthing switch shall be at least equal to those specified for the isolator.

8.3 **CURRENT AND VOLTAGE TRANSFORMERS**

8.3.1 General Requirements

1. Secondary terminals of each voltage and current transformers shall be brought out in a weather-proof terminal box. Facility shall be provided for short circuiting and earthing the CT secondary at the terminal box. The star point whenever required shall be formed at the terminal box only.

2. Terminal and polarity marks shall be indelibly marked on each VT & CT on the associated terminals and these marks shall be in accordance with relevant standards.

3. In case of unearthed voltage transformers both the terminals of the primary winding shall be brought out through bushings rated for full line voltage. In case of earthed voltage transformers, the end of the primary winding intended to be earthed shall be brought out through a bushing and earthing connection shall be made outside. This is required to facilitate meggering of the primary winding for which the earth connection has to be removed. The neutral side bushings of the voltage transformers shall be rated for 1.1 kV class.

4. The secondary terminal box for the voltage transformers shall also include necessary MCBs for protecting the secondary circuit

5. Whenever a VT secondary winding is used for both measurement and protection application, it shall have dual accuracy class of 0.2/3P, unless otherwise specified.

6. All CT cores in this specification shall be of low reactance type except metering core.

7. No turns compensation shall be used in case of 'Class PS' CTs.

8. Turns compensation, if any, should be clearly brought out in the offer in guaranteed particulars.

9. In case of multi ratio CTs, the minimum specified requirements in respect of VA, accuracy and knee point voltage (KPV) and maximum secondary resistance specified shall be met at all taps.

10. Magnetizing characteristics (extending well beyond KPV) and secondary impedance values shall be furnished in guaranteed particulars for all protection cores.

11. Voltage transformers shall be of electromagnetic type. Capacitor voltage transformers shall not be acceptable.

12. Voltage and current transformers shall be provided with the following accessories:

13. Voltage and current transformers shall be given tropicalised treatment for satisfactory operation in hot and humid climate.

a) Two earthing terminals for connecting the PURCHASER's earthing conductors specified.

b) Rating and diagram plates shall be provided as per IEC standards.

8.3.2 VOLTAGE TRANSFORMERS

1 Voltage transformers shall be of the metal enclosed, gas-insulated inductive type, mounted directly on the high voltage enclosure with plug in contacts without fuse that allow easy removal.

2 Minimum accuracy, burden and transient response characteristics shall be in accordance with the specification.

3 Secondary terminals must be located in accessible grounded terminal boxes on the PT enclosure itself. The secondary connections must be wired to the terminal strip in the respective bay marshalling cubicle.

4 BIDDER shall provide the VT selection scheme for outgoing feeders ie. potential supply to protection system shall be switched to bus VT depending on position of bus side disconnect switch (power supply to the feeder and VT potential supply for protection shall be from the same bus.)

8.3.3 CURRENT TRANSFORMERS

8.3.3.1 Number and Location of CTs
a) The CTs shall be provided as per specification.
b) The physical relative location of CT cores should be as per the locations shown in the single line diagrams, to ensure overlapping of protective zones.
8.3.3.2 Minimum Accuracy for Relaying Cores
PS class, Class 0.2s & Class PS shall be as per specification. The relaying cores shall be of low remanence design. Gaps in the core shall not be larger than necessary to limit remanence. The core remanance shall not exceed 10% of the saturation flux that is created by the application of 10 DC ampere turns per inch length of core around the magnetic path.

8.3.3.4 Other CT Requirements.
a) For each type of CT, application data shall be supplied in accordance with IEC 60185.
b) Readily accessible name plate(s) shall be provided for each CT showing ratings, terminal markings and low remanence designation.
c) The position of each primary terminal in the current transformer shall be clearly marked by two plates permanently fixed to the metal cladding at each end of the current transformer section.

d) In addition to the information requested, short time rating factors for 5, 15, 30 and 60 minutes shall also be provided.
8.3.3.5 Current transformers must have secondary terminals outside the high voltage enclosure, mounted in suitable accessible terminal boxes. All secondary leads of all CTs must be wired to shorting type terminals on the terminal strip in the local control panel of each breaker bay.
Note: The details of the CTs will be finalized later, based on the protection relay study.

8.4 **Surge Arresters**

The specifications and characteristics of the surge arresters shall be finalized during detailed engineering.

8.5 **LOW VOLTAGE PANELS**

The accessories and auxiliary equipment required for the correct functioning of each circuit element shall be installed in conveniently located mechanism cabinet or could be an integral part of the circuit element.

8.5.1 General Requirements

a) Individual local control panels/Cabinets/Cubicles for each circuit shall be supplied as a part of this contract to facilitate local control of circuit breakers, isolators and earth switches. These panels shall also house the various relays, timers, etc. to realise various interlocks as per PURCHASER's requirement among circuit breakers, isolators and earth switches. The contacts, signals and conditions originating form/going to the gas insulated switchgear, associated auxiliary and monitoring equipment shall be wired up to the local control panel, for PURCHASER's further use.

b) Completely separate and isolated circuit shall be used for switchgear control, tripping, alarms and auxiliary devices. CLOSE and TRIP circuits shall be kept isolated to their final mechanical or electrical actuators. Trip circuits shall be individually and permanently monitored for continuity.

Each auxiliary control circuit shall be monitored and shall be protected by a two pole miniature circuit breaker with auxiliary contacts.

c) Constructional Features

1. All panels shall be totally enclosed rigid sheet steel structures. All doors, removable covers and plates shall be gasketed all around with neoprene gaskets. All accessible live connections shall be shrouded and it shall be possible to change individual fuses, switches, MCBs without danger of contact with live metal.
2. A ground bar for terminating the ground wires of shielded control cables shall be located near the cable entrance location.

3. A receptacle rated 415V, 20A, AC 3 phase, 4 wire shall be installed in each panel in addition to a light point with door switch and one 6 pin, 240V AC, 5/15A socket outlet.

4. Adequate safety precautions shall be taken to avoid accidental contact with 415V potential. The following precautions shall be observed:

i) All live parts shall be completely shielded using a halogen free fire retardant insulating material.

ii) 600V terminal blocks shall have removable covers and wiring shall be separated from other potentials.

iii) A clear and legible warning notice carrying wording "DANGER-415V" shall be located on the enclosure door.

5. All control equipment shall be suitable for operating in an ambient temperature varying between +10 deg. C and +40 deg.C.

6. Cabinet doors shall have provision for padlocking. Door shall be constructed such that they do not seize in the event of an internal fire.

7. All live parts shall be provided with at least phase to phase and phase to earth clearance in air of 25 mm and 20 mm respectively.

8. Adequate interior cabling space and suitable removable cable gland plate shall be provided. Necessary number of cable glands including cable glands for cables from control room to GIS shall be supplied and fitted on to this gland plate. Cable glands shall be screwed-on type and made of brass. The cable entry shall be from bottom only.

9. All the hardware required for fixing the panel shall be in BIDDER's scope.

10. Terminal blocks for terminating all control, indication and monitoring wiring from the associated circuit element shall be installed in each cabinet. All terminal blocks shall be identified with marking strips. The conductor size range which the terminals can accommodate shall be clearly shown on the BIDDERS drawings. The terminal blocks used for cable connections shall be disconnecting type. All terminal blocks shall be covered by acrylic covers.

11. Disconnecting type terminal links shall be provided for current transformer circuits.

d) Switches/ MCBs

1 Switches/MCBs shall be hand operated, air break, heavy duty, quick make, quick break type conforming to applicable IEC standards.

2 It shall be the responsibility of the VENDOR to fully coordinate the overload and short circuit tripping of the MCBs with the downstream MCBs/fuses provide satisfactory discrimination.

3 A single throw isolating switches for complete isolation of the DC control circuits shall be provided.

f) **Control & Auxiliary Power Supply**

1 All control equipment shall be suitable for operation on specified DC voltage system.

2 In case two systems are working on two different battery potentials, say A and B, both A and B potentials shall not be connected to the contacts of same relay. However, it is permissible to use, for example, the relay coil on A and the contacts on B battery. Dissimilar potentials shall not occur on contacts of same relay.

3 DC & AC power supply shall be done in a manner which will enable isolation of individual equipment. Common supply bus will be formed in the cubicle and then power supply shall be distributed into individual equipment through MCCBs.

4 Separate circuits with switches, fuses etc of adequate rating shall be provided for control of space heater, lighting and power receptacle etc. These shall be on 240V, 1 phase AC supply.

g) **Relays**

1 Relays for various control, monitoring and blocking functions of a particular circuit element shall be installed in associated local control panel. Protective relays shall be subject to transient tests and shall be approved by the PURCHASER. All relay shall have dust covers. Please refer Section C3 for detailed specifications of BCUs and BCPUs.

2 Necessary auxiliary relays for alarm, time-delay relays, voltage relays as required for control and protection shall be mounted inside the local control panel. Voltage relays shall have sufficient thermal capacity for continuous energisation, using external resistors, if necessary.

3 Auxiliary relays shall be rated to operate satisfactorily between 80% and 110% of the rated voltage.

4 Each relay shall be provided with at least 4 NO and 4 NC potential free contacts for the PURCHASER's use.

5 Coils of all the relays shall be adequately rated to avoid spurious operation of relays on DC system ground or induced surges. Minimum pick up current of relay coil shall be 100 milli amps.

6 All relays shall be tropicalized and suitable for maximum ambient temperature of 40 deg. C.

7 Make and type of relay shall be subject to the PURCHASER's approval.

h) **Space Heater**

Strip type space heaters of adequate capacity shall be provided inside each cabinet. Heaters shall be complete with rotary type ON-OFF switch, HRC fust on phase or a single-pole MCB with overload and short circuit protection, link on the neutral and a thermostat to cut off the heaters at 45 deg.C. The heaters shall be suitable for connecting to 240V, 1 phase, and 50 Hz supply.

i) **Interior Lighting and Receptacle**

Control cabinet shall be provided with a 240V, 1 phase, 50 Hz, 40W preferably fluorescent lighting fixture for interior illumination controlled by an ON-OFF switch and 240V, 1 phase, 5/15 amp. 6 pin receptacle. Power source for interior lighting and receptacles shall be completely independent of control power source.

j) **Internal Wiring**

1 LV control panels shall be completely wired, ready for the PURCHASER's external connections at the terminal blocks. All wiring shall be carried out with wires of 600V grade, stranded copper conductors. The insulation shall be fire retardant low smoke type, approved and tested in accordance with PURCHARSER's requirement. Power circuits shall be wired with stranded tinned copper conductors of adequate sizes to suit the rated current. Alarm and indication circuits shall be wired with stranded, tinned copper conductors of sizes not smaller than 1.25 sq.mm and shall be shielded type. CT circuits shall be wired with stranded copper conductor of size not smaller than 2.0 sq.mm.

2 Engraved identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire. All wiring shall be terminated on terminal blocks. Terminals shall be adequately rated for the circuit current the minimum rating shall be 20 A. Control wiring shall be protected against mechanical damage and shall be colour coded in accordance with PURCHASER's requirement. Colour sleeves may be used in lieu of continuous colouring. Physical separation between various colour wiring shall be maintained as much as possible.

3 The wire terminations shall be made with solder less crimping type of tinned copper lugs which firmly grip insulation and conduction.

4 Panel wiring shall be securely supported, neatly installed by lacing and tying, readily accessible and connected to equipment terminals and terminal blocks. Flame retardant plastic wiring channels/troughs with strap on covers shall be used for this purpose.

k) **Mimic Diagrams** (Optional)

Mimic diagrams shall be provided on local control panels. The mimic strips shall be screwed onto the panel and shall be made of anodised aluminium. Colours of the various voltages of the mimic bus shall be subject to the PURCHASER's approval. The width of mimic strip shall not be less than 7 mm.

l) **Local Alarm/Annunciation**

1 Window type alarm annunciation shall be provided on local control panels of each bay for various abnormal conditions. The alarm windows should have provisions for detecting cleared and un-cleared faults and flashing for new faults.

2 The following abnormal conditions shall be annunciated (additional to list). i) Low gas pressure for each gas compartment of the bay. ii) Low-Low gas pressure for each gas compartment of the bay. iii) High gas pressure for each gas compartment of the bay. iv) Spring motor excessive start. v) Spring motor run excessive. vi) Spring motor overload. vii) Spring motor circuit trouble. viii) Spring is charged. xiii) Breaker pole discrepancy. xiv) Isolator open/close incomplete. xv) Isolator motor overload, one for each bay , xvi) D.C. control supply failure. xvii) Alarm circuit D.C. healthy (continuously `ON') , xviii) Selector switch local , xix) Four spare windows.

m) **Labels and Diagram Plate**

1 Every equipment mounted in the cabinet shall be provided with individual labels with equipment designation/rating. Also, the cabinet shall be provided on the front with a non-rusting label engraved with the designation of the cabinet.

2 Inside the door, a circuit diagram engraved on non-rusting metal shall be fixed for reference.

9. **SF6 Gas**

9.1 Density and Pressure

The nominal operating pressure of SF6 insulated gas in the equipment shall be as low as is compatible with the requirements for electrical insulation and space limitations to reduce the effects of leaks and to ensure that there is no chance of the gas liquefying at the lowest ambient temperature. The initial gas pressure or density at the time of charging the equipment shall provide a sufficient margin above the minimum allowable pressure for the plant to be safely operated for a reasonably long period before recharging is necessary.

10.2 SF6 Gas Purity

a) The SF6 switchgear shall be designed for use with SF6 gas complying with the recommendations of IEC-60376 at the time of the first charging with gas. All SF6 gas supplied as part of the contract shall comply with the requirements of IEC. 60376.

b) Molecular sieve or activated alumina or other absorbent for removal of SF6 arc products and moisture absorbents shall be provided in each gas compartment.

c) The SF6 gas shall have the following characteristics:

1) Physical properties: Colourless, odourless, non-toxic and non-flammable.

2) Density at 20^{o}C and/Bar 6.08 g/l 8) Preferred cylinder size 40 Ltr.

3) Type of cylinder Seamless type

10.3 SF6 Gas Monitoring Devices

1. All gas compartments must have their own independent gas supervision and alarm systems. Each gas supervision circuit shall be equipped with a temperature compensated pressure gauge, test connection point and maintenance connection point and the same shall be easily accessible. Bus bar side Disconnecter (DS)/Earth Switches (ES) shall have common gas density monitor for all the three phase.

All other equipments such as Circuit breaker, Line side DS/ES can either have common or separate gas density monitor system for all the three phases.

2. The gas density and pressure sensitive devices, together with all relays supplied by the manufacturer for use in protection, shall be approved by the PURCHASER. It shall be possible to test all gas monitoring relays without de-energising the primary equipment and without reducing pressure in the main section. Disconnecting type plugs and sockets shall be used for test purposes; the pressure/density device shall be suitable for connecting to the male portion of the plug.

3. Two potential free electrical contacts shall be provided with each and every alarm condition. These are to be grouped together and wired to the cable termination blocks in the local control panels to give remote alarm indications/annunciations in equipment being supplied by the PURCHASER. The BIDDER will be advised of the grouping required after the contract has been placed.

4. BIDDER shall advise if the breakers are suitable for breaking the load current even if SF6 gas pressure has reduced to atmospheric pressure.

10.5 Sectionalisation

10.5.1 The assembly shall consist of completely separate, pressurized sections. The switchgear gas enclosures must be sectionalised with gastight barriers between sections or compartments as per the below:

a) One compartment for bus bar, Isolator and earthing switch
b) One compartment of circuit breaker and cable connection

10.5.5 The mass of gas in all the individual compartments at rated nominal density shall be indicated in the bid.

10.6 Support Insulators and Section Barriers

10.6.1 The support insulators and section barriers/insulators shall be manufactured from the highest quality material. They shall be free from all voids and the design shall be such as to reduce the electrical stresses in the insulators to a minimum. They shall be sufficiently strong to ensure that the conductor spacing and clearances are maintained when short circuit faults occur.

10.6.2 Tests shall be carried out during the manufacture of the switchgear to ensure that all insulators and barriers are free of partial discharge at a voltage which is at least 20% greater than the maximum service voltage.

10.6.3 The Gas section barriers including seals to the conductor and enclosure wall shall be gas-tight and shall be capable of withstanding the maximum differential pressure that could occur across the barrier i.e with a vacuum drawn on one side of the barrier and on the other side, at least twice the rated gas service pressure that can exist under normal operating and maintenance conditions or the maximum gas over pressure, at least equal to the operating pressure of the relief devices, that could be attained with a persistent internal arc fault.

10.7 Gas Seals

All gas seals shall be designed to ensure that leakage rates are kept to specified minimum under all normal pressure, temperature, electrical load and fault conditions.

10.8 Expansion Joints and Flexible Connections

10.8.1 Expansion joints or flexible connections, in the metal enclosures, to absorb the actual or relative thermal expansion and contraction of the SF6 equipment as well as structures, foundations and floors on which the equipment is mounted, resulting from variations in the temperature of the switchgear equipment shall be provided, if required.

10.8.2 The number and position of expansion joints or flexible connections are to be determined by the BIDDER to ensure that the complete installation will not be subjected to any expansion stresses which could lead to distortion or premature failure of any piece of the GIS equipment, support structure or foundations.

10.8.3 Electrical continuity of the connection for all enclosures across bolted joints/expansion/flexible connections shall be achieved.

10.9 Supply of SF6 Gas

The contract shall include the supply of all the SF6 gas necessary for filling and putting into commercial operation the complete switchgear installation being supplied including loss during installation. In addition, ten percent of the total SF6 gas required for the GIS shall be supplied as spare and shall be included in the contract.

11. Earthing

1. The MANUFACTURER shall provide a "Main Ground Bus", rated 31.5 kA for 3 sec to which all intentionally earthed parts of the assembly must be connected.

2. It shall be the responsibility of the VENDOR to provide a sufficient number of earth points so that dangerous voltages are not induced in the enclosure by the fault currents circulating in the inner conductor.
3. Every section of the SF6 switchgear equipment including all panels, cubicles, kiosks and boxes shall be solidly bonded to the earthing system.

4. Earth switches, voltage transformers and panels shall be bonded to the earthing system as specified in the relevant previous clauses.

8. All steelwork, access decking, handrails etc., shall also be effectively bonded to the earthing system.

9. The design of the earthing system shall be such as to ensure the safety and protection of all operating and maintenance personnel under all normal and fault conditions.

10. The enclosure of the equipment and support structure of GIS shall be earthed in such a way that the following conditions are obtained:
(a) The touch potential at any part of the enclosure is less than 65 V.

(b) The induced current during normal operation is prevented from entering the earthing grid.

12. Interlocks

All interlocks required between circuit breaker, disconnect and earth switches shall be as per the recommendation of the GIS manufacturer.

13. Future Extension

It is proposed to make provision for additional bays at a later date.

1 It shall be possible in future to extend the bus bars. BIDDER shall separately quote for additional items required to be provided now to facilitate future extension without necessitating complete outage of the bus bars.

2 It is a firm requirement that no changes are made to the enclosure during future extension. Also, the downtime must be minimum when extension is carried out. During erection/testing of extension, outage of only one bus section and associated equipment will be available. Under no circumstances outage of both the bus sections (resulting in complete shutdown of the station) will be permissible. The BIDDER is required to bring out in detail his proposal for achieving future extension and indicate if shutdown of any part of the equipment/circuit will be required for erection, dielectric testing along with Gas Line Diagram etc. The bidder will give step by step procedure for extension of bays on either side of GIS, at later date.

14. Foundation Channels & Supporting frame work

1 All supporting steel structures for switchgear bays, bus duct support, etc. shall be a part of Bidder's supply.

2 All 33kV GIS shall be supplied with bolts, nuts, washers and accessories required for fixing the GIS to the foundation.

15. Temperature Rise Temperature rise of enclosure and conductor shall be such that the final temperature does not exceed the values specified for specified site conditions including the effects of solar radiation. BIDDER shall provide test reports/ calculations to prove this.

16. Gas Leakage The guaranteed maximum gas leakage shall be less than 1% per year for any individual gas compartment and for the whole equipment.

