



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

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:

SI 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
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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 specification .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 synchronize 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 1:1 APS
Common Control* Cards ----- -----	
DACS (Cross Connect) Power Supply ----- -----	1:1 APS or distributed 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
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.

6.0 Termination 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 (DACCS) 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:	2.048 Mb/s ± 50 ppm
Interface Code:	HDB3
Impedance:	75 ohm unbalanced
Peak Level @ 120 ohm:	3.0 volts ± 10%
Peak Level @ 75 ohm:	2.37 volts ± 10%
Maximum Insertion Loss:	6 dB
Signal Waveform:	Per CCITT G.703
Frame Structure:	Per CCITT G.742
Jitter Performance:	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

Clause No.	Description	Page No.
1.	Intent of specification	1
2.	Design and construction	2
3.	Tests	12
4.	Spare parts	15
5.	Horizontal Centrifugal pumps	15
6.	Diesel Engines	20
7.	Piping, Valves and Specialities	24
8.	Air Vessels	33
9.	Heat detectors, fire detectors and spray nozzles	33
	Portable and Wheel/ Trolley mounted Fire Extinguishers	35
10.	Instruments	36
11.	Electric Motors	40
12.	Battery & Battery chargers	46
13.	Control and Annunciation panels	48
Drawing	For (1) P&I diagram for Hydrant and HVW spray system (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)	Drawing

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 m200m³/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°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. Annunciators 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
with indication lamp | 1 Set |
| 4. | DOL starter with
thermal O/L relay | 1 Set |
| 5. | Indicating lamp showing
power ON | 1 Set |
| 6. | Indication lamp with drive
ON/OFF | 1 Set |
| 7. | Indication lamp showing
Motor Trip | 1 No. |

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
selecting either jockey pump | 1 No. |
| 4. | D.O.L. starter with overload
relay self-resetting type, for all the drives. | 1 No. each |
| 5. | Start/stop push button for
Jockey Pump with indication
lamp with pad-locking
arrangements in stop position | 1 Set for each pump |
| 6. | Indication lamp for trip
indication | 1 No. each for pump |
| c) | Panel for 2 Nos. battery charger
& Diesel Engine driven fire water pump | 1 No. |

The panel shall be provided with the following :

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

- | | | |
|----|---|------------|
| 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 employers 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:

<u>Sl.No.</u>	<u>Description</u>	<u>Number</u>
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.

<u>Sl.No.</u>	<u>Description</u>	<u>Number</u>
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 - Projectsq

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/cm²g 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/cm²g.

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/cm²g

b) **Internal diameter**

The branch pipe, coupling and nozzles shall be subjected to a hydrostatic test pressure of 21 kg/cm²g 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/cm² 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°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 required 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 50°C 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 360° in steps in 90°.
- (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 °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 lamincold, 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°C
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 DETECTOR

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 DETECTOR

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 DETECTOR

1.0	Manufacturer	OPTCL Approved make
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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°C to 60°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
9	Conductor resistance.	12.1 Ohms/kM at 20°C
10	Insulation material	PVC insulation Type A as per

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 \pm 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 \pm 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/cm ²
9.1	Body	16 kg/cm ²
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 Grey cast iron, grade Grade LTB 2 FG200 of IS 210.	
5.2	Hand wheel	Grey cast iron, grade FG200 of IS 210.	
5.3	Bonnet & Wedge	Bronze to IS 318 Grey cast iron, grade Gr.LTB 2 FG200 of IS 210.	
5.4	Stem	High tensile brass, Stainless steel grade HT1 or HT2 of IS:320	
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/cm ²
9.1	Body	16 kg/cm ²
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 / cm ²

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
220/33 KV Gas Insulated Switchgear (GIS)

CONTENTS

- 1. General Specification**
- 2. Electrical Ratings**
- 3. Equipment Specification**
 - 3.1 General**
 - 3.2 Technical Specification of HV components**
 - Circuit breaker**
 - Disconnecter**
 - Maintenance earthing switch**
 - Fast acting earthing switch**
 - Current transformers**
 - Voltage transformers**
 - Surge Arresters**
 - SF6/Air bushings**
 - EVH-Power cable connection**
 - Local control cubicle**
 - Tools**
 - Spare parts**
 - Other services**
 - Standards and codes**
 - Others**

220 / 33 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 disconnectors and earthing switches Instrument transformers:
- IEC 60044-1 : Instrument transformers - Part 1: Current transformers
- IEC 60044-2 : Instrument transformers - Part 2: Inductive voltage transformers
- IEC 60044-6 : Instrument transformers - Part 6: Requirements for protective current transformers for transient performance

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 60376 : Specification of technical grade sulphur hexafluoride (SF6) for use in electrical equipment
- 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

EN 50052 : Cast aluminium alloy enclosures for gas-filled high-voltage switchgear and control gear

EN 50064 :Wrought aluminium and aluminium alloy enclosures for gas-filled high-voltage switchgear and control gear.

