



ODISHA POWER TRANSMISSION CORPORATION LIMITED
OFFICE OF THE SR. GENERAL MANAGER,
CENTRAL PROCUREMENT CELL,
JANAPATH, BHUBANESWAR – 751022.

TECHNICAL SPECIFICATION

250 KVA GENERATOR

SPECIFICATION OF 250 KVA DIESEL GENERATOR

SILENT TYPE WITH AMF ARRANGEMENT

1X 250KVA, 380 BHP, 200KW, SILENT AMF Diesel Generator set, 1500 RPM, Water cooled, 6-Cylinders, Diesel engine with AMF control panel, 250 KVA latest REPUTED AND BRANDED make Engine , Alternator and AMF Panel as required. (Optional accessories and specification also be enclosed)

Diesel engine Specifications and accessories:-

AVM with Acoustic enclosure type, Capacity-380 BHP, 6-Cylinders engine cooling system:

Water/coolant cooling, Radiator type

24V, self starting system with 2-Lead Acid batteries with automatic charging systems etc.

Diesel tank-As per manufacturer recommendation but for 350 ltr capacity minimum.

Safety Controls:

1. Low Lube oil pressure
2. High water temperature
3. Battery Charging indicator
4. Oil temperature indicators
5. Warning signals with hooters
6. Rpm indicator

Alternator

1X 250KVA capacity, 415v AC, 3phase,50Hz, 1500rpm

- a) Numerical type AVR etc.
- b) Control panel accessories for both DG sets
- c) Frequency meter
- d) Pilot lamps
- e) Current transformers
- f) Instrument fuses

g) Suitable rating ACB (2 Incomers + 1 bus coupler 800A, 4 Pole 50KA rating L&T/ Siemens make ACB)

h) Control cables and other accessories as per manufacturer

i) Electronic KWH meter of 0.2 class acc

J) ELCB etc.

Engine shall conform to BS. 649 or IS 10002: 1981, Alternator BS 2613: 1970 or IS 4722: 1968 etc **or its latest.**

Cables (a) Control cable as required

(b) Power cables-3.5 CoreX300 Sqmm three run for each Generator for a length of 200 mtr (Total 1200 mtrs) of **PVC armored Aluminium cable.**

1. DIESEL ENGINE:

An engine of reputed make, suitable for 1X 250KVA GENSET, inline type, turbo charged, water cooled, electric starting, 1500RPM, four stroke, Multicylinder diesel engine confirming to BS: 5514/ BS: 649/IS:10000, with 10% overloading for 01 hour in any 12hours of continuous operation in standard operating conditions in our country. The engine should be able to take 100% load with deration up to 50`C ambient temperature and up to 250m altitude.

2. COOLING SYSTEM:

- Heavy-duty radiator with fan
- Cooling water centrifugal pump
- Coolant Inhibitor

3. EXHAUST SYSTEM:

- Exhaust Gas Turbo Charger
- Exhaust manifolds
- Suitably designed critical grade Nelson silencer complete with thermal insulation and Aluminium cladding.
- Suitably designed exhaust pipe with flexible for carrying the exhaust gases out with minimize back pressure on engine.
- Suitably designed stack of height 05mtrs above the roof of Multistoreyed building (total 35m above ground level) so that the back pressure on engine is minimum. The exhaust stack may be supported with the building wall through clamps, rubber pads, so that vibration is not transmitted to the building.

- Suitably designed pipe for connecting silencer with stack, so that the back pressure on engine is minimum.
- The engine back pressure should not be more than 2.5inches of mercury at exhaust point.
- Port hole shall be provided as per the emission regulation part- III(CPCB publication).