17. Losses Manufacturers shall provide details of the losses at rated current.

18. Tests and Test Reports

19.1 The Type test reports shall be submitted with the bid.

19.2 Acceptance and routine tests for all supply equipments/components parts shall be carried out as per the relevant standards for the respective equipment. These test reports and shall be submitted to the PURCHASER before despatch of the equipment.

19.3 Local control panel shall be subjected to the following tests:

i. High Voltage test (2000V for 1 minute)

ii Megger test.

iii Electrical control, interlock and sequential operation tests

20. DRAWINGS DATA AND GUARANTEED TECHNICAL PARTICULARS TO BE FURNISHED BY THE BIDDER

20.1 The following drawings/information for each items are to be supplied as part of this contract:

a) Outline dimensional drawings of 33kV GIS and accessories.

b) Shipping drawings showing dimensions and weights of each package.

c) Assembly drawings and weights of main component parts.

d) Drawings giving the weights for foundations.

e) Name plate diagrams.

f) Schematic control along with logic block diagram and wiring diagram for all auxiliary equipment.

j) Test reports

k) Crane requirements for assembly and dismantling

l) Cable box connections.

m) Foundation drawing of GIS, support structures, cable box etc.

20.2 Manufacturer shall submit following for Purchaser's reference before despatch of the transformer.

a) Six (06) copies of instruction books/operation and maintenance manuals and spare part bulletins.

b) Descriptions literature and data on GIS construction.

20.3 After the award of the contract six (6) copies of drawings, drawn to scale, describing the equipment in detail shall be forwarded for Purchasers approval, and shall subsequently provide eight (8) complete sets of final drawings, one of which shall be auto positive and editable soft copy suitable for reproduction, before the despatch of the equipment.

21. Technical particulars of 33KV Cubicle GIS.

Sl. No.	Particulars	33 kV GIS (Cubicle type)
1.		
a)	Type (Model No.)	To be specified by the bidder.
b)	Standard Applicable	IEC-62271-100 / IEC-62271-200
2.	Service	Indoor
3.	Enclosure	Sheet Steel with anti corosion paints.
4.	Nominal System Voltage	33 kV
5.	Highest System Voltage	36 kV
6.	No. of phases and frequency	3ph. 50 Hz
7.	Busbar material	Aluminium
8.	Bus Color code	RYB
9.	System Earthing	Solidly earthed
10.	Circuit Breaker Rating	
10.1	Continuous Current Rating at 40 Deg C	2000A
10.2	Short Circuit Rating	31.5 kA
10.3	Short Circuit duration	3 sec
11.	Rated making Current	As per IEC-62271
12	Operating duty	O-0.3sec-CO-3 minutes -CO
13	Leakage rate per year in gas compartment	Less than 0.2%
12.	Busbar rating	As per SLD
13.	Outgoing feeder rating	As per SLD
13.	Power Frequency Withstand voltage	70 kV for 1 minute
14.	Impulse withstand voltage (1.2/50 micro sec)	170 kV
15.	Control Voltage	220 V DC
16	Spring charge motor voltage	220 V DC
17.	CT Ratio	Secondary Current 1A (Ratio during detail engineering)
18.	PT ratio -STAR/ STAR/ Open delta	(33//3) / (.11//3) / (. 11/3)
19.	Aux. Contacts	As per manufacturer standard
20.	Termination	
20.1	Incomers	XLPE Cables **
20.2	Outgoings	XLPE Cables **
21.	Degree of protection (HV equipment)	IP – 65 for Gas Compartment

** Notes:

1) The length details of the XLPE cables shall be estimated during detailed engineering.
2) Interface of 33kV GIS the feeder bays to be finalized during detailed engineering.
3) From the 33 KV GIS XLPE cable shall be used for station transformers.

GUARANTEED TECHNICAL PARTICULARS FOR 33KV GIS

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR BREAKERS / PANELS

01.	Manufacturer's Name and Country of origin	
02.	Manufacturer's Design / type Ref	
03.	Frequency	
04.	Rated Voltage	
05.	Highest system voltage	
06.	Rated current	
07.	Short Circuit current rating with duration	
08.	Certificate or report of short circuit type test	
09.	Rated operating duty cycle	
10.	Short Circuit Breaking Current : (a) Symmetrical (b) Symmetrical at rated voltage (c) Asymmetrical at rated voltage (i) Per Phase (ii) Average (iii) D.C.Component	
11	Arcing time (at rated breaking current) in ms.	
12	Opening time	
13	Total break time in milli sec.	
	(a) At 10% rated interrupting capacity (b) At rated interrupting capacity	
14.	Make time in ms.	
15.	Dry 1 minute power frequency withstand test voltage (a) Between line terminal and Earth KV rms (b) Between terminals with breaker contacts open	
16.	1.2/50 full wave impulse withstand test voltage (a) Between line terminal and Earth KV p (b) Between terminals with breaker contacts open KVp	
17.	Contact pressure	
18.	Contact Resistance	
19	Control Circuit Voltage AC / DC	
20	Power required for Closing Coil at 220 V	
21	Power required for Tripping Coil at 220V	
22	Whether Trip free or not	
23	Whether all the interlocks provided	
24	Overall dimensions	
25	Gauge of the MS sheet used for the fabrication of the cubicle Size and type of stiffeners used	
26	Total weight of one complete Breaker	

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 33KV CURRENT TRANSFORMERS

01.	Manufacturer's Name and country of origin	
02.	Manufacturer's design Ref / Model	
03.	Applicable Standards	
04.	Type	
05.	Rated Primary current	
06.	Rated secondary current	
07.	Rated frequency	
08.	Transformation ratios	

09	Number of cores	
10	Rated output (Core wise)	
11	Class of insulation	
12	Class of accuracy (a) For metering (b) For Protection	
13	Short circuit current rating and its duration	
14	Secondary resistance at 70 Deg C	
15	Continuous over load (percentage)	
16	One minute power frequency dry withstand voltage	
17	1.2/50 micro sec. impulse withstand test voltage	
18	One minute power frequency withstand test voltage on secondary	
19	Instrument safety factor	
20	Type of primary winding	

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 33KV POTENTIAL TRANSFORMERS

01.	Manufacturer's Name and country of origin	
02.	Manufacturer's design reference	
03.	Applicable Standards	
04.	Type	
05.	Ratio	
06.	Rated Primary voltage	
07.	Rated secondary voltage	
08.	Rated frequency	
09.	Class of accuracy	
10.	No. of phase and method of connection	
11.	Burden	
12.	One min. power frequency dry flash over voltage	
13.	1.2/50 micro sec. impulse withstand test voltage	
14.	Class of insulation	

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR NUMERICAL RELAYS

01.	Manufacturer's Name and country of origin		
02.	Manufacturer's design Ref / Type		
03.	Applicable Standards		
04	Current setting range for		
	(a)Over current relay	IDMTL Instantaneous	
	(b) Earth-fault relay	IDMTL Instantaneous	
	(c) Contact Rating		
05.	Details on IDMTL characteristics		
06	Whether High Set is Transient free		
07	Whether separate Time setting for IDMTL / Instantaneous Elements available		
08	Whether Relay senses True RMS Current		
09.	Accuracy for different settings and limits of errors		
10	Whether settings site selectable and HMI provided		
11	Whether Alpha Numeric LED display		
12.	Whether Compatible for 220 V DC		
13	Whether Compatible for 1 A CT Secondary		
14	Whether Self diagnostic features available		

15	Whether Communication Port RS 485 Compatible for MODBUS / IEC / DNP.3 provided	
16	Whether Blocking characteristics available for blocking the unscrupulous tripping of Upstream Breakers	
17.	a) Whether relay test block is provided b) Type of test block with literature	
18.	Whether draw out type unit or not	
19.	Types of case	
20.	Reset time	
21.	Burden of relay	
22.	Maximum and Minimum operating ambient air temperature	

Specification for Online Partial Discharge (PD) Monitoring System for HV GIS

A proven and well established online continuous partial discharge monitoring must be supplied with every high voltage GIS module complying the following key features:

Standards:

- The System shall be type tested by independent accredited test house to ES BN 55022 (CISPR22), IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-27, IEC 60068-2-56, IEC 60255-5, IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-6, IEC 61000-4-8, IEC 61000-4-9, IEC 61000-4-10, IEC 61000-4-12, IEC-61850, IEC-60270 standards for use within EHV substations

Sensors:

- Meet sensitivity according to CIGRE TF15/33.03.05 1998 or latest at every place in the GIS (5pC or better) will be verified as part of site sensitivity tests. A sensor location drawing has to be submitted by the bidder.
- The PD couplers shall be of passive, maintenance free antenna type meeting CIGRE TF15/33.03.05 standrads with detection spectra range: 250 MHz to 1.5 GHz. Pre-amplifier installed as part of the coupler is not acceptable. UHF amplification or conditioning is only allowed at electronic node unit.

Analyser:

- Continuous real-time measurement and PD analysis; not multiplexed data collection.
- Supports up to 2000 UHF sensros on one system and shall have a signal sensitivity of -75dBm or better with fixed broadband monitoring (bandwidth >=1 GHz) and historical PRPD over 5, 10 or 15 minute recording period (software selectable).
- The System shall be capable of synchronizing, capturing and displaying PD data for a power test frequency in the range 40Hz to 220Hz. The System shall be capable of operation during and assisting with HV testing of the GIS.
- The PDM System shall be able to discriminate between partial discharge sources, external interference and transients resulting from switching operations of the high-voltage equipment either by Smart Gating with external type noise antenna and/or Smart Coincidence Filter and/or Artificial Intelligence Software detection package.
- All UHFchannels shall be monitored continuously and simultaineously to ensure no PD pulses are missed.
- The System shall be sensitive to partial discharge signals throughout the frequency range 250-1500 MHz. However, it is recognised that in some cases the use of filters may be necessary to reduce the sensitivity of the System at certain frequencies to signals arising from telecommunications and other external sources.

Software:

- IEC61850 standard for communications within substations with Node communication must be by Ethernet, scalable, industrial standard between data nodes central server by Node data connection via both Copper Ethernet and Multi Mode Fibre Optic.
- >2M defect records from multiple customer sites.
- UHF Signal classification (5 types or better) for GIS by Separate Multiple Hybrid Expert System and the multiphase analysis result shall be clearly indicated to the operator. The PDM System shall, combine Artificial Neural Networks (ANNs), Genetic Algorithms (GAs) and Fuzzy Logics (FLs).
- The System shall have time synchronisation facility, individual channel control and PD Alarm Wizard for configuration of all PD alarms within substations including station auxiliary supply failure.
- Automatic report generator, alarm and configurable by customer over web or client server interface with provision of SMS & E-Mail.

- The System application software shall incorporate function for the complete recording of PD activity during GIS HV tests. The function shall allow complete review of PD activity during or after the test.
- The System shall have provision for conntecting to a PC at OPTCL headquerter location with remote application software which can automatically support remote accessing for remote substations.
- Ability to call and display, within Application software, 2 Dimensional GIS Schematics showing spatial relationship between couplers in the GIS, 3 Dimensional GIS models (Optional) showing spatial relationship between couplers.
- History data shall be recorded upto 15 minutes in software selectable steps. History plots shall be capable of being displayed over a period up to 5 years.
- The HMI system shall be equipped with Relational Database Management System (RDBMS) which is complient to Microsoft ODBC (Open Database Connectivity), ANSI 92 SQL (Structured Query Language), Allow remote database access for LabVIEW application. Examples of ODBC compliant RDBMS that provide remote access are Microsoft SQL Server, Oracle and IBM DB2. Proper authorisation and authentication shall be provided to use such softwares from original producer.
- Data shall be displayed in three dimensional oblique, snapshot and real time, two dimensional point on wave (both amplitude and discharge rate), PRPD (phase resolved partial discharge) online and historical, STT (short term trends) and 24 hour Summary
- System shall record switching transient generated by CBs and disconnectors. (Optional analysis of switching paterns)

ODISHA TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

11/33/132 KV H.T. XLPE POWER CABLE

SPECIFICATION FOR 11 & 33 KV XLPE CABLE

TECHNICAL SPECIFICATION FOR 33 kV CROSS LINKED ETHYLENE INSULATED PVC SHEATHED SINGLE CORE, (DIFFERENT CROSS SECTION AREA) COPPER POWER CABLE.

1. SCOPE

This specification covers the design, manufacture, testing, inspection at manufacturer's work, supply & delivery F.O.R. destination of **(DIFFERENT CROSS SECTION AREA)** Single Core XLPE insulated PVC sheathed Cable and single core XLPE cable suitable for solidly grounded system size as per clause(5) mentioned below.

2. PARTICULARS OF THE SYSTEM

The cable should be suitable for use on 50 Cycles, 3 Phases solidly earth neutral system & working voltage of 33kV.

3. STANDARDS

The cable covered under this Specification shall conform in all respects with the latest editions of IS-7098 (Part-2) 1985 & IS-8130-1984 & IEC:60502 of the latest version thereof.

4. TECHNICAL PARTICULARS

33kV, Single Core under ground XLPE insulated PVC sheathed cable suitable for working potential of 33kV on earthed system manufactured in accordance with IS-7098 (Part-2) 1985 with latest amendments or latest editions thereof. The electrolytic grade copper conductor with formation of segmental type as per IEC-60228, tapped with semi conducting conductor shall comply with requirements specified in IS:8130-1984. The insulation shall be chemically cross-linked polyethylene confirming to the physical, electrical and ageing property as required in latest edition of IS-7098 (Part-2) 1985. Cable shall be provided with both conductor screening and insulation screening. The conductor screening shall be non-metallic and shall be consisting of either semi-conducting tape or a layer of semi-conducting compound or combination of two. The insulation screening shall consist of non-metallic semi conducting tape of extruded semi conducting compound layer in combination with non-magnetic metallic shield. Armouring shall be arranged over the core and it shall be of non-magnetic material. The material for the Armouring shall be as per relevant ISS. Over the Armouring the cable shall be provided with extruded PVC outer sheath. The composition of PVC compound shall be type ST-2 of iS-5831-1984. The colour of outer sheath shall be black or grey.

5. SIZE

The size of the cable shall be: -
Single Core 300mm2

6. TESTS

6.1 Type Tests

The equipment offered should be type tested. Type test report should not be more than seven years old, reckoned from the date of bid opening, in respect of the following tests, carried out in accordance with ISS-7098/IEC-871/IEC-60502, from Govt./Govt. approved test house, shall be submitted along with bid:

i) Physical tests for insulation and outer sheath.
ii) Bending test.
iii) Di-electrical power factor test.
iv) Heating cycle test followed by di-electrical power factor as a function of voltage and partial discharge test.
v) Impulse withstand test.

The remaining type test report as per clause 3 of ISS-7098/IEC-871/IEC-60502 shall be submitted by the successful bidder within three months from the date of placement of order. These type test reports shall be from Govt./Govt. approved test house and shall not be more than seven years old, reckoned from the date of placement of order. The failure to do so will be considered as a breach of contract.

6.2 ROUTINE TESTS AND ACCEPTANCE TESTS

All routine and acceptance tests shall be carried as per relevant ISS in the presence of Nigam's representative.

7. INSPECTION

The material shall be inspected and tested before dispatch by an authorized representative of OPTCL in respect of quality.

8. TEST CERTIFICATES

The supplier shall supply test certificates from a Govt. agency in respect of quality as per IS:7098(part-II) 1985 with latest amendments thereof for approval of the purchaser.

9. PACKING

The cable shall be supplied in non-returnable wooden drum as per IS:10418:1982 so constructed, as to enable the cable to be transported on each drum. The cable wound on such drum shall be one continuous length. The ends of cables shall be sealed by means of non-hygroscopic sealing material.

10. MARKING

The marking on the drum shall have the following information: -

a) Reference to Indian Standard & cable code.
b) Name of the manufacturer & trade name.
c) Nominal cross section area of conductor for the cables.
d) Number of core.
e) Sequential No. at each meter.
f) Type of the cable & voltage for which it is suitable.
g) Length of cable on the drum.
h) Approximate gross weight.
i) Net weight of the cable.
j) Drum identification number.
k) P.O. No. and date.
l) Consignee's name with designation.
m) Year of manufacture.

Note: Cable should be marked with ISI Certification mark.

11. DRAWINGS & INSTRUCTION MANUAL

The tenderer shall supply the following drawings with the tender: -

i) Detailed drawing of the cable showing conductor, screening insulation, Armouring, outer sheath etc.
ii) Detailed drawing showing jointing of cable and sealing of end boxes.

Copies of instruction manuals for testing, installation jointing operation and maintenance of cables, shall also be submitted with the offer for reference of the purchaser.

12. CONTINUOUS A.C. CURRENT CAPACITY:

Continuous a.c. current capacity shall be as per Table given below.

Conductor sizes in sq.mm.	Continuous a.c. current capacity in Amps at maximum conductor temp. of 90 deg .c. for 33 kV cable	
	When laid direct in the ground 30 deg.C	When laid in air 40 deg.C.
70 sq.mm	155	165
95 sq mm	175	200
120 sq mm	195	230
150 sq mm	225	265
185 sq mm	255	310
240 sq mm	290	345
300 sq mm	325	396
400 sq mm	385	460
500 sq mm	450	590
630 sq mm	660	1000
800 sq mm	720	1140
1000 sq mm	760	1240

13 SHORT CIRCUIT CURRENT

Short circuit current of 11,22 & 33 kV XLPE cable shall be as per given below.

Duration of Short Circuit t in sec	Area of Al. Conductor	Short circuit current 33 kV in kA

t	A	I=0.094 x A/sq.rt (t)
1	70 sq.mm	6.58
1	95 sq mm	8.93
1	120 sq mm	11.28
1	150 sq mm	14.1
1	185 sq mm	17.39
1	240 sq mm	22.56
1	300 sq mm	28.2
1	400 sq mm	37.6
1	500 sq mm	47
1	630 sq.mm	59.2
1	800 sq mm	75.17
1	1000 sq mm	93.97

14. TESTS AND TESTING FACILITIES :

14.1 TYPE TESTS:

All the type tests in accordance with IS: 7098 (Part 2) ,IEC 60228, (amended upto date), shall be performed on cable. The same is to be furnished for verification if the type test has been conducted in last five years from the date of submission of GTP & drawing for approval. If the same is not available than the firm to conduct the type test again and submission for verification.

14.2 ROUTINE TESTS:

All the Routine tests as per IS:7098 (Part 2) ,IEC 60228,(amended upto date) shall be carried out on each and every delivery length of cable. The result should be given in test report. Partial discharge test must be carried out in a fully screened test cell. It is, therefore, absolutely essential that the manufacturer should have the appropriate type of facility to conduct this test which is routine test.

The details of facility available in the manufacturer's works in this connection should be given in the bid.

14.3 ACCEPTANCE TESTS:

All Acceptance tests as per IS:7098 (Part 2) /IEC 60228,(amended upto date) including the optional test as per clause no 18.4 and Flammability Test shall be carried out on sample taken from the delivery lot.

14.4 SHORT CIRCUIT TEST:

The contractor shall also undertake to arrange for the short circuit test as a type test on any one size of each voltage grade i.e on one size of 11 kV, one size of 22 kV and one size of 33 kV earthed grade shielded XLPE cables. If facilities for carrying out short circuit tests are

available at the works of the supplier, and provided the certification procedure is approved by the Purchaser, testing at the supplier's works will be acceptable.

Short Circuit test shall be witnessed by the purchaser's representative.

14.4.1 The short circuit test shall be preceded and followed by the following tests so as to ensure that the characteristics of the cable remain within the permissible limits even after it is subjected to the required short circuit rating.

a) Partial Discharge Test.

b) Conductor Resistance Test.

c) High Voltage Test.

14.4.2 The manufactured cable will be acceptable only after such a sample test is successfully carried out at CPRI or at suppliers works and approved by the Purchaser.

14.5 TESTING FACILITIES

The supplier / tenderer shall clearly state as to what testing facilities are available in the works of manufacturer and whether the facilities are adequate to carry out type, routine and acceptance tests mentioned in specified IS. The facilities shall be provided by the bidder to purchaser’s representative for witnessing the tests in the manufacturer’s works. If any test cannot be carried out at manufacturer’s works reason should be clearly stated in the tender.