EN 50068 : Wrought steel enclosures for gas-filled high-voltage switchgear and control gear

EN 50069 : Welded composite enclosures of cast and wrought aluminium alloys for gas-filled high-voltage switchgear and control gear

EN 50089 : Cast resin partitions for metal enclosed gas-filled high-voltage switchgear and control gear.

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 EN standard.

SURFACE TREATMENT

Steel (covers):

Indoor: Hot galvanised or painted

Outdoor: 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 7035

Internal surfaces (aluminium wrought alloy): without surface treatment

External surfaces: material description: high-resistant 2-component polyurethane paint

Shade: RAL 5018

gloss: silk gloss - silk-matt

drying: air or stove dried

top coat: outdoor: Alexit top coat 5225, 5:1

indoor: Celerol top coat 362-24

reaction component: Alexit hardener 402

thinner: Alexit thinner 62 or 68

The used lacquers are free of harmful materials like cadmium, lead and chromic acids.

GAS

Gas compartments, monitoring of gas compartments:

- ~ SF6 serves as insulant for the enclosure of several separately-sealed gas compartments
- ~ static filters in all gas compartments - with single-phase encapsulation for each phase - 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 and surge arresters form separate gas compartments.
- ~ the disconnecter gas compartment can contain other devices e.g. earthing switch, cable connection module.
- ~ 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 0.2 % 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.

NOTE: The Bus of the 220 KV & 33 KV GIS System shall be of **Aluminum** of adequate size and should be capable of withstanding the short circuit current level of 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:

All the Incomer feeders of 220 KV shall be with Gas Insulated Bus duct with termination of SF6 Gas to Air Bushings and the transformer feeders shall be with Gas Insulated Bus duct with termination of SF6 Gas to Oil Bushings.

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 220 KV side
6. Bus Pts in 33 KV side
7. Current transformers
8. Surge arrester

9. Bus and elbow sections
10. Cable end enclosures / SF6 Bus . duct.
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.(220 & 33 KV side)
2. Line Capacitor Voltage Transformer: 220 KV side.
3. 33/0.43 KV,315 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 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 245kV 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:

		220 KV side
i)	Phase design	1ph

ii)	Rated voltage	KV	245
-----	---------------	----	-----

	A	Rated lightning impulse withstand voltage (peak)	KV	1050
	B	Power frequency 1 minute (r.m.s.)	KV	460
iii)		Rated frequency	Hz	50
iv)		Rated current (bus bars) [At 40°C]	A	3150
v)		Rated short-time current (r.m.s) (3s)	KA	40
vi)		Rated making current (peak)	KA	100
vii)		Rated short circuit breaking current	KA	40
viii)		Partial discharge level, complete bay 1.5 x U//3	pC	< 10
ix)		SF6 gas pressure at 68 °F / 20 °C, 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/steel enclosures and filled with SF6 gas for insulation. Enclosures shall be of single phase encapsulation for 245kV 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 integrated isolated device.

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 with out 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.

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 \leq 150 PPM (volume)

Others \leq 500 PPM (volume)

The Gas loss of the switchgear shall be in no case higher than 0.2% per year.

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 0.2% 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 CORONA SHIELD

Corona shield, if necessary, shall be located at appropriate location inside the enclosure. The manufacturer to ensure that the shield do not vibrate or displaced throughout the plant life.

Material of the corona shield should be Alloy of Aluminum.

3.1.16 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.

3.1.17 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.

3.1.18 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.

3.1.19 REPAIR

In case of any internal fault in the bus bar or bus bar dis - connector, circuit breaker, repair works must be possible with minimum effect for remaining operation.

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.

3.1.20 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.

3.1.21 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.

3.1.22 AUXILIARY CONTACTS

Each equipment shall be furnished with adequate number of electrically independent contacts at users 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.

3.1.23 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 design with the specified ratings. The breaker shall be Self-Blast / 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.

Breaker disposition may be horizontal or, vertical. However, the breaker layout arrangement shall be preferably 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

		220 KV* individual pole operated mechanism
Nominal operating Voltage	kV	220
Highest system Voltage	kV	245
Nominal operating current(at 40°C)	A	3150
System earthing		Solidly earthed
Rated withstand voltage with respect to earth		
Lightning	kV	1050
Power frequency	kV	460
Rated short-circuit breaking current (r.m.s.), 3s:	kA	40
Rated making current (peak):	kA	100
Rated break time	ms	As per IEC-62271-100
Rated opening time	ms	As per IEC-62271-100
Rated closing time	ms	As per IEC-62271-100
Close-open time	ms	As per IEC-62271-100
Rated cable and line charging breaking current	A	250/125
Number of breaks per pole	Nos.	1

First pole to clear factor		1.3 minimum
Operating mechanism :		Hydraulic/Spring
Number per single phase circuit breaker		1
Rated operating sequence		O-0.3s-CO-3 min-CO / CO-15sec-CO
Time for recharging CO cycle		
Type		Hydraulic/Spring
Number of trip coils		2 in each pole
Number of closing coils		1 +1 (Stand by)in each pole
Rated control voltage (DC)	V	220 DC

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 $\pm 10\%$ frequency $\pm 5\%$

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 breaker 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 gap between the open contacts shall be such that it can withstand at least the rated phase to ground voltage for eight hours at minimum operating pressure of SF6 gas due to its leakage.