4. FUEL SYSTEM:

- P.T. Fuel pump
- Fuel Injectors
- Fuel filters
- Fuel hoses

5. LUBE OIL SYSTEM:

- Lube oil pump
- Lube oil filters
- Super Bypass filters

6. INTAKE AIR SYSTEM:

- Air intake manifold
- Air cleaner with replaceable elements-inner/outer

7. GOVERNER

- Electronic Governor
- Electronic control panel with digital metering

8. STARTING SYSTEM:

- Electric starter – 24volts DC
- Battery Charging alternator

9. COUPLING ARRANGEMENT:

- Flywheel to suit single bearing alternator
- Flywheel housing (SAE housing)
- Inbuilt AM pads to reduce vibrations and eliminate misalignment of engine and alternator

10. SAFTY CONTROLS:

- High water temperaure
- Low lube oil pressure
- Over speed, Over Crank

11. ENGINE INSTRUMENT PANEL (ENGINE MOUNTED):

- Starting switch with OFF/START KEY
- Water temperature display
- Lube oil pressure display
- RPM display
- Tachometer with hour meter

12. MAUALS:

- Engine operation and maintenance manual
- Alternator manual with Parts catalogue
- Engine maintenance schedule
- Warranty card
- Engine routine certificate

13. ALTERNATOR:

- Synchronous brushless, single bearing alternator, rated at 250KVA, suitable for continuous operation at 1500rpm generating 415volts at 0.8 power factor (lag) suitable for 50Hz, 3 phase, 4 wire system. The alternator shall be self excited, self regulated, foot mounted fitted with ball and/or roller bearings. The alternator shall be suitable for tropical climate and shall conform to BS: 2613/ IS: 4722. The class of insulation shall be "H" type.

14. BASE FRAME:

Heavy duty base frame of study design made of M.S. steel with necessary reinforcement and pre-drilled holes, to support the DG set and enclosure.

15. VIBRATION INSULATION:

Specially designed poly bond anti-vibration mounts for vibration insulation should be used between engine/alternator and base frame.

16. FUEL TANK

Base fuel tank of sheet metal (14SWG), having a capacity of min. 350liters, duly fabricated and painted, complete with drain valve, air vent, level indicator, inlet and outlet connection, locking arrangement to avoid theft of oil, and housed in the base frame.

17. BATTERIES:

Two numbers batteries or as required for starting of 12 volts, 180 AH each in dry and uncharged condition of reputed make with ignition charging, connecting leads and terminals, provided inside the enclosure.

18. COUPLING AND MOUNTING ARRANGEMENT:

The engine and alternator shall be directly coupled and mounted through in build AVM pads on a heavy duty steel base frame. There shall be no chance of mis-alignment of the DG set and the vibrations of the DG set shall not get transmitted to the base-frame and to the enclosure.

19. AMF CONTROL PANEL:

The control panel body shall be fabricated out of 16SWG MS sheet. Panel shall be floor mounted indoor installed, dust and vermin proof. Control wiring shall be 2.5sq.mm shall be used. Cables shall be ferruled for proper maintenance/ checking/ wiring of panel. Detachable cable gland plates are to be provided. This shall be of indoor type.

The panel shall be equipped as follows:

Power Circuit:

- One contractor for mains
- One contractor for DG set interlocked with the mains contractor.

Metering:

- One voltmeter with selector switch
- One ammeter with selector switch
- One frequency meter
- Fuel level gauge

Set of push buttons, selector switches and indicating lamps

- Continuous sensing of mains and generator voltage
- Auto start and changeover in case of mains failure
- Auto stop and changeover in case of mains resumption
- Three attempt starting
- Over current relay for protection against overloading of DG set

Audio- Video annunciation with engine shutdown for

- Low lube oil pressure
- High cooling water temperature
- High canopy temperature
- Over current trip

Battery charger consisting of

- Transformer of suitable rating

- Rectifier rate selector switch for “ Trickle” or “ Boost”
- DC ammeter and DC voltmeter
- An indicating lamp for battery being charged

20. The DG set should comply with the noise limit of 75db(A) at 01m from the enclosure surface and other requirements given in and as per the document “ System & Procedure for Compliance with Noise Limits for Diesel Generator Sets(upto 1000KVA)” issued by CPCB.

21. The diesel engine shall comply with the emission limits given in G.S.R. 371, dated 17.5.02 and G.S.R. 520, dt. 01.7.03 (irrespective of the date of implementation given in the notification) and certified as per emission norms of DOI already notified and or any latest emission note declared by the concerned authority.