15 QUALITY ASSURANCE PLAN:

A detailed list of bought out items which got into the manufacture of cables should be furnished indicating the name of the firms from whom these items are procured. The bidder shall enclose the quality assurance plan invariably along with offer followed by him in respect of the bought out items, items manufactured by him & raw materials in process as well as final inspection, packing & marking. The Company may at its option order the verification of these plans at manufacturer's works as a pre qualification for technically accepting the bid. During verification if it is found that the firm is not meeting with the quality assurance plan submitted by the firm, the offer shall be liable for rejection.

16 SCHEDULES:

16.1 The tenderer shall fill in the following schedule which form part of the offer. Schedule `C' - Tenderer's Experience.

8.2 The tenderer shall submit the list of orders for similar type of equipments, executed or under execution during the last three years, with full details in the schedule of Tenderer's experience (Schedule `C') to enable the purchaser to evaluate the tender.

SCHEDULE - C

SCHEDULE OF TENDERER'S EXPERIENCE

Tenderer shall furnish here a list of similar orders executed/under execution by him to whom a reference may be made by purchaser in case he considers such a reference necessary.

Sr. No.	Name of client	Value of order	Period of supply and commissioning	Name and address to and description
1	2	3	4	5

NAME OF FIRM

NAME & SIGNATURE OF TENDERE

DESIGNATION

DATE

ANNEXURE-I

LIST OF STANDARDS

(All amended up to date)

SR.NO.	STANDARD NO.	TITLE
1.	IS: 8130 ,IEC 60228:	Conductors for insulated electric cables and flexible cords.
2.	IS :7098 (Part 2) ,IEC 60502:	XLPE PVC sheathed cable for working voltages from 3.3 kVupto and including 33 kV.
3.	IS:7098(pt-2),IEC 60502:	Insulation XLPE.
4.	IS: 7098(pt-2),IEC:60502:	Insulation Metallic & Non Metallic Screen.
5.	IS: 7098(pt-2),IEC:60502:	Fillers: Non Hygroscopic PVC/Polypropeline Fiber to maintain roundness of cable.
6.	IS:7098 (pt-2),IS:3975,IEC:60502 (pt-2):	Armour.
7.	IS:7098(pt-2), IEC:60502 (pt-2):	Outer Sheath:PVC ST 2.
8.	IS :10462 (Part I) –1983 :	Fictitious calculation method for determination of dimensions of protective coverings of cables.

Example: TECHNICAL DATA FOR 300 Sqmm
The bidder to furnish the data for different size cables as req

STANDARDTECHNICAL PARTICULARS FOR 33 kV Single - CORE UG XLPE Insulated CABLE Copper

1.	Type of cable	33kV UG XLPE/AWA/HDPE 1 Core
2.	Standard according to which cable has been manufactured and tested	Standard IS 7098PA T2
3.	Rated Voltage (Uo/U}	:18/33 kV
4.	Highest System Voltage which the cable can withstand	36 kV (Um)
5.	Maximum Conductor temperature for continuous operation	90^{0}ac
6.	(a) Maximum short time conductor temperature with duration	:220°Cfor 1sec.
	(b) Maximum allowable conductor temp.during overload	:95°Cfor 2 hours
7.	Conductor Details	
	(a) Normal Cross-Sectional Area	:300 mm^2
	(b) Material and Grade	.COPPER/ Compacted stranded circular ·as per IS 7098PA T2
	(c) Shape of Conductor	: Circular
	(d) Diameter of Conductor	: 19.54 mm (Approx.)
	(e) No. of Strands and Diameter of each Strand	: 53 (Min.)/2.04 mm (Approx.)
	(f) Water swellable powder/yarn provided	: Yes
	(g) Conducting water swellable tape with 50% overlap over compacted conductor provided	Yes

8. Extruded Conductor Screen

(a)	Material	• Semi-Conductive XLPE
(b)	Nominal Thickness	:0.50 mm (Approx.)
(c)	Diameter over Conductor Screen	: 26.5 mm (Approx.)
(d)	Designed maximum stress at Conductor Screen	: 3.05 kV/mm

9. Insulation

(a)	Material	: XLPE
(b)	Nominal Thickness	: 8.80 mm
(c)	Minimum Thickness at any point	7.1 mm
(d)	Diameter over insulation	37.5 mm (Approx.)
(e)	Designed maximum stress	1.90 kV/mm
(f)	Detail of vulcanization process	
	(i) Extrusion Method	:Triple Extrusion Process
	(ii) Curing Method	: Dry Cure
	(iii) Cooling Method	:Water
	(iv) CO/ or VOl Line	: ccv line

10. Extruded Insulation Screen

(a)	Material	Semi-Conductive XLPE
(b)	Thickness (Nominal/Minimum)	1.0 mm/ 0.85 mm
(c)	Diameter over Insulation Screen	39.5 mm (Approx.)
(d)	Strippable/ Bonded	Bonded

11. Conducting Longitudinal Water Sealing.

(a)	Material	Water Swellable Tape applied with 50% overlap.
(b)	Thickness	0.3 mm (Approx.)

12.	Metallic Sheath/ Screen	
	(a) Material	Copper
	(b) No. of Strands	64
	(c) Diameter of each Strand (Nom/Min)	2.0mm
	(d) Diameter of Cable after stranding	50 mm (Approx.)
	(e) Armour coverage	Full coverage.Armour wires shall be applied as closely as practicable.Overall gap between armour wires should be less than diameter of single wire(i.e 2.04mm)
13.	Non-conducting Longitudinal Water Sealing.	
	(a) Material	Water Swellable Tape applied with 50% overlap.
	(b) Thickness	0.3 mm (Approx.)
14.	HDPE Outer Sheath	
	(a) Type	ST7
	(b) Colour	Black
	(c) Thickness (Nom/min)	2.6 mm (Nominal)/2.11 mm (Min. Spot)
	(d) Conductive Coating Provided	Graphite Coating
15.	Nominal OVerall Diameter of Cable	51 mm (Approx.)
16.	Nominal OVerall Weight of Cable per Metre	5.46 kg/m
17.	Standard Drum Length with Tolerance	500m±5%
18.	Minimum Bending Radius allowable during installation	1180 mm (during installation) 944 mm (after laying)

19.	Short Circuit Current Rating of Conductor with maximum conductor temperature (90°C) at the commencement of fault (i) 1Sec. Duration	42.90 kA
20.	Maximum Continuous Current Rating of a Circuit comprising of 3 nos. Single Core Cable laid in trefoil formation at a depth of 1.05 M.	
	(i) Soil Temperature	30^0 C
	(ii) Ambient Temperature	40°C
	(iii) Soil Thermal Resistivity	150°C Cm/W
	(iv) System of Bonding	Solidly earthed at both ends
	(a) Laid in Ground(at a depth of l.OSM)	420A
	(b) Laid in Ducts	360A
	(c) Installed in Air	620A
21.	Short Time Overload capacity with Duration of cable installed as per conditions mentioned in Item no.22 (2 hours)	
	(a) Laid in Ground(at a depth of 1.05M)	490 A
	(b) Laid in Ducts	473 A
	(c) Installed in Air	N/A
22.	Maximum AC Resistance at 90°C	0.078 ohm/km
23.	Equivalent Star Reactance of a Circuit comprising of 3 Nos. of Single Core cable laid in Trefoil Formation	0.111
24.	Maximum Charging Current per Conductor at Nominal Voltage 1.64 *AI* km	

25.	Loss in Metallic Screen of a Circuit comprising of 3 nos. of Single Core Cable installed in Trefoil Formation as per item no. 22	13.53 W/m
26.	Maximum Current in Metallic Screen when the cable is installed as per item no. 22 (Circulating Current	88A
27.	Derating factor of Cable installed per Item No.22 under following conditions Ambient Temperature	
	(a) 35°C	:As Attached
	(b) 45°C	file
28.	Group derating factor of Cable Circuits installed as per Item no. under following conditions	
	(a) Laid 100 mm. apart	:As Attached
	(b) Laid 250 mm. apart	:As Attached
29.	Induced voltage in metallic screen : V/km when conductor is carrying 100 Amps(V/Km)	5
30.	Circulating current in metallic screen when conductor is carrying 100 Amps.	34 A
31.	Test Voltages	
	(a) Impulse Withstand Voltage at 90°C	170 kVp
	(b) Rated Power Frequency Withstand Voltage	63 kV for 5 minutes Yes
	(c) Water penetration test as per IEC 60502-2	(24-hours Water penetration test without heating cycles)
	(d) Abrasion Test on HOPE Outer sheath as per IEC 60229	Yes (Physical Abrasion test as per IEC 60229 clause 4.1.2.1)
	(e) Recommended Test Voltage after installation	Comply with Clause 20 as per IEC 60502-2

32.	Details of Drum	
	(a) Material and Weight of Drum	:Wooden Reel/ 840 kg (Approx.)
	(b) Weight of Drum with Cable	: 3570 kg (Gross Weight) (Approx.)
	(c) Flange Diameter of Drum	: 2150 mm (Approx.)
	(d) Barrel Width of Drum	: 1100 mm(Approx.)
	(e) Spindle hole Diameter	:120 mm (Approx.)
33.	Safe Pulling force	5kg/mm^2 of CU area. *II* 3kg/mm^2 of AL area.

1.0 INSTALLATIOIN OF 33 kV U.G. CABLES:

1.1 System particulars:

Nominal system voltage	33 kV
Highest system voltage	36.3 kV
Maximum permissible one phase System voltage (both cores insulated)	42 kV
Maximum permissible one phase System voltage (one core earthed)	21 kV
Number of phases	3
Frequency	50 Hz
Method of grounding	Solidly Earthed
Total relay and breaker operation time	15 to 20 cycles
Basic impulse level	170 KVp

1.2 METHOD OF LAYING:

1.2.1 This involves digging a trench in the ground in all types of soils including laterite and rock and laying cable(s) on a bedding of minimum 75-mm sand at the bottom of the trench, and covering with additional sand of minimum 75-mm and protecting it by means of tiles, bricks or slabs. The desired minimum depth of laying from ground surface to the top of the cable shall not be less than 1.2-m. At railway crossings the same shall be measured from bottom of sleepers to the top of pipe.

1.2.2 The desired minimum clearances are as follows:
Power cable to power cable: Clearance not necessary; however, larger the clearance, better would be current carrying capacity.

Power cable to control cables:	0.2-m
Power cable to communication cable:	0.3-m
Power cable to gas/water main:	0.3-m

1.2.3 RCC Hume pipes or earthenware/stoneware pipes depending on the crossing and load should be used where cables cross roads and railway tracks depending on the requirement, and at each particular location either RCC Hume pipes or stoneware pipes shall be used as directed by the Owner's representative. Spare ducts/pipes for future extension should be provided as per the directions of OPTCL. Such spare ducts/pipes shall be sealed off. The inner diameter of the ducts/pipes shall not be less than 225 mm. The ducts/pipes shall be mechanically strong to withstand forces due to heavy traffic when they are laid across the roads/railway tracks.

1.2.4 The power cable should not be laid above the telecommunication cable, to avoid danger to the life of the person, digging to attend to the fault in telecommunication cable. For identification of power cables, the cable protective cover, such as bricks or RCC slabs shall be marked as "OPTCL". The likely interference to the existing telecommunication cables should be avoided by referring to and coordinating with the appropriate telecommunication authorities.

1.3 ROUTE PLANS:

Tentative cable route plans will be furnished to the contractors, indicating the roads, position of substations and road crossings. The exact route survey and alignment will be decided on evaluating the findings by excavating trial holes by the contractor / subcontractor. The work should be taken upon only after OPTCL's Engineers approve the final route. The OPTCL reserves the right to change, alter deviate the route on technical reasons. It is the responsibility of the contractor to conduct necessary detailed route survey and submit of proposals to the owner for approval.

1.4 TRIAL HOLES:

The Bidder shall excavate trial holes, for alignment purpose at appropriate distance apart as warranted by the local conditions, keep a record of the findings and close the trial holes properly to avoid hindrance / accidents to pedestrian traffic. The final route / alignment of the cable shall be decided based on the finding of the trial holes.

1.4.1 It is the responsibility of the bidder to maintain as far as possible the required statutory clearances from other utility services.

1.4.2 Any damage caused, inadvertently to any utility services shall be set right & it is the sole responsibility of the contractor to do the same to the satisfaction of the concerned utility.

1.5 LAYING OF CABLES:

1.5.1 The contractor shall excavate the cable trench using manual and mechanical modes. An air compressor driven pneumatic drill or equivalent mechanical excavating tool will be essential if the crossing is to be made with minimum delay. Where paved footpaths are to be dug to excavate the cable trench, care must be taken to carefully remove the pavement slabs and store them properly and relay them properly after the work is completed.

1.5.2 The contractor shall take all precautions while excavating the trench to protect the public / private property and to avoid any accidental damage. Any accidental damage should immediately be reported to the concerned utility.

1.5.3 The contractor is liable to pay for all damages caused by his workmen. The sides of the excavated trench shall, wherever necessary be well shored up with timber and sheeting and use of danger boards wherever required. The depth of the cable trench shall be 1. 2 m.

1.5.4 The width shall be sufficient for easy handling of the cables during the laying operations depending upon the method of laying employed. For road crossings and railway crossings the same shall be 1.0 m. At other places the width varies from 0.45m to 1.0 m depending on number of cables to be laid in the trench.

1.5.5 The excavated material shall be properly stored to avoid obstruction. The bottom of the excavated trench should be carefully leveled and freed from pebbles / stones. Any gradient encountered shall be gradual.

1.5.6 There is a likelihood of a situation demanding that more than one cable is required to be run in the same trench. The contractors shall agree to increase the width of the trench to accommodate more than one cable.

1.5.7 The arrangement of cable trench duly indicating the position of cable, sand cushion, back fill and concrete finishing shall be as per sketch enclosed. It should be noted that the excavation required for laying the cable shall be finished accordingly by providing the sand cushion, back fill etc

2.0 PAVING OUT OF THE CABLE:

15.1 The pulling shall be done by hand and in such a manner as to provide good bedding for the protective cable covers like tiles or bricks. The maximum permissible pulling force on XLPE armored cables shall not exceed $P= 9 D^2$ Newton where P is the pulling force in Newton and D is the outer diameter of the cables in mm. However the normal values of pulling force shall be around 15 to 20 percent of this force when laid in trenches, 20 to 40 percent with one or two 90 degree bends in trenches, 50 to 60 percent when the bends are 3 or more. The cables shall have a minimum of 0.3-m clearance from the communication cables or water supply mains whenever they are encountered.

The excavated cable trench shall be drained of all water and bed surface shall be smooth, uniform and fairly hard before laying out the cable. The cable shall be pulled in the trench only on cable rollers spaced out at uniform intervals to prevent damage to cable.

The laying out process shall be smooth and steady, without subjecting the cable to abnormal tension. The cable laid out shall be smoothly and evenly transferred to the ground after providing sand cushion and shall never be dropped. All snake bends in the cable shall be straightened out.

3.0 FLAKING:

3.1 Wherever it is not possible to lay off the entire cable drum length, the cable should be cut and properly sealed and if it is necessary to remove the cable from the drum, it should be properly flaked, in the form of figure 8. Such cable lengths should be properly stored at site.

4.0 SAND CUSHION:

4.1 When the cable has been properly straightened the trench shall be covered with 75mm thick layer of good quality clean sand cushion. Then the cable shall be lifted and placed over the sand cushion. Again, another layer of sand 75mm thick should be laid and

gently pulled on to the top of the cable to form a depth of 75mm from the top of the cable. The minimum envelope cushion around the cable shall not be less than 150 mm.

5.0 CABLE COVERING TILES:

5.1. The earthen ware cable covers / tiles shall be of burnt clay and so made and fired that they shall be true in shape, well burnt in kilns throughout and free from detrimental cracks. Except for the interlocking features straight covers shall be rectangular in plan with the underside flat.

5.1. The size of RCC covers should be 250mm long x 350mm wide. The thickness at the outer edge should be 50mm. The average breaking load shall be not less than 135Kg. The tiles should be laid side-by-side without any gap in between.

6.0 PREVENTION OF DAMAGE DUE TO SHARP EDGES:

6.1 After the cable has been laid in the trench and until the cable is covered with its protective covering, no sharp metal tool shall be used in the trench or placed in such a position that may fall into the trench.

6.2 Rollers used during laying of the cables shall have no sharp projecting parts liable to damage the cables.

6.3 While pulling cable through Hume pipes/stoneware pipes/G.I. pipes/M.S. pipes, the cable shall be protected to avoid damage due to sharp edges.

6.4 Warning tape:

A pre warning, Red color plastic / PVC tape, 250 mm wide 150 microns thick, two runs shall be laid at approximate 500mm above the cable specified depth, throughout the Trenched cable route. The tape shall carry the legend printed in black continuously as under

CAUTION / OPTCL / 33 KV CABLES ARE BELOW. With a '**SKULL AND BONE'** Signs

6.5 The cables shall never be bent, beyond the specified bending radius

7.0 CABLES OVER BRIDGES:

7.1 Wherever the cable route crosses bridges the cable shall be laid in the ducts, if provided, by removing and replacing the R.C.C. covers and filled with sand cushion.

7.2 In the absence of the cable ducts over bridges, the cable shall be laid in suitable size RCC/steel/G.I. pipes or as directed by the engineer In-charge and the pipe covered by cement concrete if necessary to protect from direct sunrays and Masonry/RCC supports at suitable intervals, wherever required as decided by the Engineer in charge and/or stipulations of concerned Highway/Railway/local authorities.

8.0 CABLE CROSSING OPEN DRAINS WITH LONG SPAN:

8.1 Wherever the cable has to cross open drains, with a long span, the cable shall be laid in suitable size RCC closed duct/GI pipe/ hume pipe properly jointed with suitable collars. The GI pipe/hume pipe shall be firmly supported on pillars, columns, or suitable support of R.C.C. foundation & walls in CC 1:1½ : 3 to the required depth & width as required at site and directions & drawings as per technical specifications & procedures of PWD.

8.2 Wherever the U.G. cable has to cross the sewerage or water supply line the U.G. cable has to be taken below them maintaining adequate clearance. Further wherever the U.G. cable runs parallel to the telephone cable a separation distance of at east 300-mm shall be maintained. The cable should be taken inside Hume Pipes wherever required.

8.3 The cables shall be laid in Hume pipes/stoneware pipe wherever the cable and trench crosses private roads, gates, etc. In order to avoid inconvenience the stoneware pipe should be laid first after excavation and excavated trench shall be back filled, compacted and surface properly redone to restore that original condition.

9.0 ROAD CROSSINGS:

9.1 The road cutting whether cement concrete, asphalt or macadam road shall be taken after obtaining approval from civic authorities, Police, Telecom authorities and work should be planned to be completed in the shortest possible time. Where necessary the work shall be planned for night time or light traffic time. . In the excavated trench across the road the GI pipe or hume pipe (NP3 class) of appropriate size shall be laid, excavation back filled compacted and surface shall be redone in shortest time to allow the traffic on the road.

10.0 FOOTPATH CUTTING:

10.1 The pavement slabs shall be removed, neatly stacked on side before starting excavation.

11.0 REINSTATMENT:

11.1.1 After the cables and /or pipes have been laid and before the trench is filled in all joints and cable positions should be carefully plotted and preserved till such time the cable is energized and taken over by the engineer in charge. The requisite protective covering will then be provided, the excavated soil replaced after removing large stones and well rammed in successive layers of not more than 20cm in depth, where necessary the trench being watered to improve consolidation. It is advisable to leave a crown of earth not less than 50 mm and not more than 100 mm in the center and tapering towards the sides of the trench.

11.1.2 The temporary reinstatement of roadways should be inspected at regular intervals, more frequently during the wet weather and immediately after overnight rain. If trench is to be closed overnight and settlement should be made good by further filling to the extent required, such temporary reinstatement should then be left for a time so that soil thoroughly settles down.

11.1.3 After the subsistence has ceased the trench may be permanently reinstated and the surface restored to the best possible condition.

12. CIVIL AND STRUCTURAL WORKS:

12.1 The scope of civil works include:

(a) Earth excavation and cable laying, removal of excavated earth, design, supply and provide plain and / or reinforced cement concrete for the cable trenches, back filling, de-watering of trenches. The surplus earth should be disposed off suitably at all leads/lifts. Excavation should be done in all types of soils laterite or rock either manually or using machines as per site requirements & instructions.