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

One Hydraulic operating mechanism/spring operating mechanism shall be supplied for each single phase circuit-breaker. Electric motor for the mechanism shall be DC operated.

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.

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. Disconnectors 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

		220 KV SIDE
Rated Voltage	kV	245
- Lightning	kV	1050
- Power frequency	kV	460
Nominal operating current(at 40°C)	A	2000
Rated short-circuit withstand current (r.m.s.), 3s	kA	40
Type of operating mechanism		Motor
Number of drives per 3 phase		1
Control voltage (DC)	V	220 DC
Number of CO permissible without	No.	As per latest IEC standard or

maintenance	equivalent.
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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 a energized bus section.

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

		220 KV SIDE
Rated Voltage	KV	245
- Lightning	kV	1050
- Power frequency	kV	460
Rated current	A	NA
Rated short-circuit withstand current (r.m.s.), 3s:	kA	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.

3.2.4 DISCONNECTOR / EARTHING SWITCH

The combination of disconnector and earthing switch having common drive system shall be preferable. The arrangement would ensure best mechanical interlocking between disconnector and an earthing switch, compact design, reduced hardware and thus an overall improved performance.

3.2.5 FAST ACTING EARTHING SWITCH

1. General

Fast acting earthing switches can be located at the busbar and at all external HV connections of feeders (like HV cable or overhead line). The switching capability shall be as per IEC 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 a 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

		220 KV SIDE
Rated Voltage	kV	245
- Lightning	kV	1050
- Power frequency	kV	460
Rated current	A	NA
Rated short-circuit withstand current 3s, (r.m.s.):	kA	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

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.

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. 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

		220 KV SIDE
Core number per phase	Nos.	05 cores *
Accuracy - Metering - Protection		Metering 0.2 & protection PS class *
Rating Primary	A	1200-600-300 *
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 220kV/(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 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 transformers 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 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

		220 KV SIDE
Rated voltage	KV	245
- Lightning	kV	1050
- Power frequency	kV	460
Primary winding	kV	220/√3
Secondary winding	V	110/√3
No of secondary windings	Nos.	2
Accuracy of secondary winding class		0.2 /3P

Burden		100//100
Partial discharge level at 1.5 U//3	pC	As per IEC

3.2.8 SURGE ARRESTERS:

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

		220kV
Rated voltage	KV	192
Line discharge class		3
Nominal discharge current (8/20µs)	kAp	10
Max. Lighting Impulse Residual Voltage with 8/20µs	kVp	1050kVp at 10kA

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 must be designed to cause negligible damages in case of porcelain rupture, having either a low pressure volume or a small SF6-gas volume next to the porcelain.

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 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.

Followings are the sizes of the 33 KV XLPE cables proposed to be adopted in the GIS sub-station.

33 KV XLPE armoured single core, 800 Sq mm copper Cable to be used.

(1) From 33 KV side of the Power Transformer to the 33 KV GIS cubicle.

(2) 33 KV XLPE armoured three core, 95 Sq mm copper Cable to be used. From 33 KV GIS cubicle to 33 KV side of the Station Transformer.

33KV side XLPE cables are to be terminated at transformer end and also at GIS cubicle end. Quantity and type of such termination kit to be decided by the bidder.

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
- position indicators
- 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.

The LCCs shall be separate from the GIS switchgear. A general arrangement drawing showing the installation position shall be submitted with the quotation.

The LCCs shall be installed indoors. The LCCs 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.

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	1 set
Leakage detector	1 piece
SF6 filling and evacuating 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

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) Disconnecter	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 & 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 STANDARDS AND CODES

All electrical switchgear, the components of the control system, the protection scheme shall be conforming to the relevant IEC standards and publications of the latest issue.

The following standards are applicable in the relevant parts to the individual components of the gas insulated switchgear:

IEC 62271-203	High-voltage metal enclosed switchgear for rated voltage of 72.5 kV and above
IEC 62271-100	High-voltage alternating-current circuit breakers
IEC 62271-102	Alternating current dis-connector and earthing switches
IEC 60694	Common clauses for high-voltage switchgear and control gear standards
IEC 60044	Current and voltage transformers
IEC 60060	High voltage test techniques
IEC 60071	Insulation coordination
IEC 60099	Surge arresters
IEC 60137	Bushings for alternating voltage above 1000V
IEC 60255	Electrical Relays
IEC 60265	High voltage switches
IEC 60270	Partial discharge measurement
IEC 60376	Specification and acceptance of new sulfur hexa-fluoride
IEC 60480	Guide to checking of sulphur hexafluoride (SF6)
IEC 60529	Degrees of protection
IEC 60815	Pollution levels
IEC 62271-209	Cable connections for GIS
IEC 61000	Electro-magnetic compatibility (EMC)
IEC 61634	Use and handling of SF6
IEC 61639	Direct connections Transformer . GIS

3.2.17: 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 disconnecter can be opened only if the associated circuit breaker is opened.
- The feeder disconnecter cannot be closed if the switchgear is closed and bus bar disconnecter is closed.
- The earthing switch of each bus bar may be closed only if all the bus bar disconnections are opened.