(b) The design of cable duct/pipe ducts for crossing drains, roads, Railways, Highways, canals etc., shall be suitably done and rates quoted shall include complete supplies and erection as per relevant schedules. The Masonry work / concrete work should be done as per standard PWD practices and specifications & instructions of engineer-in-charge.

(c) Design, fabrication, supply & erection of galvanized steel structures for cable end terminations.

(d) Supply of all consumables and sundry materials not included in the specifications in detail but are necessary to meet the intent of the project.

12.2 Codes and standards: Unless otherwise stated, latest editions of the following standards are applicable.

1) IS: 1255: Installation and maintenance of power Cable.
2) IS : 5820: Specification for pre-cast concrete cable cover.
3) IS : 209 : Quality of zinc for galvanizing.
4) IS : 2062 : Structural steel.
5) IS : 456 : Plain and reinforced cement concrete.
6) IS : 800 : Use of structural steel in general building construction.
7) IS : 2016 : Plain washers
8) IS : 2633: Zinc coating on galvanized steel.
9) IS : 3063 : Spring washers.
10) IS : 5358: Hot Dip Galvanized coating on fasteners.
11) IS : 6639 : Hexagonal bolts for steel structures.
12) Any other equivalent International/ National standard

12.3 Excavation and measurement in hard rock: Blasting in hard rock shall be done as per IS: 4081 (latest edition). The hard rock excavated shall be stacked, measured and reduced by 40% for voids. Pre-measurement of rock is to be recorded when measured on section. The quantity whichever is less shall be paid.

12.4 Back, filling materials: The back filling of excavated trenches around foundation, shall consists of one of the following materials as the Engineer-in-charge may direct in each location.

i. Selected sieved earth from excavated soil.
ii. Selected sieved earth brought from borrow area

iii. Sand filling (sieved).

NOTE: Sieved sand shall be strictly used for all the works.
Filling shall be done after the work of laying cables and providing sand cushion is completed. The contractor shall commence concrete finish only after the proper reinstatement and approved by the Engineer-in-charge.

12.5 Back filling for cable trench: Back filling shall be done in horizontal layers of thickness not exceeding 300-mm thickness, free from pockets with careful watering where necessary for compaction. The backfill earth shall be riddled free from materials likely to cause damage to the cables. The thermal backfill surrounding the cable shall be as per the design approved by the owner. Surplus available/ New earth after refilling should be disposed off to a place away from site at all leads & lifts.

12.6 **Cable route markers/joint markers:**

Permanent and durable type, cable route markers/joint indicating blocks should be provided as per the design supplied by the purchaser. The cement concrete shall consist of one part cement, two parts sand, four parts aggregate of size 20 mm and down. The finishing should be given a smooth cover surface of cement mortar and shall have the appropriate legends, 5 mm deep engraved on them as "OPTCL 33 KV CABLE", or "OPTCL 33 KV CABLE JOINT" as the case may be. Markers shall be of size 700x240x75mm thick RCC and fixed in cement concrete at top of cable trench at 250mts distances.

12.7 Pipes: Hume pipes and accessories conforming to the relevant Indian standard specifications shall be used wherever required. All sundry materials like coupling, collars, caps to cover the pipe ends before cable is pulled in shall be provided. Stoneware pipes, shall be of good quality, salt glazed and approved by the Owner's representative. Hume pipes, stoneware pipes, can also be used where the cable passes through the passage or driveways of public and private buildings as per the directions of the Owner's representative for each particular location. The size of the pipe shall be at least 225 MM. The pipe joint shall be done by using proper sleeves so as to get tight fitting. Suitable steel rope will be drawn in pipe to pull the cable. Before drawing the cable, wire brush to be drawn through pipe to clean the burrs and steel ball (sphere) shall be pushed through pipe to know whether pipe is smooth for drawing the cable. G.I pipes of suitable size shall be used wherever required as per site requirement G.I pipes shall be of "**B**" grade.

12.8 **SAND:** The sand used for filling should be sieved, free from pebbles and approved quality. Only river sand should be used. The depth & width of sand filling should correspond to the details shown in the drawing.

12.9 **RCC Work**: RCC work required for supports to hume pipe /G.I. Pipes & others shall be of required size and depth constructed as per PWD specifications. The foundations should be of RCC as per design and drawing (to be furnished by the bidder) and got approved. Care to be taken to divert/bailout water wherever necessary during constructions. All RCC work should be of 1:1½ :3 proportion. The surface of

supporting wall should be neatly plastered and finished suitable clamps should be provided for holding the pipes in position.

12.10 **CONCRETE:** All plain concrete/RCC provided should correspond to relevant IS codes. Concrete mixing should be done with machines. Curing should be as per codal requirements. All plain concrete should of 1:2:4 proportions. Before laying concrete at top of cable trenches, the back fill earth should be thoroughly compacted with water. The Concrete should be compacted and nearly finished to correspond to the road level.

12.11 Precast RCC slabs/ or interlocking stones for cable protection at top shall be provided as per drawing and design with wedge shaped notches on one side and protruding wedges on the other to facility interlocking and placing RCC shall be of M20 grade and shall be provided in stretches of concrete roads and such others reaches specified and decided during execution. Interlocking stones of approved quality should be provided wherever instructed.

13. CABLE AND JOINT MARKERS:

13.1 Permanent means of indicating the positions of joints on site should be provided. During the course of permanent reinstatement cable and joint markers, should be laid directly above the route of the cable and the position of the joint respectively.

13.2 Wherever it is not possible to place the marker directly over the cable route or the joint, the marker should be suitably placed near the cable route or joint on which the distance of the cable route or joint at right angles to and parallel to the marker should be clearly indicated.

13.3 The position of fixing the markers will be at the discretion of the Engineer In-charge.

14. JOINTING OF CABLES:

14.1 **GENERAL**: It shall be noted that the U.G. cables are of XLPE insulation and needs special care in jointing. The cable jointer and his assistant shall have experience in making joints/terminations. Jointing work should commence as soon as two or three lengths of cables have been laid. All care should be taken to protect the factory-plumbed cap/seal by laying the end solid in bitumen until such time as the jointing is commenced.

14.2 Jointing of cables in carriage ways, drives, under costly paving, under concrete or asphalt surfaces and in proximity to telephone cables and water mains, should be avoided whenever possible.

14.3 **JOINT PITS:** The joint pits should be of sufficient dimensions as to allow jointers to work with as much freedom of movement and comfort as possible. The depth of the pit should be at least 0.3-m below the cables proposed to be jointed. The sides of the pit should be draped with tarpaulin sheet to prevent loose earth from falling on the joint during the course of making. The pit should be well shored with timber, if necessary. An overlap of about 1.0-m of the cables to be jointed may be kept, for allowance to adjust the position of the joint. When two or more cables are laid together the joints shall be arranged to be staggered by 2 to 2.5 m.

14.4 **SUMP PITS:** When jointing cables in water logged ground or under monsoon conditions, a sump pit should be excavated at one end of the joint pit in such a position so that the accumulating water can be pumped or baled out by buckets without causing interference to the jointing operation.

14.5 **TENTS:** A tent should be used in all circumstances wherever jointing work is carried out in the open irrespective of the weather conditions. The tent should be so covered as to have only one entrance and the back facing the direction of the wind. The tent cover should be properly weighted or tied down on the sides.

14.6 **PRECAUTIONS BEFORE MAKING A JOINT OR CUTTING A CABLE**: The cable end seals should not be opened until all necessary precautions have been taken to prevent circumstances arising out of rainy/inclement weather conditions, which might become uncontrollable. The cable seals should be examined to ascertain if they are intact and also that the cable ends are not damaged. If the seals are found **broken or the lead** sheath punctured, the cable ends should not be jointed until after due examination and testing by the engineer in charge of the work.

14.7 **MEASUREMENT OF INSULATION RESISTANCE**: Before jointing is commenced the insulation resistance of both sections of the cable to be jointed should be checked by insulation resistance testing instrument. An insulation resistance-testing instrument of 2.5/5 kV shall be used. The insulation resistance values, between phases and phase to earth shall be recorded. The actual jointing operation shall start only after the approval of the engineer in charge of works.

14.8 **PRECAUTIONS TO BE TAKEN ON LIVE CABLES IN SERVICE:** Sometimes it becomes necessary that a H.V. cable, which is in service, be cut for making a straight joint with a new cable. In such cases work on joint should start only after the in service cable is properly identified, isolated, discharged, tested and effectively earthed. Search coils, interrupters or cable-identifying instruments should be used for this purpose.

14.9 **IDENTIFICATION NUMBERS / COLORS AND PHASING**: The cables should be laid and jointed number to number or color to color shown on the core identifying marks and prevent cross jointing. In all cases, the cables should be tested and phased out, and more particularly so when the cable terminates at Ring Main Unit/Sub-Station.

14.10 **MAKING A JOINT**: The Heat shrinkable joints used shall conform to the specification vide Annex 2. The contractor should furnish all the technical particulars of these joints and obtain approval only in case they are found superior to the heat shrinkable joints. Epoxy based joints are not permitted. Comprehensive jointing instructions obtained from the manufacturer of joint kits shall be meticulously followed. The connection of the earth wires should be done using flexible bonds connected to cable sheath using clips or soldering. Aluminum conductor strands shall be joined by mechanical compression method, using suitable die and sleeve with a good quality tool. The joints shall conform to specification as per IS 13573.

14.11 **TRANSITION JOINTS**: Wherever straight through joints will have to be made with existing cables under the following conditions the contractor shall arrange such type of joints and execute them with skilled jointers:

(1) Between cables having two different types of insulation viz., paper and XLPE.
(2) Between cables having two different types of conductor material, viz., copper and aluminum.
(3) Or a combination of the above.

The transition joints shall conform to IS: 13705 - Transition joints for cables for working voltages from 11 kV up to and including 33 KV _ performance requirements and type tests.

14.12 **CABLE TERMINATIONS**: Cable terminations required are both indoor and outdoor type and invariably be of heat shrinkable type conforming to the specifications vide Annex 2. All the technical particulars to establish the superiority in the performance of these joints shall be furnished while seeking approval. The terminations shall conform to specifications as per IS: 13573. The instructions furnished by the manufacturer of termination boxes/kits should strictly be followed.3

14.13 Wherever a cable rises from the trench to end in a termination, to be finally connected to an overhead line or a transformer, the following instructions should be complied with:

i) One coil to be made and left in the ground for future needs.
ii) The rise of cable, immediately from the ground level should be enclosed in suitable diameter GI pipe to a height of 2 m.
iii) The balance portion of the cable should be neatly curved, in 'S' shape.
iv)The cable and pipe should be properly fastened by using appropriate clamps/support. The hardware of clamps shall be painted with red oxide and enamel paint or galvanized.
v) The lugs on the termination shall be compressed with a suitable compression tool.

15. **EARTHING AND BONDING**:

15.1 The metal sheath and Armor should be efficiently bonded and earthed at all terminals to earth electrodes provided. The cross sectional area of the bond shall be such that the resistance of each bond connection shall not exceed the combined resistance of an equal length of the metal sheath and Armor of the cable.

16. TESTING BEFORE AND AFTER LAYING AND JOINTING:

16.1 All new cables should be tested for insulation resistance before jointing with a 2.5 kV megger. After satisfactory results are obtained cable jointing and termination work should commence. Records of this shall be maintained.

16.2 All cables after laying and jointing works are completed should be tested systematically and insulation and pressure tests should be made on all underground cables.

16.3 All test results should be recorded in tabular form in logbooks kept for the purpose.

16.4 The cable cores should be tested for: -

i) Continuity;
ii) Absence of cross phasing;
iii) Insulation resistance to earth; Insulation resistance between conductors.
iv) Conductor Resistance (dc) measured with a suitable bridge.
v) Capacitance. Using Capacitance Bridge.

17. H.V. TESTS:

17.1 After the laying and jointing work is completed, a high voltage test should be applied to the cable to ensure that the cable has not been damaged during or after the laying operations and there is no defect in the jointing.

17.2 The high voltage tests should be as per IS 1255 or as per international standards. The H.V. testing instruments shall be brought by the bidder. The dc test voltage to be applied after installation and before commissioning between any conductor and metallic sheath/screen/armor shall be 60 kV.

18. **TESTING AND RECORD OF CABLE CONSTANTS**:

18.1 When the cable is ready, just before commissioning, the cable constants, viz., the resistance, capacitance and inductance of each conductor should be determined and recorded, along with frequency at which the values of capacitance and inductance are determined.

19. GUARANTEE:

19.1 All cable joints/termination done by the contractor shall be guaranteed for 24 months from the date of energization of the complete cable. In the event of failure during the guarantee period, the restoration work shall be done free of cost by the contractor within 24 hours of giving notice or else the expenditure incurred by OPTCL to re-do the joint/termination will be recovered from the performance guarantee amount with the OPTCL. (See Performance guarantee clause in special Conditions of contract.)

20. CABLE RECORDS:

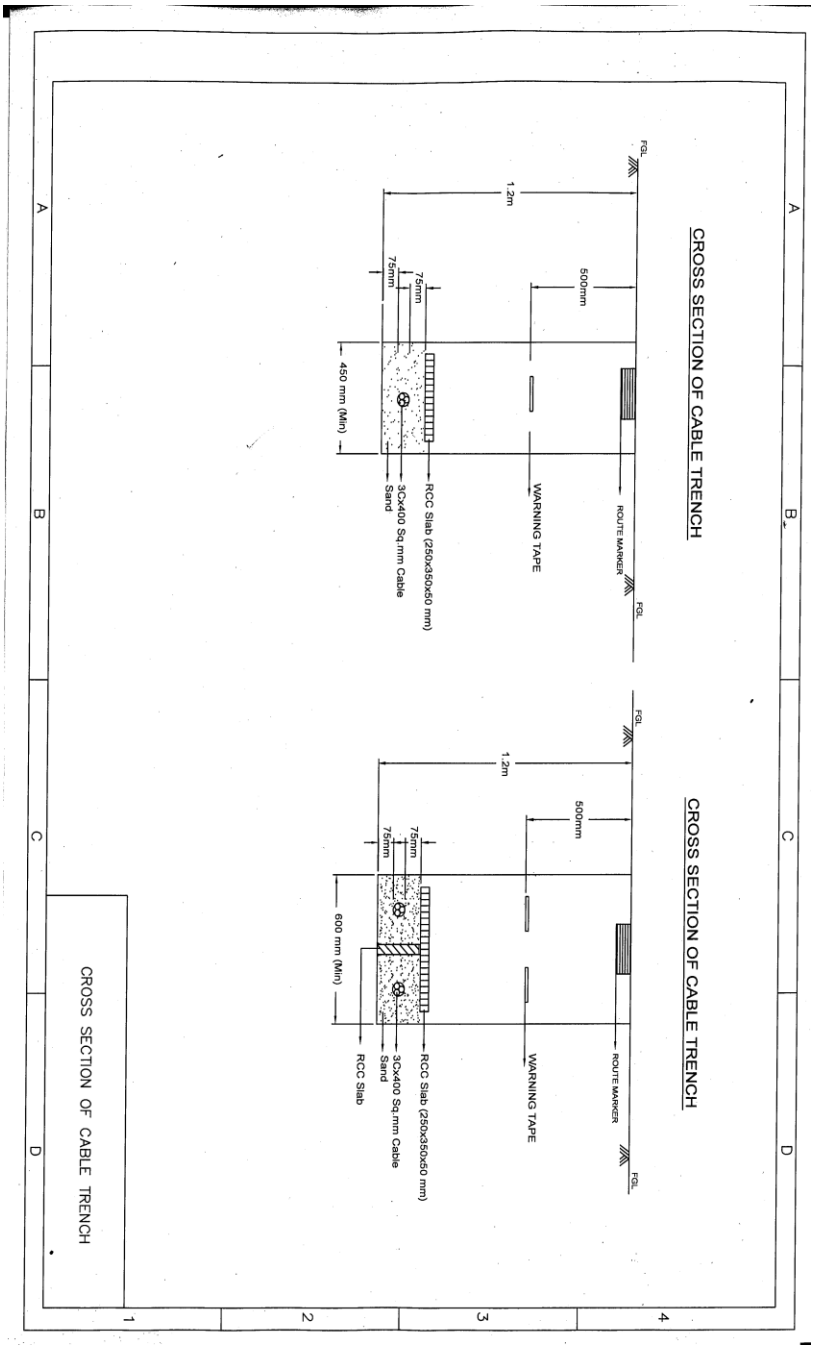
20.1 Accurate neat plans/sketches, drawn to suitable scale (1 cm = 10M) should be prepared and furnished by the contractor after the completion of each work.

20.2 All relevant information should be collected at site, during the progress of work and preserved for preparation of drawings.

20.3 The following essential data should be incorporated on all drawings.

a) Size, type of cable or cables.
b) Location of the cable in relation to prominent land mark property. Kerb-line, etc., with depths.

c) The cross section showing where cables are laid in pipes or ducts, giving their sizes, type and depths.
d) Position and type of all joints.
e) Location of other cables which run along side or across the cable route.
f) Position and depths of all pipes, ducts, etc., which are met as obstruction to the cable route.
g) Accurate lengths from joint to joint and
h) Manufacturers name and drum number of the cable, between sections/joint to joint.
i) Year and month of laying


CROSS SECTION OF CABLE TRENCH
FGL
1.2m
500mm
75mm
75mm
75mm
450 mm (Min)
RCC Slab (250x350x50 mm)
3Cx400 Sq mm Cable
Sand
WARNING TAPE
ROUTE MARKER
FGL
CROSS SECTION OF CABLE TRENCH
FGL
1.2m
500mm
75mm
75mm
600 mm (Min)
RCC Slab (250x350x50 mm)
3Cx400 Sq mm Cable
Sand
RCC Slab
WARNING TAPE
ROUTE MARKER
FGL
CROSS SECTION OF CABLE TRENCH
A
B
C
D
1
2
3
4

33 kV CABLE JOINTING KITS

SPECIFICATION OF CABLE KITS

The distribution system in which the cables along with the Straight through and end termination kits joints are expected to perform reliably over a period of 30-35 years, is a five phase, 3-wire System operating at 33 KV with solidly earthed neutral at the source neutral terminal with maximum possible continuous voltages being 36KV, and cable conductor temperatures up to 90°C on a continuous basis and This specification defines the requirements for 33KV Straight through and end termination kits jointing Cable Joints kits for underground 33 kV XLPE insulated power cables. The requirements cover the material properties of the components used in the Cable Joints as well as the performance of these products after installation on cables. Heat shrinkable components are based on polymeric materials and are to be supplied in an expanded state. Heating of these components to a temperature generally above 120°C would activate their elastic memory and cause these components to recover or shrink down on a substrate within a specific application range.

Service Conditions

under short circuit conditions up to 250°C.

The Service conditions include ambient temperatures range from -5°C to 50°C, height of installation up to 700 m above sea level, dusty, industrially polluted as environments, humidity levels up to 95% and heavy average rainfall of 600 mm (annually).

GENERAL REQUIREMENTS

All materials used and products provided under this specification must be in accordance with the standards listed below of this specification

REFERENCES:

1. Standard Number ESI-09-13- Performance Specification for high voltage, heat shrinkable components for use with high voltage solid cables up to an including 33,000 volts.
2. IS 13573 Type Test and Performance Requirements for cable Terminations and Joints on XLPE Cables from 6.6 KV to 33 KV ratings.
3. IEC 61238-1 : Compression and Mechanical Connectors for Power Cables with copper or aluminum conductors - Tests Materials and Requirements.

All materials components and products offered shall be of the latest designs, incorporating any improvements in materials and installation procedures knowledge of which has been gained through the manufacturers' research or experience.

The jointing materials and components shall be offered in the form of kits. The kits shall be supplied complete with all necessary tubings components (mechanical connectors/ earthing/ cable preparation etc) to form a ready to energize joint / termination.

2 Quality, Environmental Management **System and Laboratory Accreditation**

2.1 The kits shall be offered from the factory having a valid IS0 9001:2000 Quality Management System(QMS) certificate for the goods offered. The goods shall include the shrinkable and moulded components, as well as connectors.

3.0 Units **of measurement**

In all correspondence, in all technical schedules and drawings metric units of measurement shall be used.