3.2.18: 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.

3.2.19: LOW VOLTAGE CABLES & CONTROL CABLES

The Low voltage cables & control cables shall be of 0.6/1kV 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.

3.2.20: 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 220 KV 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) 220 KV SF 6 TEST BUSHINGS:

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

Note- For 220kV GIS test bushings are not required as per tender SLD.

3.2.21: 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 from the buried **HDG MS earth flat** conductor of a cross section of **300 sq.mm (50X6)**. 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.

EQUIPOTENTIAL EARTH MAT:

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.

3.2.22: 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.

(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.

3.2.23:

SCHEDULE OF EQUIPMENT/MATERIALS

Item No	Description of Equipment/Materials	Quantity	Total Quantity
1	Package – 220 KV 220 KV GIS INFOCITY-II SS(Double bus)		
	220 KV Indoor line bays with all equipments (Feeder)	1 Nos each	02 Nos
	220 KV Indoor Transformer bays with all equipments	1 Nos each	02 Nos

	Indoor bus bar VTs and bus bar earthing Switches etc.,	2 Sets	2 sets
	220 KV Indoor Bus-coupler bay with all equipments	1 No	1 No.
2	ACCESSORIES		
	SF6 Gas handling plant of adequate capacity	1 Set	-
	SF6 gas service cart with all accessories	1 Set	-
	Bushing for cable testing	1 set	-
3	TESTING EQUIPMENT		
	GIS testing equipment(Bidder should include all such testing equipment ,which are required for detail testing of GIS system)	1set	-

3.2.24: 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	Oil pressure switch	2 Sets
8	Auxiliary contacts for circuit breaker	1 Set
9	Auxiliary contacts for DS and ES	1 Set
10	SF6 gas in steel bottle 52 Kg / bottle	2 Nos.
11	Hydraulic Pump/spring charge motor for circuit breakers	1 unit
12	Complete drive mechanism for disconnect switches and grounding switches	1 unit
13	Motor for disconnect switches and grounding switches	1 unit
14	Complete drive mechanism for fast acting grounding switches	1 unit
15	Motor for fast acting grounding switches	1 unit
16	Rupture disc for circuit breakers / potential transformer	1 no
17	Set of spares for local control cabinet including M.C.B., fuses, time relays, auxiliary relay and terminals	
18	Rupture disc for other compartments	2 nos
19	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

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 /isolated 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 50°C.

- 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.

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(One bus shall be as Main & the other shall be as Reserve/Transfer 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.

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. Disconnecter 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 Disconnectors 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 0.2 & 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 remanence 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 from/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 atleast 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 tropicalised 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 solderless 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 `ONq , 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°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 corrosion 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		

COMPREHENSIVE AMC(FOR 220/33 KV GIS SUB-STATION)

TRAINING AND RESPONSIBILITY OF OPERATION AND ANNUAL MAINTENANCE OF THE PROPOSED 220/33 KV GIS SUB-STATION.

The guarantee period of the proposed GIS sub-station shall be 12 months from the date of successful energisation of the sub-station. The successful bidder shall arrange on-site training of OPTCL's personal on operation and maintenance for 36 (thirty six) months beyond the guarantee period. The Bidder also to undertake all maintenance work during the guarantee period. Only the bidder's personal trained by GIS manufacturer shall conduct the training & maintenance works.

The detailed training program and personal deputed to conduct the training are subject to approval of OPTCL. Details credentials of the technical personals to be engaged for the above works are to be furnished by the successful bidder to the OPTCL for scrutiny and decision of such qualified technical personals engagement.

The same personal deputed for training shall also be responsible for day to day maintenance and operation of the GIS modules for the same period. It will be the responsibility of the personal deputed for training, to guide the operation & maintenance people placed by OPTCL for the substation, for proper operation, monitoring and maintenance practices. For this purpose, the deputed personal shall always be available at site round the clock.

For Operation & Maintenance of GIS substation for 3 years beyond the Guarantee period (Bidder to keep the trained personal (trained & certified by GIS supplier to handle the operation & maintenance of 220/33 KV GIS S/S) at substation for the period of 3 years, round the clock. Bidder to keep necessary spares & consumable for carrying out O&M and a detail list to be furnished along with the bid (BOTH IN NON PRICE SCHEDULE IN PART-I & IN PRICE SCHEDULE IN PART-II).