4.0 Packing and Marking

The joint/termination kit shall be properly packed with all the shrinkable tubings, moulding components and connectors, lugs, other accessories as required to form a self contained kit. The packing shall be of such design as to prevent moisture and dust ingress and shall also protect the contents against mechanical damage.

External packing shall carry a label with the following information clearly marked:

- Name of Manufacturer
- Manufacturers reference
- Year of Manufacture/ Purchase order No.
- Expiry date whenever applicable

The kits shall also include the following:

a) Installation Instruction sheet manuals containing complete step by step instructions in the English language.

b) A check list stating the quantities and description of components contained in the kit shall be supplied in each kit.

Each component of the kit shall be separately packed in polyethylene and component name/part number shall be marked on the polyethylene packing.

All materials and components comprising the kit shall be clearly and permanently marked in a prominent position with the supplier's/manufacturer's name, product identification, batch number and year of manufacture. The batch number shall allow for full traceability of manufacture including the new materials which make up the polymeric compounds used in extrusion and moulding processes. Extruded components (tubing and wrap-arounds) shall additionally be marked with their expanded and fully recovered internal diameter. They may alternatively be marked with the upper and lower diameters of their range of application.

Markings on extruded components shall be repeated along the length with gaps not exceeding 200mm. Components which cannot be marked shall have the above information provided on immediate packaging.

Packed kits shall be packed in carton boxes which shall be placed in wooden pallets in order to facilitate fork-lift handling.

5.0 Storage

Components and kits shall be capable of being stored without deterioration in an ambient air temperature 5°C to 50°C when protected from direct sunlight.

6.7 Inspection and testing

All materials covered by this Specification shall be subject to inspection and test by the Authority during manufacture and before final despatch from manufacturer's works. The approval of the Authority of any such inspection or test will not, however, prejudice the right of the Authority to reject the materials or any part thereof, if it does not comply with the specification when erected or does not give complete satisfaction in service. The contractor shall make available to the Authority for the inspection and testing all required personnel and offer facilities (equipment, testing instruments etc.) at no cost to the Authority. The Authority may, however, use his own instruments and apparatus as a check.

Before any part of the jointing materials is packed or despatched from the manufacturers works, all tests called for are to have been successfully and satisfactorily carried out in the presence of the Inspector and a certificate issued to that effect by the Inspector in writing.

Adequate notice is to be given when any part of the jointing materials is ready for inspection or test and every facility is to be provided by the Contractor and his sub-contractors to enable the Inspector to carry out the necessary inspection and witness the tests. Duplicate copies of all principal Test Records and Test Certificates are to be supplied to the Inspector for all tests carried out in accordance with the provisions of this specification.

The jointing materials and all component parts thereof are to be fully tested in accordance with the provisions of the latest relevant standards as stated in paragraph 2.0 of this Specification or as may be agreed in writing with the Inspector. Test Certificates are to be forwarded to the Purchaser together with the invoices.

Guarantee.

The Straight through and end termination kits jointing kits shall be guaranteed for five years form the date of supply.

6.10 Samples

BIDers are required to submit with their BIDs two No’s samples of the kits offered as to be delivered in case of order. The kits shall include the installation instructions.

BIDs without samples shall not be considered. The samples shall be returned to the BIDers, after the award, at their own expenses.

6.11 Training

Bidders are required to provide training for OPTCL staff and also to the available outsourced cable jointers for at least 10 man days in phase wise over the period of the contract, at dates that will be decided at a later stage. All expenses i.e trainers wages,

living expenses. Training materials i.e cables and jointing materials shall be provided by shall be covered by the Bidder.

7.0 TECHNICAL REQUIREMENTS

The technical requirements described below refer to heat shrinkable, elastic and moulded products (separable connectors).

7.1 Design **and** Technology

Product design shall be based on the use of heat-shrinkable or elastic tubings and moulded parts to provide for the functions of high voltage insulation, electrical stress control, electrical screening, sealing and environmental protection as necessary. The use of tapes to provide primary insulation, screening or primary stress control is not acceptable.

BIDers shall submit evidence with their BIDs that designs are based on sound engineering principles, accumulated know-how and satisfactory service experience.

Design shall aim at minimizing the number of component parts and the time and skill required for satisfactory installation.

For joints single anti tracking tube design is required, which shall provide both anti tracking and stress control grading.

Anti-track and weather-resistant tubing shall be used in outdoor Straight through and end termination kits kits in all positions where the material surface is subject to electrical stress. Mastics or adhesives used as sealants for these tubings must be similarly anti-track and weather-resistant.

All necessary sealants shall be provided pre-coated on the internal surfaces of tubings and moulded parts. Sealant surfaces shall be protected by release paper as necessary.

Screening of conductor connectors shall be achieved with *single* co-extruded dual wall tubing/Tripple wall tubing comprising an inner insulating layer and an outer conducting layer. Separate or additional insulating and conducting tubings are not acceptable. The insulating layer shall provide an insulation thickness at least 30% more than the cable insulation.

7.2 Lugs **and connectors**

7.2.1. Mechanical **shear bolt type**

Mechanical shear bolt type connectors shall be used as follows:

They shall have the following characteristics/features:

(i) They shall be in accordance with EN 61238-1.

(v) Connectors shall be of the water block type, and the shear bolt heads to be hexagonal.

(vi) Lugs on aluminium cores shall be provided with oxidation inhibiting compound, or any other approved means for inhibiting oxidation.

(vii) Bolts of the shear bolt type shall be suitable for M12 bolt

7.3. Installation Instructions

Detailed installation instructions with drawings for all joints and terminations offered, including all parts, shall be provided with the BID documents in English language.

The successful BIDer shall provide installation instructions in English language.

7.4 Component types

For heat shrinkable materials:

(i) The tubing components (such as internal insulating tubing, stress control tubing, anti-track tubing, external protective tubing) shall conform to the requirements given of EA TS 09

The moulded components shall conform to the requirements given in List 2 of EA TS 09-13.

(ii) The sealants shall conform to the requirements given in List 3 of EA TS 09-13 and EA TS 09-11.

7.4.1 Specific requirements for components

Electric stress control for the cable insulation screen ends and over the connectors shall be achieved by tubings.

The stress control material shall have defined impedance characteristic, volume resistivity, and permittivity (dielectric constant). The AC impedance shall remain constant despite of thermal ageing, which will take place due to heating effect within the conductor and the temperature of the environment.

7.4.1.2 Non tracking erosion and weather resistant, insulating tubing and moulded parts

BIDers must provide proof of weather and track resistance of the polymeric material offered, through actual field studies or through accelerated laboratory studies, to confirm a minimum of 30 years expectancy.

This should include:

(i) Thermal Endurance - An Arrhenius plot to confirm the life expectancy on continuous exposure at 90° C.

(ii) Tracking and Erosion Resistance Test to prove the withstand ability against effects of surface electrical leakage currents.

(iii) Weathering Data properties.

7.4.1.3 Track Resistant Sealant is (Insulating and Weather Resistant)

Sealing of the interfaces between components subject to electrical stress shall be achieved by using a track resistant sealant or a hot melt adhesive. This sealant/adhesive shall be pre-coated inside the shrinkable components. BIDers must provide the following information:

(a) The adhesive peel strength the sealant provides between Non tracking tubing and non tracking moulded part.

(b) The dielectric strength, tracking and erosion resistance of the sealant as per ASTM D2303.

7.4.1.4 Tripple wall co, extruded Tubing

(a) The Tripple wall tubings are manufactured by means of co extrusion.

Further the BIDer shall have

- Proof of accelerated laboratory and long term field usage to confirm the retention of key properties within permissible limits due to thermal ageing. Minimum key properties before and after ageing to be stated.

- Confirmation of the minimum thickness of insulation provided over the connector for the maximum size of conductor for which the tubing is supplied.

The insulation layer shall provide an insulation thickness at least 30% more than the cable insulation.

7.4.1,5 Void Filling, Stress Relieving Mastic

BIDers must submit:

(a) Data of the stress relieving mastic, which should include information on the volume resistivity, and permittivity.

The mastic shall provide a void free interface between the stress control layer and the cable insulation as well as the connector and Proof of long term usage in the field to confirm satisfactory performance.

7.5. Specific **Requirements for Joints.**

7.5.1 General requirements for joints.

7.5.1.1 External leakage insulation between the live conductor and earth potential using anti-track and weather resistant material.

7.5.1.2 Electrical stress control using electrical stress control material over the cores.

7.5.1.3 Hermetic sealing of the interfaces between the cable accessory and cable surfaces, bushings or cable lugs by use of track resistant adhesive/sealant.

7.5.1.4. Detail technical characteristics wrap around sleeve if offered must be provided.

7.5.2.4 Outdoor termination kits shall provide means for protecting the exposed insulation of the conductors from UV radiation.

8.0 TESTS

8.1 Type **Tests on Components**

1. The BIDer shall submit with the BID documents test certificates tested not more than 5 years to prove that shrinkable or elastic or moulded components connectors used for cable joints and termination kits comply with the performance specification as indicated IS 13573 1992 with latest amendments and EATS 09-13. Test certificates shall be submitted with the BID documents.

8.2 Routine Tests on Components

BIDers must submit with their BIDs routine tests certificates as per the requirements of EA TS 09-11 and EA TS 09-13.

In addition, during the acceptance testing of the first and any other subsequent consignment, components will be randomly selected by the Inspector from jointing kits and will be subjected to the following routine and type tests, at CPRI.

The cost of testing shall be inclusive of all tests specified at CPRI in the bid cost. Visual examination

a) Dimension
b) Flame Retardance
c) Packing and markings.

8.3 Type Tests on 33 kV Straight through and end termination kits kit

The BIDers are required to submit with their BIDs the type test certificates mentioned in the following paragraphs, for Straight through and end termination kits kit

9.0. **Bidders must submit**

2. Test certificates certified by CPRI or any international recognized testing laboratory as per IS 13573 1992 with latest amendments not more than 5 years..

3. Test certificates certified by CPRI or any international recognized testing laboratory as per EATS 09-13 not more than 5 years.

4. Test certificate as per IEC 61238-1 from CPRI or any international recognized Mechanical Connectors testing laboratory not more than 5 years.

5. Documentary evidence including graphs showing the effects of temperature and thermal ageing on the impedance of the stress control material offered.

4 A technical explanation as to how the correct electrical properties of the material Vs volume resistivity, permittivity and AC impedance, have been derived

5 The recommended lengths of the stress control material.

6 Proof of accelerated laboratory and long term field usage to confirm the retention of the properties within permissible limits under variations of temperature and thermal ageing

7 Full set of dimensioned drawings including installation instructions

8 Transport, storage and installation requirements

9 Acceptance letter of two samples to be submitted

GUARANTEED TECHNICAL PARTICULARS FOR 33 KV UG CALES						
NORMAL STRAIGHT THROUGH JOINT TRIPPLE EXTRUSION WITH MECHANICHAL CONNECTOR						
Bidders Name						
CLASS OF POWER CALES						
Sl.No.	**PARTICULARS**					
1	Name of the manufacturer					
2	Country of Manufacture					
3	Type (Design) of joint					
4	No. of years the design is in commercial use					
5	Rated voltage	KV				
6	Rated Current	Amps				
7	Suitable for conductor	Sq.mm				
8	Connector, type, material					
9	Partical discharge test 72 KV	PC				
10	A.C. withstand voltage	KV				
11	Impulse withstand voltage +ve and -ve 10 times	KV				
12	Load cycling 90 deg. C +50 deg. C (No. of cycles)					
13	Load cycling as above under 1 M water (No. of cycles)					
14	D.C. withstand (maximum voltage)	Hrs.				
15	D.C. withstand voltage 15 Min.					
16	Conductor thermal short circuit 250 deg. C, 1 sec.					
17	Shield thermal short cuircuit 250 deg. C 1 Sec					
18	Type tested to standard (s)					
19	Additional Information					
20	Comply with IS					
21	Comply with EATS/ESI					
22	Comply with IS					

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR ACCESSORIES					
Out door type Cable end Termination (Sealing End) With unicon tube					
Bidder's Name					
Class of Power Cables					
1	Manufacturer's Name				
2	Country of Manufacture				
3	Class and Type				
4	No. of years the design is in commercial use				
5	Rated Voltage kV				
6	Total Creepage distance (mm)				
7	Maximum conductor size, Al (sq.mm)				
8	Details of terminal connectors				
9	Power frequency voltage 1 min. (kV rms) dry withstand test				
10	Power frequency voltage wet with stand voltage KV & duration				
11	Power frequency voltage 6 H Dry withstand voltage Kv. Rms.				
12	Radio interference voltage (R.I.V) Test (Micro Volts)				
13	Practical discharge (corona) extinction test :				
	a) Extinction voltage Kv rms				
	b) Minimum detector sensitivity PC				
14	Impulse voltage Lightning voltage Dry with stand kV (Crest)				
15	Direct voltage 15 Min. Dry with stand KV				
16	Description of materials used in the terminations with electrical & mechanical particulars				
17	Mounting Structure Details for termination				
18	Electrical & Mechanical Particulars of				
	a) Heat Shrinkable Tubing				
	b) Heat Shrinkable Moulded parts				
	c) Heat Shrinkable adhesives / sealents				
19	Type tested to (standard(s))				
20	Other details				
	Please enclose complete Technical literature				

20	Comply with IS					
21	Comply with EATS/ESI					
22	Comply with IS					

TECHNICAL SPECIFICATION FOR 132 kV XLPE (CROSS LINKED POLYETHYLENE) INSULATED POWER CABLE:

1.1 SCOPE

1.1.1 The scope under this section covers design, manufacturer, testing, packing, supply, delivery and laying of 132kV XLPE, insulated power cable including integrated testing and commissioning, technical support, supervision of maintenance, training of Employer's staff and documentation for a complete System necessary to deliver the requirements of this Specification.

1.2 STANDARDS:

Unless otherwise specified, the cables shall conform, in all respects, to IEC-60840 and IS:7098 (Part-III)/1993 with latest amendment or latest edition for cross linked polyethylene insulated PVC sheathed cable for working voltage of 132 kV.

The following standard specifications of latest version updated to as on date of opening of this bid document will govern supply, laying testing and commissioning of cables and their accessories that are being used in this Contract. In case of conflict between such codes and/ or standards and the specification, the specifications shall govern.

Sr. No	Title of Specification	Specification No.
1	Cross linked polyethylene insulated Thermoplastic sheathed cables	IEC: 60502–2 IEC: 60840, IEC: 62067
2	Conductors for insulated cables.	IEC : 60228
3	Test on cable over Sheath which have a special protective function and are applied by extrusion	IEC 60229
4	HDPE pipes	BIS 4984
5	Power cables with extruded insulation and their accessories for rated voltage above 30 kV and up to 150 kV- Test Methods & requirements	IEC 60840
6	Power Cables with extruded insulation and their accessories for rated voltages above 150kV.	IEC: 62067

Sr. No	Title of Specification	Specification No.
7	Impulse test on cables & their accessories.	IEC 60230
8	Cyclic and emergency rating of cable	IEC 60852-2
9	Common test methods for insulating and sheathing material of electrical cables.	IEC 60811
10	Electric test methods for Electric cables – Test methods for Partial Discharge measurements on lengths of extruded power cables.	IEC 60885

1.3 PRINCIPAL PARAMETERS:

1.3.1 132 KV (E) grade XLPE single core power cable conductor electrolytic grade copper of single length, with formation of stranded compacted circular conductor for size up to 800/1000 Sqmm and segmental type for size above 800mm2 as per IEC-60228, tapped with semi conducting tap, shielded with extruded semi-conducting layer, insulated with dry gas cured cross linked polyethylene (XLPE) insulation, insulation screened with extruded semi- conducting layer, insulated core copper-wire, screened lapped with a combination of semi- conducting water swell able and poly aluminium laminated followed by black extruded PE (Poly-ethylene) inner sheath. Corrugated Aluminium armoured and black HDPE ST7 with graphite coating or extruded conductive layer overall cable, confirming to IEC-standards for construction and also confirming to IS:7098 (Part-III)/1993 or any latest amendments thereof.

1.3.2 Outer sheathing should be designed to afford high degree of mechanical protection and should also be heat, oil chemicals and weather resistant.

1.3.3 The cable should be suitable for laying in covered trenches and/or underground for outdoor

1.3.4 The sheath/screen bonding system shall provide a continuous current path through the cable sheath and jointing kits and shall be bonded. The bonding ends shall be suitably earthed with/without SVL as per approved configuration/design. The sheath voltage under full load condition shall not exceed the voltage specified/allowed in relevant standard for safety of personal as well as

satisfactory working of cable. Sheath shall be solidly grounded at suitable location with or without SVL. Bidder must indicate details of configuration proposed along with sufficiency calculation with the bid so as to limit induced voltage of sheath within 65V.

1.3.5 **CABLE PARAMETERS**

Sr. No.	**System Particulars**	**132kV**
i)	Voltage Grade (Uo/U)	76/132
ii)	No. of Cores	Single
iii)	Size (mm^2)	$630mm^2$, $800mm^2$,$1000mm^2$, 1200 mm^2
iv)	Nominal system voltage KV	132
v)	Highest system voltage KV	145
vi)	System Frequency Hz	50
vii)	Variation in Frequency	± 3%
viii)	Fault level individually for i) Conductor ii) Cu. Screen/Armour	 31.5 KA for1sec 31.5 KA for 1sec
ix)	Maximum allowable temperature	
	a) Design continuous operation at rated full load current, the max, temp. of conductor shall not exceed. ^0C	90
	b) The conductor temperature after a short circuit for 1.0 sec shall not exceed. ^0C	250
x)	Basic insulation level (1.2/50 Micro Second Wave)	625 KVP
xi)	1-min. power frequency withstand voltage (rms)	275 KV
xii)	System earthing	Effectively earthed

1.4 **OPERATION CHARACTERISTICS:**

a) One/Two Three-phase feeders, each consisting of 1 runs of 4 Single core cables, feed power at 132 kV

b) In normal situation, each cable will have to be designed to carry a continuous current, to deliver a rated power of Transformers and its designed overload.

c) The cable should be designed for a suitable current carrying capacity under normal situation, and which will cater for the above overload capabilities also, will be required.

1.5 GENERAL TECHNICAL REQUIREMENTS:

1.5.1 CONDUCTOR:

The cable conductor shall be made from electrolytic grade copper with formation as stranded compacted circular conductor for size upto 800 sqmm and segmental type as per IEC-60228 for the size above 800mm^2.The conductor shall confirm to IS:8130/1984.

1.5.2 CONDUCOTR SCREEN:

A Conductor screen made of semiconducting compound shall be provided over the conductor, by extrusion. The extruded coat shall be continuous, with a constant mean depth, without bump, perfectly adhering to the insulation envelope. A semiconducting tape(s) shall be provided below the extruded semi-conducting conductor screen to prevent penetration of the compound into the underlying conductor. The conductor having a semi-conducting screen shall ensure perfectly smooth profile and avoid stress concentration. The conductor screen shall be extruded in the same operation as the insulation; the semi-conducting polymer shall be cross-linked. Minimum thickness of the conductor screen shall be 0.55 mm. The electric resistivity of the conductor screen shall not be more than 5000 Ω cm at 20ºC and not more than 25000 Ω cm at the working rated temperature.

1.5.3 INSULATION:

The Insulation envelope shall be of cross-linked polyethylene (XLPE) insulation applied by extrusion should be suitable for 132kV system voltage. The nominal thickness of insulation shall not be less than 11 mm, subject to tolerances as per IEC 60840. The manufacturing process shall ensure that the Insulation shall be applied by extrusion and vulcanized using dry curing process to form a compact homogenous body free from micro voids and contaminants. The insulation compound shall be of high quality, heat, moisture, ozone and corona resistant. The insulation shall withstand mechanical and thermal stressed under steady state and transient operating conditions. The extrusion method should give very smooth interface between semi-conducting screen and insulation.