REMARKS:- THE AMC FOR 3 YRS SHALL COMMENCE JUST AFTER THE GUARANTEE PERIOD OF SUBSTATION AS STIPULATED IN THE TENDER SPECIFICATION.

SCOPE OF AMC(Comprehensive):

(I) **Annual Maintenance Contract (Comprehensive)** for the GIS Sub-station to be provided by the contractor for a period of 03(Three) Years beyond the Guarantee period and shall have following scope:-

AMC shall be inclusive of all equipment, materials, T&P's, Technical personnels and labours.

(a) **Preventive Maintenance** Quarterly(every three months): Contractor to Check Properly to ascertain the performance to the satisfaction of OPTCL in each quarter. These inspections to be carried out in presence of OPTCL Engineer and your representative. A report on such inspection & testing along with the status of the GIS Sub-station to be jointly signed for reference and record. In case any defects are noticed during Preventive Maintenance, such defects are to be rectified immediately. The materials/equipments required to rectify the defects are to be supplied by the bidder free of cost to OPTCL. In case the contractor fails to

perform the Preventive maintenance within the scheduled stipulated time, the purchaser shall recover from the supplier/bidder a penalty for the delay as per the Penalty clause indicated below **(III-A)**.

(b) Break down maintenance: In case any defect is noticed, the contractor should attend the ascertain the defects and should rectify the same within 15 days for minor defects and within 30 days for the major defects to the contractor. In case the contractor fails to rectify the defects within the scheduled time, the purchaser shall recover from the supplier/contractor a penalty for the delay as per the Penalty clause indicated below **(III-B)**. The date of troubles/defects of the GIS Sub-station, shall be reckoned as the base date for computing the Penalty amount.

(II) TERMS OF PAYMENT: (For AMC Contract of GIS Sub-station)

The terms of payments under this contract shall be governed as per the following:

1. Your unconditional acceptance of this order.

2. A performance Bank Guarantee as per the proforma enclosed for 10% of the total Maintenance Contract price(for 03 years) , which will remain valid for more than two months from the expiry of the contract period. The performance BG for AMC shall be furnished before 02(Two) months of the expiry of the Performance BG for the GIS sub-station.

3. Payment will be made equally at the end of each half(every six months) period starting from the date of contract agreement as per the details below:

(a) Release of payment for the 1st instalment:- All the GIS Sub-station s need to be Checked Properly under Preventive Maintenance (PM) to ascertain the performance to the satisfaction of OPTCL in each quarter. This inspection to be carried out in presence of OPTCL Engineer and your representative and a report on inspection & testing along with the status of the GIS Sub-station should be jointly signed and furnished to the verifying authority(Concerned A.G.M) for verification and onward transmission to C.G.M (O&M)/Nodal Officer. C.G.M (O&M)/Nodal Officer shall intimate/forward the documents along with the invoice to Sr.G.M (CPC) for release of the payment. The contractor to furnish the draft format for the inspection/testing & Status report of the GIS Sub-station ,which shall be approved by the C.G.M (O&M),OPTCL, Bhubaneswar.

(b) Similarly the payment of 2nd instalments (last Instalment of the each year)of each year are to be paid to you at the end of each year (12 months) , during which the inspection of GIS Sub-station, to keep the GIS Sub-station in a healthy and functional condition, shall be carried out by the contractor, on production of documents as indicated above.

(III) PENALTY:

(A) In the event of failure on your part to comply with the provisions of the contract regarding attending to the **Breakdown** of the GIS Sub-station as indicated elsewhere, a penalty @0.5% of the total contract value for each day of delay, or part thereof, for such delay, subject to no upper ceiling, will be levied, without prejudice to any other remedies to which OPTCL may also be entitled, under the provisions of the contract/bid specifications.

(B) In the event of failure on the part of contractor to comply with the provisions of the contract regarding attending to the **Preventive maintenance**(PM) of the GIS Sub-station as indicated elsewhere, a penalty @30% of the total AMC value for the period shall be imposed for that quarter.

(IV) PERFORMANCE SECURITY:

(a) You are requested to furnish a **composite bank guarantee** of 10% of the contract value in our standard bank guarantee format (as enclosed) towards security payment and performance from any Nationalised/Scheduled Bank having a place of business at Bhubaneswar on non-judicial stamp paper worth of Rs.500.00 (Rupees five hundred) only or as applicable as per the prevailing laws. The said B.G. shall be

accompanied with the confirmation letter from the issuing bank & should be capable of being encashed at Bhubaneswa. The B.G. shall be furnished in favour of Senior General Manager (CPC), OPTCL, Bhubaneswar-751022 within 30 days from the date of issue of AMC order and shall remain valid for two months more than the expiry of the contract period. Where the contract is extended, the B.G. should also be suitably extended, to cover the entire contract period.

(b) No interest is payable on the Composite Bank Guarantee for AMC .

(c) In case of non-fulfillment of contractual obligation in any manner, performance bank guarantee shall be invoked without intimation to you.

(V) GUARANTY:

It will be your responsibility to maintain the entire GIS Sub-station as described in the scope of the contract in healthy and functional manner. The repair and replacement work will be attended & rectified immediately failing which the penalty clause as at **clause-III** shall be applied. The replacement of equipments will be done by using materials from the stock to be kept under you. Any equipment/materials removed from the GIS Sub-station location and taken for rectification, will be rectified and returned back to OPTCL at your(contractors) own risk and expense, within 15 days from the date of such removal. The date of removal will be reckoned as the date of handing over & taking over report jointly signed by OPTCL Engineer of the concerned GIS substations and contractors representative.

(a) An indemnity bond shall be furnished before receiving materials from OPTCL .

(b) In case the materials/equipment are not returned back to OPTCL within 15 days , a penalty shall be levied on the bidder as per clause **III-B**. In case the bidder did not return the materials taken from the GIS Sub-station the BG furnished towards the AMC shall be encashed without any intimation to you.

(VI) NODAL OFFICER:

A nodal officer shall be appointed by OPTCL, who will monitor the execution of entire maintenance activities within the scope of this contract. You will furnish all the records, reports, receipts etc., to the Nodal Officer, who will forward the documents, after due verification, for initiation of quarterly payment activities.

(VII) CONTRACT AGREEMENT:

The contractor shall prepare and finalise the Contract Document for signing of the formal Contract Agreement with us, as per the proforma to be provided to **the contractor**, on non-judicial stamp paper of appropriate value within fifteen days from the date of this order. The contract papers shall be prepared in 2(two) originals and copies shall be 1(one) no for GIS sub-station is proposed.

(VIII) DURATION OF CONTRACT:

This AMC shall be in force for a period of 03(three) Years, beyond the Guarantee period as stipulated in the Specification.

ODISHA TRANSMISSION CORPORATION LIMITED



TECHNICAL SPECIFICATION

FOR

11/33 KV H.T. XLPE POWER CABLE

1. SCOPE:

The specification covers design, manufacture, shop testing, packing and delivery of 11 & 33 kV , single/multi core , cross linked polyethylene insulated ,armoured, copper conductor power cables by road/rail to the designated Store Centers /project site in the State of Odisha. These cables shall be suitable for the 3 phase AC-50 Hz system with the nominal voltage of 11/33 KV which may reach maximum of 12/36 KV respectively.

These cables shall primarily be designed for effectively earthed neutral system.

2. SERVICE CONDITIONS:

Equipment to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

2.1 Maximum ambient temperature (deg C)	50
2.2 Maximum temperature in shade (deg C)	45
2.3 Minimum temperature in air (deg C) in shade	3.5
2.4 Relative Humidity (%)	10 to 100
2.5 Maximum annual Rainfall (mm)	1450
2.6 Maximum Wind Pressure (kg/mm ²)	150
2.7 Maximum altitude above mean sea level (Meters)	1000
2.8 Isoceraunic level (days/year)	50
2.9 Seismic level (Horizontal acceleration)	0.3 g.
2.10 Moderately hot and humid tropical climate, conducive to rust and fungus growth.	

3. STANDARDS:

3.1 Unless otherwise specified elsewhere in this specification, the rating as well as performance and testing of the HT XLPE power cables shall conform to the latest revisions available at the time of placement of order of all the relevant standards as listed in, but not limited to **Annexure-I**.

4. GENERAL TECHNICAL REQUIREMENTS:

4.1 6.35/11 kV & 19/33 kV earthed, single/multi core power cables shall normally be with stranded compacted Annealed plain copper conductor as per IS: 8130 ,IEC 60228 (amended upto date), provided with conductor screening (of extruded semi-conducting cross link material) and shall be insulated with XLPE of natural colour Identification of cores shall be by colour, as per provision of

clause 13.1 of IS: 7098 (Part 2) ,IEC 60502 (amended upto date). The insulation (XLPE) screening shall be provided consisting of extruded semi-conducting cross link material in combination with a metallic layer of copper tapes. Three such screened cores shall be laid up together with fillers and/or binder tapes where necessary and provided with extruded inner sheathing of heat resistant PVC conforming to type ST-2 of IS: 5831 - 1984(amended upto date).

Maximum continuous operating temperature shall be 90 deg C under normal operation and 250 deg C under short circuit condition.

Armouring shall be provided consisting of single galvanized round steel wires (In case of Single core cable armouring shall be of Non-magnetic material) conforming to IS:7098 Pt 2/IS: 3975 /IEC 60502-Pt 2 (amended upto date) and over the armouring a tough outer sheath of PVC compound shall be extruded. The PVC compound for the outer sheath shall conform to type ST-2 of IS: 5831/IS:7098 Pt 2/IEC 60502 Pt 2 (amended upto date). The colour of the outer sheath shall be black. The cable shall be manufactured strictly conforming to IS:7098 (Part 2) /IEC 60502(amended upto date) and shall bear **ISI** mark.