1.5.3.1 The voltage gradient in the rated working conditions shall be

a) equal to or less than 6kV/mm at the level of internal semiconductor.

b) Equal to or less than 3kV/mm at the level of external semiconductor

1.5.3.2 The mechanical characteristics shall be as follow:

a) In delivery condition:

1) minimal traction resistance : 12.5 Mpa

2) minimal elongation before breaking : 200%

b) After ageing of 240 h at 135°C:

1. maximal variation of traction resistance : □ 25%

2. maximal variation of elongation before breaking : □ 25%

1.5.3.3 The isolating envelope shall comply with the hot condition elongation test:

a) temperature : (200)°C

b) on load duration : 15 minutes

c) mechanical constraint : 0.2 Mpa

d) maximal elongation on load : 100%

e) maximal elongation after cooling : 15%

1.5.4 **INSULATION SCREEN:**

To confine electrical field to the insulation, non-magnetic semi- conducting shield shall be put over the insulation. The insulation shield shall be extruded in the same operation as the conductor shield and the insulation by suitable extrusion process (triple extrusion). The XLPE insulation shield should be bonded type. Metallic screening shall be provided. The metallic screen shall be of copper wire having fault current capacity same as the conductor (31.5KA for 1-sec).

1.5.4 INNER SHEATH:

The inner sheath shall comprise of a combination of semi-conducting water swell able and ploy aluminium laminated tape. The tape shall be applied over the extruded insulation screening to block and prevent moisture propagation in a longitudinal direction. The sheath shall be suitable to withstand the site conditions and the desired temperature. It should be of adequate thickness, consistent quality and free from all defects. The sheath shall be extruded and of black P.E. (Poly-ethylene).

1.5.6 **ARMOUR:**

Metallic sheath shall be of Corrugated Aluminum sheath. The dimension of armoring shall be as per latest IS:3975/19988, IEC-60840. The armour shall be having fault current same as capacity conductor (31.5KA for 1 sec.)

For metallic sheath of Corrugated Aluminum the bidder shall submit the calculation of area of aluminium sheath in this support.

1.5.6.1 **BEDDING TAPE**

The bedding shall be anticorrosive layer of Bitumen compound.

1.5.7 **OUTER SHEATH:**

The outer sheath shall be extruded red/yellow/blue colour or similar (as per phase). Suitable semi conducting layer coated on black HDPE ST7 with graphite coating or extruded conductive layer confirming to IEC: 60840, shall be applied over armoring with suitable additives to prevent attach by rodents and termites. The outer sheath

should have embossing at every one meter for Supplier Name, manufacturer name, DMRC, Voltage grade etc.

5.7.1 The Mechanical Characteristics shall be as follow :

c) - In delivery condition

1) - minimal traction resistance : 12.5 Mpa

2) - minimal elongation before breaking : 200%

d) - After ageing of 240 h at 135°C:

1) - traction resistance:

2) - minimum value : 12.5MPa

3) - maximum variation : □ 25%

4) - elongation before breaking:

5) - minimum value : 200%

6) - maximum variation : 25%

5.7.2 The variation is the difference between the medium value obtained after ageing and the medium value without ageing, expressed in percentage of the last.

1.5.8 CONSTRUCTION:

1.5.8.1 All materials used in the manufacture of cable shall be new unused and of finest quality. All materials should comply with the applicable provision of the tests of the specification. IS, IEC, Indian Electricity Rules, Indian Electricity Act and any other applicable statutory provisions rules and regulations.

1.5.9 **CURRENT RATING:**

The cable will have current ratings and de-rating factors as per relevant standard IEC.

1.5.9.1 The one-second short circuit rating values each for conductor, screen & armour shall be furnished and shall be subject to the purchaser's approval.

1.5.9.2 The current ratings shall be based on maximum conductor temperature of 90 deg. C with ambient site condition specified for continuous operation at the rated current.

1.5.9.3 SIZE:

The different sizes of cable shall be 132 kV Single Core

a) 630mm^2

b) 800mm^2

c) 1000mm^2

d) 1200mm^2

1.5.10 OPERATION:

1.5.10.1Cables shall be capable of satisfactory operation under a power supply system frequency variation of plus minus 3% voltage variation of plus, minus 10% and combined frequency voltage variation of 10% (absolute sum).

1.5.10.2 Cable shall be suitable for laying in ducts or buried under ground.

1.5.10.3 Cable shall have heat and moisture resistance properties. These shall be of type and design with proven record on transmission network service.

1.5.11 LENGHTS: The cable shall be supplied in standard drum lengths as below:

Size of cable	**Standard Drum Length**
a) Single Core, 630mm^2,800mm^2, 1000mm^2, 1200 mm^2	750 meters $\pm$ 5% tolerance and $\pm$ 2% overall tolerance in total quantity of cable.

1.5.11 **INDENTIFICATION MARKING:**

Identification of cables shall be provided externally at three meters' intervals to identify as under:-

i) 'Name of Manufacture'
ii) 'Year of manufacture'
iii) 'Voltage grade' to be printed/embossed at the interval of one meter-length. The identification, by printing or embossing shall be done only on the outer sheath. Name of purchaser shall also be embossed.

1.6.0 TESTS

1.6.1 Type Tests

The equipment offered should be type tested. Type test report should not be more than seven years old, reckoned from the date of bid opening, in respect of the following tests,
carried out in accordance with ISS-7098/IEC-871, from Govt./Govt. approved test house, shall be submitted along with bid:

i) Physical tests for insulation and outer sheath.
ii) Bending test.
iii) Di-electrical power factor test.
iv) Heating cycle test followed by di-electrical power factor as a function of voltage and partial discharge test.
v) Impulse withstand test.

The remaining type test report as per clause 3 of ISS-7098/ IEC-871/ IEC-60840 shall be submitted by the successful bidder within three months from the date of placement of order. These type test reports shall be from Govt./Govt. approved test house and shall not be more than five years old, reckoned from the date of

placement of order. The failure to do so will be considered as a breach of contract.

1.6.2 ROUTINE TESTS AND ACCEPTANCE TESTS

All routine and acceptance tests shall be carried as per relevant ISS in the presence of Employer's representative

1.7 INSPECTION

The material shall be inspected and tested before dispatch by an authorised representative of the Owner in respect of quality. The inspecting officer shall also satisfy himself about the correctness of length of cables. In case the supplier is not in a position to get these tests carried out at his works, such tests may be got carried out by him at any Govt. recognized test agency at his own expense.

1.8 TEST CERTIFICATES

The supplier shall supply test certificates from a Govt. agency in respect of quality as per IS:7098(part-II) 1985 with latest amendments thereof for approval of the purchaser.

1.9 PACKING

The cable shall be supplied in non-returnable wooden drum as per IS:10418:1982 so constructed, as to enable the cable to be transported on each drum. The cable wound on such drum shall be one continuous length. The ends of cables shall be sealed by means of non-hygroscopic sealing material.

1.10 MARKING

The marking on the drum shall have the following information: -

a) Reference to Indian Standard & cable code.
b) Name of the manufacturer & trade name.
c) Nominal cross section area of conductor for the cables.
d) Number of core.
e) Sequential No. at each meter.
f) Type of the cable & voltage for which it is suitable.
g) Length of cable on the drum.
h) Approximate gross weight.
i) Net weight of the cable.
j) Drum identification number.
k) P.O. No. and date.
l) Consignee's name with designation.
m) Year of manufacture.

1.11 DRAWINGS & INSTRUCTION MANUAL

The tenderer shall supply the following drawings with the

tender: -

i) Detailed drawing of the cable showing conductor, screening insulation, Armouring, outer sheath etc.

ii) Detailed drawing showing jointing of cable and sealing of end boxes.

Copies of instruction manuals for testing, installation jointing operation and maintenance of cables shall also be submitted with the offer for reference of the purchaser.

1.12 TECHNICAL & GUARANTEED PARTICULARS:

The tenderer shall furnish guaranteed technical particulars as per the tender specification. Particulars, which are subject to guarantee, shall be clearly marked. Offer not containing this information will not be considered.

1.13 TERMINATION KITS AND STRAIGHT THROUGH JOINTS

The entire necessary Straight through joints and Sealing Ends for 132 kV shall be supplied and erected. The Straight through joints and Sealing Ends wherever required shall be moulded Type or equivalent, of reputed make with shear head type mechanical connectors of proven technology & make.

1.14 ISO Accreditation

The cable shall be manufactured by a company having ISO accreditation for quality. The manufacturing process of XLPE cable shall consist of conductor screen, insulation & insulation screen shall be extruded in a single process.(triple extrusion) and cross linked by VCV Process (Vertical Continuous Vulcanization process) dry curing technology to ensure homogeneity and absence of micro voids. The cables shall be manufactured by “Dry Curing” Process. It is mandatory that bidder should submit Plant Installation Certificate for VCV Line and for Metallic sheath machineries indicating the year of installation and other details along with bid

The Employer may decide to visit the works of cable manufacturer to confirm the manufacturing process mentioned.

PART II

TECHNICAL SPECIFICATION FOR LAYING, TESTING AND COMMISSIONING OF 132kV XLPE UNDERGROUND POWER CABLE

SECTION-1

SPECIFICATION FOR LAYING OF CABLE

1.1 GENERAL

1.1.2 The Cable Laying works shall be executed according to the rules of the Art pertaining to professional grade and generally in compliance with International Standards and Indian Standards.

1.1.3 The EHV Cables between the Power Supply Authorities Substation and the DMRC RSS shall be laid in ground depending upon the site conditions of the selected route, any of the following paying conditions, may be adopted.

1.1.4 Cable Laying Cases

Case 1 - Direct buried, with all cables laid in flat formation.

Case 2 – Direct buried, with the cables (3) of each circuit laid in trefoil formation and side by side in one trench.

Case 3 – Laid in underground duct.

Case 4 – Laid in Trench less piping.

Case 5 – Laid in abutment crossing

Case 6 – Laid in Rail Track crossing

Case 7 – Laid in Air, supported on piers/walls, for nallah-crossing

1.1.5 Details of Case 2 :

The trench for carrying the cables shall be at least 1.8m deep and 1.1m wide, which may vary as per site conditions with the approval of employer. Each of the 2 feeders shall consist of 3 single-core cables, and laid in trefoil formation. Cables shall be laid at a depth of 1.7m below the ground level and over a 100 mm bed of coarse sand. Trench is to be filled with sand upto a depth of 1100mm below the ground level. Warning concrete slabs of at least 50mm thickness shall then be laid above the sand. Trench shall then be filled with earth upto a depth of 300 mm below the ground level. A warning net shall then be laid above the earth filling (at 300 mm depth below the ground level). A warning tape shall also be laid appropriately with Purchaser's Name marked on it. The top space of 300 mm shall be suitably filled with compacted Boulder and Bitumen/Jelly and given a final finish matching the surroundings. The cables shall be tied through locking belts after 2 meters each for keeping the cables intact in case of trefoil formation. At locations, where there is change of level of laying, the cables shall be tied through locking belts after 1 meter each.

1.1.6 Details of Case 3

In specific locations, the Employer may require the cables to be laid in underground ducts. The underground ducts shall be laid where road construction or formation is under construction or where water logging stretch is expected or as per the specific site condition.

1.1.7 Details of Case 4 & 6

On all road/rail crossings and at other specific locations, cable laying shall be through trenchless drilling and the cables shall be passed through High Density Polyethylene (HDPE) Pipes or G.I. Pipes of appropriate diameter and thickness (Case-4). One spare HDPE pipe shall be laid for each feeder of 3 cables at the road/rail crossings.

1.1.8 Details of Case 5 & 7

On all abutment crossing or in air, supported on piers/walls, for Nallah crossing and at other specific locations, cable laying shall be on the galvanized steel structures which can withstand wind velocity of 160kmph, supported on piers and have sufficient structural strength. The minimum average weight of zinc coating should be 1000g/m2 (RDSO). The cables should be well protected by providing MS sheet of thickness 8mm at least fastened with nuts and bolts & tag welded on all sides to be protected from any pilferages. The arrangement shall render cable absolutely safe from any natural calamity. The cable shall not be exposed or get affected due to stray fire caused in the vicinity. Indicative arrangement is shown in the drawing.

1.1.9 Spare Cables and Pipes

When cables are laid in pipes, in addition to the pipes carrying the cables, at least one spare pipe (minimum 200 mm dia), without cable shall also be provided. In the case cables laid in underground ducts (Case 3) and cables laid in Trenchless piping (Case 4), spare HDPE pipes, one for each circuit, shall be provided. In addition to pipes for power cables, 2 additional pipes, each of not less than 100 mm dia, shall be provided to carry control and monitoring cables, one operational and one spare (As indicated in the Interfacing Requirements, other cables such as pilot wire for pilot wire protection, if required, copper-core or optic fibre cables for control and monitoring, tele-communication etc, supplied by other Suppliers.

1.1.10 **Cable protection at changeover location**

The cable path, when changing from buried in ground to underground duct or trenchless piping shall be adequately protected by proper sealing in concrete or other suitable means of sufficient mechanical strength to avoid cable from suffering damage due to heat/fire/water ingress etc.

1.1.11 **Pulling Chambers**

Pulling chambers shall be provided, as necessary, along the route. Such pulling chambers shall be 4m long, 3m wide and at least 2.5m deep. The masonry structure should be of adequate strength with water proofing to avoid any accumulation of seepage of water inside. The edges of RCC covers and masonry shall be lined in GI angles to achieve a long service life.

1.1.12 **Route Markers**

The route shall be appropriately marked by suitable retro-reflective cable markers, at suitable intervals and positions of straight through joints shall be indicated by suitable boards.

2.0.0 CABLE ACCESSORIES AND BONDING

2.1.0 Straight Through Joints

2.1.1 The straight through Joints should be HEAT SHRINKABLE type or cold shrink type of proven technology and make, suitable for underground buried cables. The joint should comprise of stress control sleeves, insulating sleeves and co-extruded dual wall Tubing comprising of an insulating and semi-conducting layer. A mechanical connector with shear head bolts shall make the conductor connection.

2.1.2 The product should be type tested as per IEC /KEMA specifications

2.1.3 GENERAL SPECIFICATIONS

a. The product offered should be proven and should be in use in India for a minimum period of 5 years for the same voltage class. List of past supplies in India to be furnished. Performance certificates to be submitted along with the offer.

b. The product offered should have unlimited shelf life.

c. Offers should be supported with type test certificates from test laboratories of repute, as per IEC/ KEMA specifications, failing which the offers shall be ignored.

2.1.4 General Specifications for Joints and Terminations for 132 kV XLPE Cables

The Terminations (Outdoor Sealing ends) and Straight Through Joints for 132 kV cables shall be of 'Heat-shrinkable, '' type or cold shrink type of proven technology and make, suitable for 132 kV (E) grade or higher, Single core 400 sq mm or higher, XLPE Insulated, Aluminium sheathed cables. The Indoor termination for use in the GIS Substation.

2.2.0 Bonding

2.2.1 Suitable bonding methods viz., Single End, Both End and Cross Bonding shall be used.

2.2.2 Link boxes with & without SVL shall be used as required.

3.0.0 TESTING AND INSPECTION

7.1.0.1.1 TYPE-TESTS

7.1.0.2 General

All the equipment which are used for this work shall be of proven design and standards to achieve a very high level of reliability in service. An equipment is considered to be proven if it is in successful operation at least for a period of two years. Irrespective of the fact that the summary of type test reports was submitted for 132kV (E) or higher grade Single core,

XLPE insulated, Copper conductor Aluminium Sheathed cable along with the bid, the Supplier shall furnish a summary of type test reports for all the equipment listed below except those equipment which are yet to be type tested being under development within three (3) months period from the date of signing the contract.

7.1.0.3 Heat Shrinkable type or cold shrink type of proven technology and make straight through joint suitable for 132 kV (E) grade Single Core 400 sq. mm or above size XLPE insulated cable with Aluminum sheath.

7.1.0.4 Heat Shrinkable type or cold shrink type of proven technology and make cable terminations (indoor & outdoor) suitable for 132 kV (E) grade

7.1.0.5 The cable and cable accessories intended to be used for this work shall be

(i) Type-tested within the last ten (10) years period prior to the date of bid opening. (ii) Proven in service for at least two (2) years as on the date of bid opening.

7.1.0.6 Submission of Performance Certificates

As a proof of satisfactory performance of following equipments during last two years from the bidder /JV partner /sub Supplier from whom Bidder intends to supply them.

7.1.0.7 Heat shrinkable ‘’ type or cold shrink type of proven technology and make straight through joint suitable for 132 kV (E) grade or above grade, Single Core 400 sq. mm or above size XLPE insulated cable with Aluminum sheath.

7.1.0.8 Heat shrinkable ‘’ type or cold shrink type of proven technology and make cable terminations (indoor & outdoor) suitable for 132 kV (E) grade

7.1.1 Type Test Results

Summary of type test results of the above mentioned equipment will be in the following format:

Sl.No.	Equipment	Manufactured By	Rating	Governing Specification for type test	Name of type test	Month/ Year conducted	Testing Lab/Testing House/In House	Result/ Remark

7.1.1.1 If the type tests of any equipment being supplied for this work are not yet conducted by the Supplier then all the type tests as per the relevant IEC shall be conducted at his expense in the presence of employer’s representative either at manufacturer’s works having requisite facilities and approved by independent laboratory like KEEMA, Netherland or CESI Italy, or at KEEMA, Netherlands or CESI, Milano, Italy.

7.1.1.2 Details of ‘Make of Cables/Accessories

The bidder shall submit to the employer the proposed “make” of all the above equipment in the bid form along with other details such as rating, quantity in use, place of installation number of years in satisfactory operation, summary of type test reports of required rating of

132kV or higher grade, Aluminum/copper conductor, XLPE insulated, Aluminum or Copper sheath cable along with the bid so as to decide the 'make' of the items. Based on the information thus furnished the employer shall decide the 'make' of the items to be used for the work. The plant & equipment being supplied against this bid shall conform to relevant IEC standards.

7.1.1.3 Rejection of Type Test Report

When the Employer rejects any specific type test report for a particular equipment stating the grounds for such rejection, the Supplier shall re-conduct the relevant type tests as per the specification in the presence of Employer's representatives before the item is supplied by him. Such type test shall be conducted by the Supplier at his own expense at the manufacturer's works approved by KEMA Netherland or CESI Italy in the presence of Employer's representative.

7.1.1.4 Type Test Reports

The type test reports of the equipment shall be of the tests carried out either at the manufacturer's works having requisite facilities or at KEEMA, Netherlands, CESI, Milano, Italy during the last ten (10) years period as on the date of bid opening. If any type test report is older than 10 years, the type tests will have to be repeated at Supplier's cost. Employer shall waive some of these tests in case of equipment / sub assemblies where the manufacturer can establish to the satisfaction of employer that such tests have already been carried out earlier or where the equipment have been proved in service. In such a case, manufacturer shall submit complete test reports along with necessary certification.

7.2.0 ROUTINE TESTS

Routine tests shall comprise of visual inspection of the items and all the routine tests as per specification. All these tests shall be conducted in the presence of Employer's nominated representative at the manufacturer's works. Routine test shall be carried out as per specification ICE 60840 latest version.

7.2.1.1 General

The following tests shall be carried out on each manufactured length of cable:

a) Partial discharge test (see 5.2.2);

b) Voltage test (see 5.2.3);

c) Electrical test on over sheath of the cable, if required (see 5.2.4).

7.2.1.2 The order in which these tests are carried out is at the discretion of the manufacturer. The main insulation of each prefabricated necessary shall undergo partial discharge (see 5.2.2) and voltage (see 5.2.3) tests according to either 1), 2) or 3) below:

1) On accessories installed on cable;

2) By using a host accessory into which a component of an accessory is substituted for test;

3) By using a simulated accessory rig in which the electrical stress environment of a main insulation component is reproduced.

7.2.1.3 In cases 2) and 3), the test voltage shall be selected to obtain electrical stresses at least the same as those on the component in a complete accessory when subjected to the test voltages specified in 5.2.2 and 5.2.3

7.2.1.4 NOTE: The main insulation of prefabricated accessories consists of the components that come in direct contact with the cable insulation and are necessary to control the electric stress distribution in the accessory. Examples are pre-moulded or pre-cast elastomer or filled epoxy resin insulating components that may be used singly or jointly to provide the necessary insulation or screening of accessories.

7.2.1.5 Partial discharge test

The partial discharge test shall be carried out in accordance with IEC 60885-3 for cables, except that the sensitivity as defined in IEC 60885-3 shall be 10pC or better. Testing of accessories follows the same principles, but the sensitivity shall be 5pC or better. The test voltage shall be raised gradually to and held at 1.75 Uo for 10 s and then slowly reduced to 1.5 Uo There shall be no detectable discharge exceeding the declared sensitivity from the test object at 1.5 Uo.

7.2.1.6 Voltage test

The voltage test shall be made at ambient temperature using an alternating test voltage at power frequency. The test voltage shall be raised gradually to 2.5 Uo) and then be held for 30 min between the conductor and metallic screen/sheath. No breakdown of the insulation shall occur 60840 @ IEC: 2004 Electrical test on over sheath of the cable When the test is required by the particular contract, the cable over sheath shall be subjected to the electrical test specified in Clause 3 of IEC 60229.

7.3.0 Acceptance tests

7.3.1 General

Acceptance tests for the power cable & its accessories shall be carried out wherever the same is mentioned in the relevant specification governing the cable and its accessories. All the acceptance tests as mentioned in the governing specification to which the product is manufactured shall be conducted in the presence of Employer’s nominated representative by the Supplier at their manufacturing works. The following tests shall be carried out on samples which, for the tests in terms b) and g), may be drum lengths of cable, taken to represent batches:

a) Conductor examination (see 5.3.4);

b) Measurement of electrical resistance of conductor and of metallic screen (see 5.3.5);

c) Measurement of thickness of insulation and over sheath

d) Measurement of thickness of metallic sheath

e) Measurement of diameters, if required

f) Hot set test for XLPE, EPR and HEPR insulations Measurement of capacitance

Measurement of density of HDPE insulation

g) Water penetration test, if applicable

h) Tests on components of cables with a longitudinally applied metal foil

7.3.2 Frequency of tests

The sample tests in items a) to h) of 5.3.1 shall be carried out on one length from each batch (manufacturing series) of the same type and cross-section of cable, but shall be limited to not more than 10% of the number of lengths in any contract, rounded to the nearest whole number. The frequency of the tests in items I) and j) of 5.3.1 shall be in accordance with agreed quality control procedures. In the absence of such an agreement, one test shall be made for contracts with a cable length above 20 km.

7.3.3 Repetition of tests

If the sample from any length selected for the tests falls in any of the tests in 5.3.1, further samples shall be taken from two further lengths of the same batch and subjected to the same tests as those in which the original sample failed. If both additional samples pass the tests, the other cables in the batch from which they were taken shall be regarded as having complied with the requirements of this standard. If either fail, this batch of cables shall be regarded as having failed to comply.

7.3.4 Conductor examination

Compliance with the requirements of IEC 60228 for conductor construction, or the declared construction, shall be checked by inspection and measurement when practicable. Measurement of electrical resistance of conductor and metallic screen The cable length, or a sample thereof, shall be placed in the test room, which shall be maintained at a reasonably constant temperature for at least 12 h before the test. If there is a doubt that the conductor or metallic screen temperature is not the same as the room temperature, the resistance shall be measure after the cable has been in the test room for 24 h. Alternatively, the resistance can be measured on a sample of conductor or metallic screen, conditioned for at least 1 h in a temperature controlled liquid bath.

7.3.5 Additional Acceptance Tests

The following additional acceptance tests shall be carried out.

1. Additional acceptance tests (1 sample/offered lot) shall be carried out for Ovality & Eccentricity.
2. Tensile strength and Elongation on insulation and over sheath before and after ageing and Thermal Stability on outer sheath of power cable.
3. finish and length measurement shall be carried on one length of each size of offered lot of power cables.

7.3.6 Short Circuit Test :

Short Circuit test for Power Cables will be conducted by the Supplier on the cable at Manufacturer's works having requisite facilities approved by KEMA Netherlands or CESI Italy or at KEEMA, Netherlands or CESI Milano, Italy & shall be witnessed by the Employer's

authorized representative.

7.3.7 TEST CERTIFICATES

Three copies of the test certificates of successful type tests if any carried out on cables and cable accessories shall be furnished to the Employer within fifteen days after completion of such type tests. Three copies of successful acceptance & routine tests carried out on cables and cable accessories and the certificate of inspection issued by the Employer's representative shall be furnished within 15 days, after the completion of tests by the Employer's representative.

7.3.8 RESPONSIBILITY OF SUPPLIER FOR DELIVERY/SUPPLY

(a) All defects detected as a result of testing / inspection shall be rectified by the manufacturer at his own expense and shall be documented and corrected prior to shipment. If in opinion of Employer, a repeat of the test is required after such rectification, this shall also be carried out at the expense of the Supplier.

(b) No cable / accessory shall be supplied until Employer has inspected the same to his satisfaction and accepted. However, such inspection and/or acceptance certificate shall not relieve the Supplier of his responsibility for furnishing the cables and cable accessories conforming to the requirements of the contract nor prejudice any claim, right or privilege which the Employer may have because of the use of defective or unsatisfactory items. Should the Employer waive the right to inspect any item, such waiver shall be obtained by the Supplier from the Employer in writing and such a waival shall not relieve the Supplier in anyway from his obligation under the contract.

(c) Only after obtaining clearance from the Employer, the Supplier shall despatch the items to site.

7.3.9 INSPECTION OF ERECTION WORK

All erection work will be subject to inspection by the Employer or his representative to ensure that the work is done in accordance with the specification and approved drawing.

7.3.10 INSPECTION AND TESTS OF COMPLETELY LAID CABLE

7.3.10.1 General

As soon as the work is completed and ready for inspection and testing, the Supplier shall advise the Employer in writing. Tests will be carried out by the Employer jointly with the Supplier. Testing equipments and staff required for the tests shall be provided by the Supplier free of charge. The Supplier shall take full responsibility for these tests interalia his other responsibilities. The Supplier shall notify the manufacturer of cable and cable accessories regarding likely date of pre-commissioning tests, one month in advance so that their representative may be available at site at the time of conducting the tests. It shall be Supplier's responsibility to ensure that the cable and it's accessories are commissioned as per laid down procedures.

7.3.11 Pre commissioning Tests for the facility as a whole The following site tests shall be conducted on a completed power cable installation as per specification IEC 60840 latest

version.

(i) Visual Inspection and Continuity Check Visual inspection shall include check for satisfactory workmanship Continuity check shall be carried out on the cable to ensure that the cable is continuous.

(ii) DC voltage test of the over sheath The test shall be conducted as per Clause 15.1 of IEC 60840.

(iii) AC voltage test for the installation. The test shall be conducted as per Clause 15.2 of IEC 60840.

(iv) the insulation resistance of the cable shall be checked before & after the HV test on cable. The core resistance shall be measured and the value corrected in accordance with clause 5 of IEC 60228.

(v) The cable must be discharged on completion of DC High Voltage Test and the cable shall be kept earthed until it is put into service. The values obtained during these tests shall be in conformity with the values obtained during inspection of the materials at the manufacturer's works.

7.3.12 PROFORMA FOR TESTS

The Supplier shall submit the results of tests in quadruplicate in an approved proforma within 7 days from the date of completion of the tests but before actual commissioning of the cable. The proforma shall be developed by the Supplier and got approved from Employer within three (3) months from the effective date of the contract.

ODISHA TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

DIGITAL POWER LINE CAREER EQUIPMENT, TELEPROTECTION COUPLER & REMOTE TERMINAL UNIT (RTU)

CONTENTS

TECHNICAL SPECIFICATION OF DIGITAL POWER LINE CAREER EQUIPMENT

General

- The PLC equipment shall comply to the standard IEC60495, second edition, 1993.
- For safety, the equipment shall conform to IEC60950-1.
- For EMC and EMI, the equipment shall comply with IEC60255-5,
- IEC61000-4-4/-5/-6/-12/-16, IEC60255-22-1.
- The system shall be of modular design and allow for easy upgrading.
- The PLC equipment shall not use fans or similar for artificial cooling under normal operating condition.

Carrier frequency section.

- The PLC equipment shall support DPLC (Digital PLC) and APLC (Analogue PLC) mode of operation in the same platform, software programmable via PC/Notebook.
- Modulation shall be SSB (Single-Side-Band) for APLC operation, and MCM (Multi-Carrier-Modulation) for DPLC mode of operation. Modulation and coding shall be implemented as software functions in DSP (Digital Signal Processing) technology.
- Transmission mode shall be 2-wire frequency duplex. The nominal carrier frequency shall be programmable from 40 to 500 kHz Minimum preferably however up to 1000 kHz.
- The carrier frequency stability over the stated temperature operating range shall be equal or better than +/- 1ppm.
- The nominal bandwidth BN for transmitting or receiving shall be programmable preferably from 4 kHz to 16 kHz in steps of 4 kHz. Transmit (Tx) and receive (Rx) bands shall be configurable for adjacent or non-adjacent operation.
- Transmit output power shall be the user-programmable for 10,20 or 40W PEP (Peak Envelope Power). 80W PEP transmit power shall be available as an option. The nominal output impendence shall be programmable as 75 or 125 Ohms, unbalanced, or 150 Ohms balance as an option.
- The return loss in transmitter band shall be > 10 dB
- The tapping loss shall be <= 1.5 dB, according to IEC60495.
- The receiver selectivity shall be ≥ 65 dB at 300 Hz from the band edges.
- The AGC range of the receiver shall be 40 dB minimum.

System operation.

- The PLC shall be programmable via PC with HMI/GUI (Graphical User Interface) based on MS-Windows.
- The PLC system shall facilitate the programming and monitoring of the remote terminal from the local terminal using the standard GUI/HMI (Human-Machine-Interface)
- An EMS (Element Management System) shall be incorporated in the HMI for monitoring and programming of the PLC terminals in the network. The EMS shall allow cyclic alarm polling of all the PLC terminals in a network.
- The DPLC shall have the facility to store minimum 256 events and alarm by an internal event recorder in a non-volatile memory.
- The DPLC must have built in test equipments functionality for PLC commissioning and monitoring eg. Received level, AGC, SNR, spectrum analyzer for RX band and test tone generation etc.

Speech and Audio Frequency (AF) signal transmission.

- The PLC shall be configurable for providing up to 3 analogue AF (audio frequency) channels with 4 kHz gross bandwidth each.
- The useful frequency band shall range from 300 Hz to 3720 Hz for each AF channel. In case of multi channel all the channels should operate simultaneously without interference on each other.
- For each channel, a speech low-pass filter shall be configurable with a programmable upper cut-off frequency of 2 kHz to 3.4 kHz in steps of 200 Hz Speech interfaces shall be configurable as 4-wire E&M, 2-wire FXO or 2- wire FXS.
- It shall be possible to configure 3 analogue speech channels in 8 kHz or in 12 kHz RF-transmission bandwidth.
- Inter-channel cross talk shall be compliant to IEC60495.
- A compandor according to ITU-T G.162 shall be configurable via HMI for each speech channel. Control inputs shall be provided for compandor switching (on/off) by the PABX.
- The frequency band above speech shall be available for the transmission of narrowband modem signals from internal or external modems. The level range of the AF-input-output ports shall be in accordance with IEC60495.
- Digital transmit filters, programmable with respect to bandwidth and center-frequency in steps of 60 Hz, shall be available for each AF channel for the local extraction, insertion and transit-connection of selected Tele-operation frequency bands.
- An equalizer shall be available for each AF channel for equalizing amplitude response distortions of up to +/-12 dB. The equalizer shall be configurable for equalizing group delay distortions. The frequency response before and after equalization shall be displayed in graphical form by means of the GUI (HMI) Equalization of the channel frequency response in both directions shall be possible from one (either) end.
- The PLC shall have local and remote loop back features.

Narrow band Data Transmission.

- The PLC shall provide - as software options - integrated modems for Narrow band data transmission.
- Transmission speed, channel centre-frequencies and the spectral bandwidth shall be programmable in steps for commonly used data rates, ranging from 100 bit/s to 2400 bit/s above speech band.
- The narrow band modems shall be designed for low delay and short recovery times following a link disturbance. In a 4 kHz channel, it shall be possible to transmit preferably up to 2 x 2’400 bps.

Broadband Data Transmission.

- The PLC shall provide - as software option - an integrated modem for broadband/high speed data transmission. Transmission speed and spectral bandwidth shall be programmable via PC/Notebook.
- The speed and transmission bandwidth shall be programmable for at least up to 64 kbit/s in 16 kHz bandwidth. The data rates shall be selectable in steps, compliant with commonly used standardized data rates.
- The system shall support automatic transmission speed adaptation in at least 3 user - defined steps, self-adapting to the prevailing line condition (noise and interference).

- The broadband modem shall provide a facility for automatic detection and suppression of narrow band interferers.

Data Multiplexing.

- The PLC equipment shall provide an internal multiplexer for the time- division multiplexing of up to 8 serial data channels that can be allocated individually to the internal modems. Data ports shall be compliant with V.24/V.28, RS-232 and/or V.11/X.21/X.24.
- The internal multiplexer shall provide data flow control for the asynchronous ports and speed adaptation for the synchronous ports according to the prevailing aggregate data rate and HV power line condition.
- All data ports shall be electrically isolated from ground and against each other.
- Point-point and point-multipoint operation with channel-sharing shall be possible.
- An Ethernet port shall be available as an option, for equipment configuration via LAN, or for general IP forwarding.

Integrated Teleprotection.

- Each teleprotection system shall support the transmission of up to 4 independent and simultaneous commands, programmable individually for blocking, permissive- or direct tripping.
- The transmission of the command signals shall be accomplished within the speech bandwidth or within the spectral bandwidth of the broadband modem, i.e. the teleprotection shall not require the allocation of extra/ separate bandwidth.
- During transmission of protection commands, other service like speech and data shall be temporarily interrupted in order to transmit the protection signal at increased power (command signal boosting). The nominal transmission time shall be < 11 ms, < 12 ms, < 13 ms for blocking, permissive and direct tripping respectively. The required SNR for a dependability of < 1E-03 shall be no more than4, 3 and 0dB for blocking, permissive and direct tripping respectively in Tac = 15 ms, 20 ms and 40 ms. The unwanted commands probability (security) shall for any SNR conditions (worst case) be no higher than 1E-04, 1E-06, 1E-09 for blocking, Permissive and direct tripping, respectively. Electrically isolated upto-coupler inputs, solid-state outputs and mechanical relay outputs shall be available as I/O interfaces to the protection relay. Voltage range shall be selectable from 24 VDC to 250 VDC nominal.
- Inputs and outputs shall be freely allocated to the commands or alarms (programmable via HMI) It shall be possible to individually delay or prolongate the input and output command signals via HMI, and to monitor their duration. All transmitted and received commands shall be logged with time stamps of1 ms resolution by the internal event-recorder, and stored in a non-volatile memory for at least 256 events.
- The teleprotection shall provide an integrated cyclic loop test.
- The teleprotection shall be software programmable via PC HMI with GUI For single - purpose teleprotection applications, the nominal transmission.
- Bandwidth of the PLC terminal shall be configurable for 2 kHz in each direction.

General

- Ambient condition 5o to 55oC
- AC Supply 230V AC+10%-15%, 50 Hz

- Battery supply -48V DC±15%

- Alarm relay output Potential Free change over contracts
  System alarm/Cabinet alarm

  Hardware alarm

  Link alarm

  Interface alarm

- Modules of Power supply Single or Doubled (Redundant)

Electromagnetic Compatibility (EMC):

- Emission in accordance with IEC/EN 61000-3-202000 standard, EN 50081-2
- Electrical safety in accordance with IEC/EN 60950-1:2001
- Power frequency magnetic field as per IEC 61000-4-8 level 4 class

Electrostatic Discharge as per IEC 61000-4-2 level 4 class.

TECHNICAL SPECIFICATION OF TELEPROTECTION COUPLER

1. SCOPE:

The specification covers the design, manufacture, testing before despatch, delivery at store and wherever necessary erection / supervision, testing at site and setting to service of the AF coupler at various GRID Sub-Station and Generating Station.

2. BASIC REQUIREMENTS:

a) All the works shall confirm to the IEC recommendation 834-1.

b) All the materials and equipments offered under this specification shall comply to Indian standards.

c) the tenderer shall submit separately a list of spares recommended by him for 10 years of operation along with item-wise prices. Supply of such spares during useful life of the equipment shall be guaranteed.

d) Following drawings shall be supplied with tender:

i) Drawing showing outline of complete AF channel and AF coupler equipment.

ii) Drawing showing out section view of the equipment.

iii) Drawing showing mounting details of all the equipments.

iv) Drawing showing the provision of accessories, descriptive literature explaining the basic Principle of operation of the equipments.

v) Two sets of instruction / operating manual containing circuit diagram, instruction for erection and commissioning of the equipments, testing schedule, fault tracing procedure shall be supplied along with each equipment.

3. TECHICAL PARTICULARS:

a) The protection equipment should be plug in type and compatible to be fitted with the carrier sets already in operation under OPTCL.

b) Tenderer shall offer protection equipment transmitting command within the speech band of the power line carrier set. The time interval that lapses between the instant command that is received from protection relay at the transmitting side and the time this command is passed on to the protection relay at the distant side shall not be more than 10ms.

c) The equipment shall be suitable for use in conjunction with distance protection system.

d) The equipment shall be suitable for operation in tropical climate.

e) The equipment shall consist of two tier bolted together one tie would contain the electronic part transmitter and receiver, while the other tier would house the test and interconnection unit. On the front side socket shall be provided to carry out test measurements.

f) Equipment should provide full duplex transmission of two non- coded permissive or blocking commands plus two coded prioritized direct tripping commands for the protection of single and double lines including breaker failure protection.

g) The equipment should be so designed that it should prevent the Circuit breakers from false tripping. The equipment should be Insensitive to corona noise, created by operation of circuit breakers, isolators, switches and electrical surges.

h) The equipment should be fully microprocessor based.

i) The equipment should use pilot signal of PLC as guard signal and frequency command signal within the speech band.

j) The equipment should provide separate frequencies corresponding to the individual commands or command combination in the PLC speech frequency band.

k) In the command state the equipment should cutoff the guard signal and transmit the command signal within the speech band. At the same time the speech and the data signal on the same channel should be interrupted during the short time of commands transmission.

l) The output relay of the receiver should operate only when receiver recognizes the missing of guard signal and simultaneously presence of a valid command signal.

m) The duration of command transfer should not exceed two seconds otherwise the receiver should give alarm.

n) The equipment should have provision for a cyclic and manual in-service loop test.

o) The equipment should have facility for counting the tripping of breaker.

4. BASIC TECHNICAL DATA:

Blocking Permissive tripping Direct tripping

a)	Nominal Transmmission timeT0		≤10ms	≤12ms	≤13ms
	Security(Puc)		<1E -04	<1E -06	< 1E -09
	Dependability(SNR/Tac)		>6dB/15 ms	>3dB/19ms	
	>0dB/38ms				
b)	Number of commands		: 4		
c)	Commands duration	:	2 seconds		
d)	S / N Ratio for reliable				
	command reception	:	6 dB		
e)	Primary supply		Internal from the operating carrier set.		
f)	Insulation		: According to IEC 834-1,IEC-495.		
g)	Ambient condition		: Adjustable between 0 to 9 dB.		
h)	Guard channel frequency		: 3600 (pilot of carrier set)		
i)	Trip / Test signal frequency	:	Within the speech band 300 to 2000		
Hz.					
j)	Secure against		: continuous or impulsive, speech and sweep tones DTMF in-band signaling		
k)	Bandwidth requirement		: NIL ,PLC pilot signal or own guard		
signal					
	Guard Signal		above speech band of 2000HZ		
l)	Command input		: Minimum 2 nos upto coupler type per interface module		
m)	Methods of tripping		: contact or battery , or dry contact		
n)	Voltage ranges		: 220 VDC		

TECHNICAL SPECIFICATIONS REMOTE TERMINAL UNIT (RTU)

RTU shall be capable of providing all functions specified herein with the addition of the necessary hardware and software modules in the field when required by owner.

The RTU shall be used for real time supervision and control of substation/power plant through owner's regional SCADA systems. LDEM shall be used for local data acquisition, monitoring and control.

1.0 The RTUs shall be capable of performing the following functions:

(a) Designed around an open ended distributed processing configuration consisting of main processor, peripheral I/O modules, termination panels, power supplies & communication equipment/interface.