4.2 SEQUENTIAL MARKING OF LENGTH ON CABLE

Non erasable Sequential Marking of length shall be provided by embossing on outer sheath of the cable for each meter length.

The quality of insulation should be good and insulation should not be deteriorated when exposed to the climatic conditions.

4.2.1 DISCHARGE FREE CONSTRUCTION:

Inner conductor shielding, XLPE insulation and outer core shielding shall be extruded in one operation by special process (viz. Triple Extrusion Process) to ensure that the insulation is free from contamination and voids and perfect bonding of inner and outer shielding with insulation is achieved. The bidders are requested to elaborate the manufacturing technique adopted by their manufacturers to achieve this motive.

The Company will order the verification of triple extrusion process at manufacturer's works as a pre qualification if it is technically accepting the bid.

During verification if it is found that the firm is not manufacturing the cable with triple extrusion process the offer shall be rejected.

5. 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
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	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

4.5 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 A	Short circuit current 33 kV in kA
t	A	$I=0.094 \times A/\text{sq.rt} (t)$
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

5. TESTS AND TESTING FACILITIES :

5.1 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.

5.2 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.

5.3 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.

5.4 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.

5.4.1 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.

5.4.2 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.

5.5 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.

6 PACKING AND MARKING :

6.1 IDENTIFICATION MARKS ON CABLE:

The following particulars shall be properly legible embossed on the cable sheath at the intervals of not exceeding one meter through out the length of the cable. The cables with poor and illegible embossing shall be liable for rejection.

- a) Manufactures name and/or Trade name.
- b) Voltage grade.
- c) Year of manufacture.
- d) Successive Length.
- e) Size of cable
- f) ISI mark

6.2 The cable shall be supplied in continuous standard length of 250 running meters with plus minus 5% tolerance wound on non returnable wooden drum of good quality and non-standard lengths not less than 100 meters upto 5% of the ordered quantity shall be accepted. Alternately cable can be supplied wound on non-returnable steel drum without any extra cost to the purchaser. Packing and marking shall be as per clause No. 21 of IS:7098 (Part 2)/IEC 60228,(amended upto date)

6.3 Supplier should provide statistical data regarding cables of all sizes viz.-

- 1) Weight of one meter of finished product of cable of various sizes and ratings.

2) Weight of one meter of bare conductor used for cables of various sizes and ratings.

7 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.

8 SCHEDULES:

8.1 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
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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 kV upto 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.

MORE INFORMATION ON POWER & CONTROL CABLES [FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V]

CRITERIA FOR SELECTION OF POWER & CONTROL CABLES

1.1 Aluminium conductor XLPE insulated armoured cables shall be used for main power supply purpose from LT Aux. Transformers to control room, between distribution boards and for supply for colony lighting from control room.

1.2 Aluminium conductor PVC insulated armoured power cables shall be used for various other applications in switch yard area/control room except for control/protection purposes.

1.3 For all control/protection/instrumentation purposes PVC insulated control cables of minimum 2.5 sq. mm. size with stranded Copper conductors shall be used.

1.4 The sizes of power cables to be used per feeder in different application shall be as applicable, described here under.

1.5 Bidder may offer sizes other than the sizes specified in clause 1.4. In such case and for other application where sizes of cables have not been indicated in the specification, sizing of power cables shall be done keeping in view continuous current, voltage drop & short-circuit consideration of the system. Relevant calculations shall be submitted by bidder during detailed engineering for purchaser's approval.

1.6. Cables shall be laid conforming to IS : 1255.

1.7 While preparing cable schedules for control/protection purpose following shall be ensured:

1.7.1 Separate cables shall be used for AC & DC.

1.7.2 Separate cables shall be used for DC1 & DC2.

1.8 For different cores of CT & CVT separate cable, core wise shall be used .The minimum sizes of the conductor for each terminal shall be 2X2.5 sqmm.

1.9 For control cabling, including protection circuits, minimum 2.5 sq.mm. size copper cables shall be used per connection.

TECHNICAL REQUIREMENTS

2. General

2.1 The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.

2.2 They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions.

2.3 The XLPE insulated cables shall be capable of withstanding a conductor temperature of 250°C during a short circuit without any damage. The PVC insulated cables shall be capable of withstanding a conductor temperature of 160°C during a

short circuit.

2.4 The Aluminium/Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects. All Aluminium used in the cables for conductors shall be of H2 grade. In case of single core cables armours shall be of H4 grade Aluminium.

2.5 The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.

2.6 Progressive sequential marking of the length of cable in metres at every one meter shall be provided on the outer sheath of all cables.

2.7 Strip wire armouring method (a) mentioned in Table 5, Page-6 of IS : 1554 (Part 1) . 1988 shall not be accepted for any of the cables. For control cables only round wire armouring shall be used.

2.8 The cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.

2.9 All the cables shall pass fire resistance test as per IS:1554 (Part-I)

2.10 The normal current rating of all PVC insulated cables shall be as per IS:3961.

2.11 Repaired cables shall not be accepted.

3. **XLPE Power Cables**

3.1 The XLPE (**90°C**) insulated cables shall be of FR type, C1 category conforming to IS:7098 (Part-I) and its amendments read alongwith this specification. The conductor shall be stranded aluminium circular/sector shaped and compacted. In multicore cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multicore cables. For XLPE cables, the inner sheath shall be of extruded PVC of type ST-2 of IS:5831. When armouring is specified for single core cables, the same shall consist of aluminium wires/strips. The outer sheath shall be extruded PVC of Type ST-2 of IS:5831 for all XLPE cables.

4. **PVC Power Cables**

4.1. The PVC (**70°C**) insulated power cables shall be of FR type, C1 category, conforming to IS: 1554 (Part-I) and its amendments read alongwith this specification

and shall be suitable for a steady conductor temperature of 70°C. The conductor shall be stranded aluminium. The Insulation shall be extruded PVC to type-A of IS: 5831. A distinct inner sheath shall be provided in all multicore cables. For multicore armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of IS: 5831 for all cables.

5. PVC Control Cables

5.1 The PVC (70°C) insulated control cables shall be of FR type C1 category conforming to IS: 1554 (Part-1) and its amendments, read alongwith this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IS: 5831. A distinct inner sheath shall be provided in all cables whether armoured or not. The over sheath shall be extruded PVC to type ST-1 of IS: 5831 and shall be grey in colour .

6. HV POWER CABLES [FOR WORKING VOLTAGES FROM 3.3 kV AND INCLUDING 33 kV]

6.1. HV POWER CABLE FOR AUXILIARY POWER SUPPLY

The HV cable of voltage class as specified for LT transformer shall be, XLPE insulated, armoured cable conforming to IS 7098 (Part-II) or IEC 60502-2 1998. Terminating accessories shall conform to IS 17573-1992 or IEC 61442-1997/IEC60502-4 1998.

6.2. Constructional Requirements

Cable shall have compacted circular Aluminium conductor, Conductor screened with extruded semi conducting compound , XLPE insulated, insulation screened with extruded semi conducting compound, armoured with non-magnetic material, followed by extruded PVC outer sheath(Type ST-2), with FR properties .

6.3 Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of the cable.

6.4 The cables shall have outer sheath of a material with an Oxygen Index of not less than 29 and a Temperature index of not less than 250°C.

7. TYPE TESTS

7.1 All cables shall conform to all type, routine and acceptance tests listed in the relevant IS.

THE SIZES OF POWER CABLES TO BE USED PER FEEDER IN DIFFERENT APPLICATION SHALL BE AS APPLICABLE, DESCRIBED HERE UNDER.

S.No.	From	To	Cable size	Cable type
1.	Main Board Switch	LT Transformer	2-1C X 630 mm ² per phase 1-1C X 630 mm ² for neutral	XLPE
2.	Main Board Switch	AC Distribution Board	2-3½C X 300 mm ²	XLPE
3.	Main Board Switch	Oil Filtration Unit	1-3½C X 300 mm ²	XLPE
4.	Main Board Switch	Colony Lighting	1-3½C X 300 mm ²	XLPE
5.	Main Board Switch	HVW pump LCP	1-3½C X 300 mm ²	XLPE
6.	Main Board Switch	Main Lighting distribution board	1-3½C X 300 mm ²	XLPE
7.	AC Distribution Board	D.G. Set AMF Panel	2-3½C X 300 mm ²	PVC
8	AC Distribution Board	Emergency Lighting distribution board	1-3½C X 70 mm ²	PVC
9	AC Distribution Board	ICT MB	1-3½C X 70 mm ²	PVC
10	AC Distribution Board	Bay MB	1-3½C X 70 mm ²	PVC
11	Bay MB	AC Kiosk	1- 3 ½ x 35 mm ²	PVC
12	AC Distribution Board	Battery Charger	1-3½C X 70 mm ²	PVC
13	DCDB	Battery	2-1C X 150 mm ²	PVC
14	DCDB	Battery Charger	2-1C X 150 mm ²	PVC
15	DCDB	Protection/PLCC panel	1-4C X 16 mm ²	PVC
16	Main Lighting DB	Lighting panels(Indoor)	1-3½C X 35 mm ²	PVC
17	Main Lighting DB	Lighting panels (outdoor)	1-3½C X 70 mm ²	PVC
18	Main Lighting DB	Receptacles (Indoor)	1-3½C X 35 mm ²	PVC
19	Main Lighting DB	Receptacles (Outdoor)	1-3½C X 70 mm ²	PVC
20	Lighting Panel	Sub lighting panels	1-4C X 16 mm ²	PVC

21	Lighting Panel	Street Lighting Poles	1-4C X 16 mm ²	PVC
22	Lighting Panel/ Sub lighting panels	Lighting Fixtures (Outdoor)	1-2C X 6 mm ²	PVC