(b) Collecting, processing and transmitting status changes, accumulated values and analog values.

(c) Time resolution for time tagged events 1 ms

(d) Receiving and processing digital and analog commands from the master station(s).

(e) Accepting polling messages from the master station(s)

(f) Supporting data transmission rates from 100 to 9600 bits per second.

(g) Supporting minimum four communication ports on outgoing side to interact with multiple Masters on con-current protocols.

(h) Supporting up to 32 IEDs on a RS 485/RS232 port for communicating with

61850 compliant systems.

(i) Support Multi-tasking, to enable RTU to concurrently scan input status, whilst executing application program or reporting functions.

(j) The microprocessor-based common logic should have Compact Flash RAM for storage of configuration files and shall support WEB server diagnosis.

(k) Function of switching of channels if dual data communication channel is available.

(l) Supports multiple concurrent protocols including IEC 60870-5- 101 without using any protocol converter as far as practicable. .

The protocol for communication between RTU & Numerical relays shall be IEC 60870-5-103.

(n) Support Multi-tasking, to enable RTU to concurrently scan input status, whilst executing application program or reporting functions.

(o) Modbus protocol support.

(p) PSU of RTU should have capability to drive 2 nos of FSK modem attached with RTU

1.1 Main Processor.

- Advanced 32-bit microprocessor with minimum 40 MHz Processing capabilities.
- Programmable RS-232 Serial ports.
- Communication between Main Processor and I/O Modules shall be on high speed Communication ports of 256 Kbps.
- Three nos. programmable RS 232 serial ports for simultaneous communication with a host of intelligent IEDs at speed of 38.4 Kbps.
- 9600 baud RS 232 maintenance port.
- Optional math co-processor
- Necessary communication module and power supply module shall be provided as part of system requirement.
- I/O Module (Digital and Analogue) shall be provided.
- The Memory capacity of processor shall be with minimum of 2 MB Flash memory adequate enough for satisfactory function of system request.
- The input voltage to the RTU power supply will be provided through 48 VDC /110VDC.

- Self diagnostic shall test memory checksums, RAM test, Configuration verification, Interrupt controller verification, Serial port test, Watchdog and power monitor, Peripheral communication checks, Error logg etc.

1.2 I/O Modules.

The I/O MODULES shall be with separate 16 bit microprocessor based, intelligent, modular unit, capable of data acquisition, control and local data processing.

Each I/O MODULE must be capable of standalone operation for data acquisition and processing so that when it is used in a non-fault tolerant configuration, it will continue its data acquisition, processing and programmable logic functions and subsequently update the Station Level Processor following elimination of the fault.

1.3 **Communication Interface**

The RTUs shall have the capability to support simultaneous communications with multiple independent master stations, a local user maintenance interface and a local logger (printer). Each RTU shall be able to support a minimum of four communication ports. Three of these ports shall be capable of supporting communications to peripheral devices such as multiple SCADA master stations, solid-state meters, microprocessor based relays and remote/local PCs; and the fourth port to be a dedicated maintenance port. The RTU shall simultaneously respond to independent scans and commands from master stations, local logger and local user maintenance interface using a centralized controller and database. The RTU shall support the use of a different communication data exchange rate (bits per second), scanning cycle, and/or communication protocol to each master station. Also, each master station's data scan and control commands may be different for different data points within the RTU's database.

1.3.1 Modems

The FSK modem shall not require manual equalization and shall include self test features such as manual mark/space keying, along loop back and digital loop-back. The modems shall provide for convenient adjustment of output level and receive sensitivity. The configuration of tones and speed shall be programmable and maintained in non-volatile memory in the modem.

The modem shall meet the following requirement :

a) Use CCITT standards including V.24,V.28.V.52 and V.54

b) Communicate data rates of 100,200,300,600 and 1200 bits per second.

c) Use CCITT V.23,R35,R.37,R.38a and R.38b standard tones for the selected RTU data rate.

d) Use frequency shift keying (FSK) modulations.

e) Use both 2 wire and 4 wire communication lines .

f) Receive level adjustable from 0 to –40 dBm @ 600ohms

g) Transmit level adjustable from 0 to -24 dBm @ 600 ohms

h) Have a minimum sensitivity of -48dBm.

1.3.2 Master Station Communication interface

RTUs shall provide multiple communication ports for possible con-current communication to SCADA system/master stations.

1.3.3 Local User Maintenance computer Interface

The RTUs shall include the interface to support the portable local computer configuration and maintenance/test terminal. The interface shall provide easy access to allow purchaser to use the maintenance terminal at the RTUs installed at the site.

1.4 Master Station Communication Protocol

Shall provide a communication protocol for communicating with master stations using the IEC 60870-5-101 communication standard. The communication protocol shall support all the requirements of this standard. The communication protocol shall be nonproprietary and the contractor shall provide complete description and documentation of the protocol to purchaser for future implementation of additional RTUs due to expansion of power system from supplier at the master stations. The RTU shall also be capable of supporting other communication protocols that may be required to communicate with additional master stations in the future.

1.5 Communication Channel Control

The RTU shall perform as a slave on the communication channel to SCADA systems. The SCADA system master stations shall initiate all communication. Where the RTU must notify the master stations of an unusual condition at the RTU (such as a power fail/restoration or RTU malfunction) or must initiate the transfer of changed data, the notification shall be accomplished within the framework of the periodic data acquisition exchanges.

1.6 Exception Reporting

The RTU communication protocol shall report changes by exception. The communication protocol shall also support an update demand scan of all status data by master stations regardless of the lack of any change in data. The reply to an exception scan request for status points shall consist of an indication of the presence or absence of a change of the status indication points in the RTU. A master station will then request the input of the changed points. The RTU shall continue to indicate exception changes until the master station acknowledges successful receipt of the changed data. The RTU shall report the current state of all status indication points to the master station in response to an update scan even if data has not changed.

1.7 Message security (to be defined in the protocol)

Each RTU communication message shall include an error code, the use of which shall result in a very low probability of an erroneous information frame (data) being accepted as valid. The error code shall be determined and appended to the message for all messages transmitted by the RTU and verified by the RTU for all messages addressed and received by the RTU. Cyclic error detection codes such as Cyclic Redundancy Check (CRC) are required.

High data integrity and consistency is required of the RTU protocols. The protocols used shall provide an adequately low Residual Error Rate (RER), depending on the Bit Error Rate (BER) of the line in use. The minimum required RER is as specified in IEC 870-5-101 protocols with the T-101 profile. This requires the following integrity: BER RER10-5 10-14 10-4 10-10 10-3 10-6.The implemented protocol shall ensure satisfactory performance at Bit Error Rate of 1x10-4

1.8 Analog Inputs

Each analog input shall be furnished with signal conditioning to provide a nominal full-scale voltage to the analog-to-digital (A/D) converter.

The A/D converter and associated signal conditioning shall meet the following minimum characteristics over a 0 Deg C and plus (+) 60 Deg temperature range:

A. Automatic self-calibration

B. Full scale accuracy of ±0.1%

C. Linearity of 0.05 per cent full scale

D. Fourteen bit binary resolution or better; plus one sign bit.

The RTU must scan all analog inputs at a rate of at least once per second and support analog dead-band reporting limits.

Unless otherwise specified, transducers will be provided and installed external to the RTU by the Customer. The transducers are "self-powered" off the sensors. Analog Input Types

The RTU must support the following analog input types: ±10 VDC, 0 to 1 mA, -1 mA to 1 mA, 0 to 5 VDC, 4 to 20 mA, 0 to ±5 mA, 0 to 5 mA, and others as requested.

For all 0 to 5 mA transducer inputs, the RTU analog sense must be set up to over range 0 to 6 mA. At 6 mA, the transducer outputs are still linear. The RTU analog inputs must be set to over range 120% on all Customer field analog inputs.

Individually shielded twisted pairs of wires with an overall shield may be used by the Customer for connections between the transducers and the analog inputs at the RTUs. The system shall have high noise immunity from stray circulating currents in the cable shield.

Common-mode noise rejection: 90 dB minimum, 0 to 60 Hz

Normal-mode noise rejection: 60 dB minimums at 60 Hz.

Adjacent channel voltage isolation: withstand the common-mode voltages of any two channels on the same analog input module differing at least 35 volts AC or peak AC.

Programmable Input Ranges Programmable gain instrument amplifier permits programming of voltage input ranges. Ranges are stored in NVRAM on a per point basis. (+/- 1, +/-5, +/- 10 V

scale)

Variable scan rate Programmable scan rate of 16.7 to 20 ms (50/60 Hz) on a per module basis **A/D Conversion** to provide excellent normal mode rejection characteristics while maintaining good

The RTU shall accommodate Analog input current from transducers, which are isolated, unipolar or bipolar, 2-wire ungrounded differential signals with full resolution.

The Analog input accuracy shall be 99.8% or better at 250 C ambient temperature. Mean accuracy shall drift no more than 0.002% per 0 C within the temperature range of –5 to +55 0

C. Determination of accuracy shall be made while the Analog multiplexer is operating at rated speed.

The Analog-to-digital converter shall have a minimum resolution of + 2048 counts (sign plus 11 data bits).Each input shall have protection and filtering to provide protection against voltage spikes and residual current at 50 Hz, 0.1 ma (peak-to-peak). Overload of up to 50% of the input shall not sustain any failures to the input.

The RTU shall make all appropriate signal level conversion and conditioning to allow full utilization of Analog inputs and meaningful reasonability checking. Including signal conditioning components, the input impedance shall not be greater than 250 Ω. Input scaling shall allow for 20% over range.

1.9 Digital Status Inputs

The digital status input interface shall be capable of accepting isolated wet or dry contact status inputs.

The Contractor shall supply necessary sensing voltage, current limiting, optical isolation, and debounce filtering independently for each digital status input. The Contractor supplied sensing volt shall not exceed 48 VDC. The sensing voltage source shall be isolated from that of the RTUs logic power such that any noise or a short circuit across the sensing supply's output terminals would not disrupt the RTU operation other than the shorted digital status input.1 ms resolution for time tagged messages is required for fault analysis

The RTU shall store all status changes for retrieval by the master stations. For communication delays or short-term failure of communication with a master station, the RTU shall store a minimum of 2000 status of change events. The RTU shall report any overflow of this status-changed buffer to the master stations.

It shall be possible to configure each status input for one of the following functions:

Single status input

Change of state

Sequence of event (SOE) time tagging with resolution of ±1 ms.

The SOE buffer capability to store 1024 events.

5. Alarm input

6. Tap position indication using 4-bit BCD coding

7. Trip/block protection signaling.

8. Hysteresis to prevent false state changes due to noise or other conditions.

1.10 Two-State Devices

All switching devices (breakers) shall be supported by a dual-contact status indication. Breakers with re-closing capability shall also be supported with momentary change detection (MCD). All other status indications shall be two-stage single-contact inputs without MCD. Single-contact two-state status point inputs will be from a single normally open (NO) or normally closed (NC) contact. Dual-contact two-state status point inputs will be from two complementary contacts (one NO and one NC). A switching device status is valid only when one contact is closed and the other contact is open. Invalid states shall be reported when both contacts are open or both contacts are closed.

1.11 Momentary Change Detection

Two-state status input points with momentary change detection shall be used by purchaser for points where multiple operations (changes of state) can occur between RTU scans (e.g. breakers with re-closing devices that operate faster than the scan rate). The RTU shall be set to capture contact operations of 20 ms or more duration. Operations of less than 20 ms duration shall be considered no change (contact bounce). 1.12.1 Power Supply Protection

Over voltage and under voltage protection shall be provided within the RTU power supply to prevent the RTU internal logic from being damaged as a result of a component failure in the power supply and to prevent the RTU internal logic from becoming unstable and causing mal-operation as a result of voltage fluctuations.

1.12 Noise Level The audible nose generated by the RTU equipment shall not exceed 50 dbA : one meter from the enclosure.

1.13 Environmental Requirements

The RTUs will be installed in control buildings without temperature or humidity control. The RTUs shall be capable of operating in ambient temperatures from –5 to + 55^0 C and relative humidity from 5 to 95%, non-condensing with rate of temperature change of 200 C/hour.

1.14 Maintainability

The RTU design shall facilitate isolation and correction of all failures. The features which promote rapid problem detection, isolation and replacement of failed components, shall be provided as following:

(a) Self-diagnostic capabilities within each RTU, which can be initiated at the RTU site.

(b) On-line error detection capabilities within the RTU and detailed reporting to the connected master stations of detected errors.

(c) Local indication of major RTU failures.

1.15 RTU SOFTWARE REQUIREMENTS

The software provided to support the functions of the RTUs should meet the characteristics described in this section.

Real-Time Executive Software

A real-time operating system shall come with the firmware, characterized by:

A. Integrated, multi-tasking with structured efficient supervisory layer

B. Priority scheduling of processes in coordination with other tasks; user applications partitioned into sets of processes

C. Inter task communication and synchronization

D. Dynamic memory allocation

E. Real-time clock to maintain calendar and time, and perform RTU timing functions.

F. Efficient real-time responsiveness.

G. During initialization, memory self-diagnostics shall occur and then initialize the system hardware and various I/O devices.

H. Device drivers will be required for:

- Managing input and output through the serial communication ports,

- High-speed link to peripheral boards, and external high-speed port, if needed.

I. Interrupt controller and interrupt servicing procedure shall prioritize and process hardware interrupts as they occur.

J. Debugging tools shall allow users, via a PC, to monitor functions, examine memory, perform communication port loop back tests, adjust modem communication port settings, check CPU usage, and process profiling.

1.15.1 Design Characteristics

All software shall be implemented according to established design and coding standards. Purchaser reserves the right to reject any software that does not conform to these standards. Complete and comprehensive documentation shall be provided for all software. The software and the database shall be sized to accommodate growth within the sizing parameters defined for the RTU without requiring software or database regeneration. The design of the software and the database shall not restrict future expansion beyond the sizing parameters. Expansion beyond the original design parameters may require software or database regeneration.

At the time the RTU is accepted, all software delivered must be up to date and in final form, including all standard software changes and field changes initiated by the Contractor or the Contractor's suppliers prior to acceptance. The software documentation must reflect these changes.

1.15.2 Operating System

The Contractor shall use a non-proprietary operating system capable of managing the distributed applications of the RTU. The operating system shall support multi-tasking and multi-programming. The minimum real-time facilities to be provided shall include process, job, database, and memory management, process synchronizing message services for communication between jobs, and device and interrupt handling.

1.15.3 Initialization/Restart Program

Software shall provide automatic restart of the RTU upon power restoration, memory party errors, hardware failures, and upon manual request. The software shall initialize the RTU and begin execution of the RTU functions without intervention by master station. All restarts shall be reported to the connected master stations.

1.15.4 RTU Operations Monitoring

Software shall be provided to continuously monitor operation of the RTU and report RTU hardware errors to the connected master stations. The software shall check for memory, processor, and input/output errors and failures.

1.15.5 RTU Configuration Support

A RTU Configuration complier shall generate or modify the database of the RTUs. The database compiler shall provide error detection services and shall produce a printed listing of the input data and the resulting RTU configuration. It shall be possible to maintain the RTU database locally and from a master station using the web server function.

1.15.6 Diagnostic Software

The Contractor shall supply diagnostic software, which monitors and individually tests each of the components of the RTU demonstrating all the capability of RTU as mentioned in this section. The diagnostics shall provide comprehensive user interaction and printout capabilities.

Reference Standard

Vendor shall ensure that equipment and required practices conform to Quality Assurance Standards ISO 9001.

Adhere to Modem standard BELL CCITT.

The RTU shall not be affected by operation of microwave and mobile radio equipment per RFI/EMI Radiation Specification FCC Part 15. Nor should RTU emit radio interference contrary to Department of Communication (Communication Canada) Standards as pertaining to digital apparatus (ICES-003-1991).

Adhere to Standards for SCADA system ANSI C37.1-1979.

Adheres to Surge Withstand Capability (SWC) ANSI C37.90a-1974/78 and IEEE 472- 1974/78; and SWC Fast Transient ANSI C37 90 1-1989; and IEC -255 - 4.

Adhere to Communication Equipment Interface and handshaking standard EIA RS232, 422 485; Definition, Specification, and Analysis of Systems used for Supervisory Control, Data Acquisition, and Automatic Control.

Tests

The RTU and cabling elements of the RTU procurement shall be tested in two parts i.e. type test and routine test as described below.

TYPE TEST:

A minimum of one of each major complete integrated units shall be fully tested to assume full compliance with the functional and technical requirements of the specification. The type test reports for the RTU shall be submitted by the bidder which shall include the tests listed in Table-1.

TABLE-1 List of Type Tests on RTU

Test No	**Description of the Test**
1	EMI/EMC Immunity tests for RTU
2	Surge immunity test as per IEC 60870-2-1
3	Electrical Fast Transient Burst Test as per IEC-60870-2-1
4	Damped Oscillatory Wave Test as per IEC 60870-2-1
5	Radiated Electromagnetic Filed Test as per IEC 60870-2-1
6	Damped Oscillatory magnetic Field Test as per IEC-60870-2-1
7	Power frequency magnetic field test as per IEC-60870-2-1
Insulating test for RTU	
8	Power frequency voltage withstand test as per IEC 60870-2-1
9	1.2/50 µs Impulse voltage withstand test as per IEC 60870-2-1
10	Insulation resistance test
Environmental Test for RTU	
11	Dry heat test as per IEC60068-2-2
12	Damp heat test as per IEC60068-2-3

Routine Test

Each complete RTU shall undergo testing to demonstrate compliance with specified requirements, standards and functional capabilities including.

Inventory check and inspection for general construction, cabling connections, drawing conformance and labeling.

Tests of proper functioning of hardware and software by a thorough exercise of all RTU functions, both individually and collectively.

Test operation and accuracy of all RTU analog inputs over entire range.

Test operation of all RTU digital input points.

Test operation of all RTU control outputs.

Test SOE and RTU time synchronization and accuracy.

Test RTU power failure and recovery.

Test of communications including all communication ports .modems and local interfaces.

For any variations in the configuration, hardware components used or variations from the type accepted equipment, owner has the right top perform any of the type testing before successful completion of the Routine testing.

Field Performance Tests

The supplier shall be responsible for providing field installation and testing. All hard wares will be installed, configured, interfaces to all field inputs and outputs established. Upon completion, a filed performance test shall be performed to exercise all functions of the RTU . The SCADA database and displays information shall be provided by the bidder. This testing will include , but not be limited to the following tests.

RTU initialization

Proper functioning of hardware and software by exercising of selected RTU functions using the master station.

Test operation of all diagnostic software and confirm issuance of mindful messages for all types of error conditions.

Test time synchronization and accuracy of the RTU from the master station.

Development and integration of database at RTU and LDMS end in line with regional SCADA master database design will be the responsibility of the bidder.

- ✓ RTU database verification including point-to-point operation and scaling accuracy using the master station.
- ✓ Integration of RTU and regional SCADA master.

RTU should have provision for adopting ***multifunction power line transducers*** for measurement of various electrical parameters of 3 phase 3 wire or 4 wire electric power system. . The DC output of multi function transducer should be available through galvanized isolated analog outputs and RS 485,half duplex serial communication port over MODBUS RTU protocol/DNP 3.0

Modular 3 Phase Ct & PT circuit boards monitor the secondaries of sub-station voltage current transformers. These boards send the waveforms to the RTU for digital signal analysis. This is called transducer less technology. It should allow the master station to display any electrical parameters (single phase or 3 phase composite) from any measurement point. These parameters should include :

- Voltage
- MW
- MVAR
- Frequency

Technical Specification of multi function transducer:

Connection	:	3 phase 4 wire
Input value:		
I in	:	1A,5A(User selectable)
V in	:	110V
DC Output	:	4 nos of galvalised isolated 4-20mA DC, 500 or 750 Ohm
Communication port	:	RS 485 Modbus RTU
Type	:	Multi drop capability
Response Time	:	Less than 500 mSec.

Temperature	:	0- 55^0 C
Humidity	:	95% RH non-condensing
Accuracy	:	±0.5 % of Span

Standards and Regulations:

IEC 60688	:	Electrical measuring transducers for converting AC electrical quantities to analog or digital signals
IEC 60687	:	Alternating current static watt-Hour Meters for Active energy