22. ACOUSTIC ENCLOSURE:

- Acoustic enclosure should be integral part of the Gen set.
- The acoustic enclosure should be modular construction with the provision to assemble and dismantle easily as per site condition.
- There should be no protruding parts.
- The enclosure should be fabricated out of CRCA sheet of 14SWG.
- The sheet metal components should be dip seven tank pretreated.
- To have long life of the enclosure it should be P.P. based powder coated (inside as well outside). All nut and bolt hardware's be Zinc coated or Stainless Steel.
- Fuel tank at the base of the DG set should have minimum capacity of 350litres. It should be provided with breather, drain plug, fuel gauge meters to indicate fuel level and locking arrangement to avoid theft of oil.
- There should be provision for filling the fuel from outside as in the case of automobiles with locking arrangement.
- Battery should be accommodated in a separate tray in the enclosure.
- There should be provision for drain plugs for draining Mobil oil/ diesel from outside the enclosure.
- The doors to be provided with high quality EPDM gaskets to avoid leakage of sound.
- The lockable type door handles should be provided.
- Sound proofing of enclosure to be done with high quality rock wool conforming to IS 8183, of minimum 100mm thickness and density of 48-64 kg/m³.

- The rock wool should further be covered with fiber glass cloth and perforated galvanized MS sheet.
- A special critical grade silencer is required to be provided to control exhaust noise. (minimum 25dBA insertion loss)
- Specially designed anti is required to be provided to meet air requirement for combustion and heat removal. A blower should be used to meet total air requirement, air changes, if required.
- Temperature inside enclosure should not exceed beyond 7' C of ambient temperature.
- A provision for emergency shutdown from outside the container should be made.
- Control panel should carry warranty of respective manufacturer for diesel generating set in enclosure.
- The acoustic enclosure shall be rain/ water proof.

23. FUEL CONSUMPTION:

- Engine should be capable of providing fuel consumption of 4 units/lit of diesel, between 80 to 100% load as per BS 5514.

23. INSTALLATION:

- (i) The base of the Genset shall be minimum 30cm from the ground level so that the oil/fuel can be drained out easily.
- (ii) The ground up to 01m around the Genset shall be made of cement concrete platform of mix 1:2:4(1 cement, 2 Coarse Sand, 4 Stone Chips 20mm).

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- b) Control panel accessories
- c) Frequency meter
- d) Pilot lamps
- e) Current transformers
- f) Instrument fuses
- g) Suitable rating ACB (800A, 50KA rating L&T/ Siemens make with 4 Poles ACB each)
- h) Control cables and other accessories as per manufacturer
- i) Electronic KWH meter
- J) ELCB etc. Engine shall confirm to BS. 649 or IS 10002: 1981, Alternator BS 2613: 1970 or IS 4722: 1968 etc.

SCHEDULE OF WORK AND SUPPLY

250 KVA DG set - 1 No.

SL. NO.	DESCRIPTION	QTY.
1.0	Supply of 250 KVA DG set with acoustic enclosure as per enclosed technical specification.	1 Set
2.0	AMF Control Panel with Numerical relay with Bus coupler Panel	1Ste
3.0	Transportation of unloading and placement of DG set to site.	1 Job
4.0	Preparation of concrete slab with load bearing capacity sufficient to take dead load of DG set	1 Job
5.0	Earthing system 600x 600mm G.I. plate, G.I strip 50mm x 6mm, 50mm dia. G.I. pipe including fittings, Charcoal and salt, Hodi cover	12 nos.
6.0	G.I. Strip: 50mm X6mm	As per site
7.0	Cabling system 3.5 core Al. armoured cable 300 sq. mm	As per site

8.0	End termination of 3.5 Core Al. Armoured cable 300 sqmm with double compression Gland and thimbles	As per site
9.0	Control Cable 2.5sq.mm 12 core	As per site
10.0	Connection with Main/Emergency Distribution Panels along with modifications in the Main/ Emergency Panel at substation of CPCB.	As per site
11.0	Exhaust system: Provision of M.S.pipe of suitable diameter (class B pipe) to height 5mtr above rooftop of DG room (total 5mtr from the ground level). The size of the pipe should be such that there is no back pressure beyond allowable limits. Suitable M.S. flange, nuts & bolts with support brackets & structure, Al. Cladding on thermal insulation to be provided.	As per site As per site
12.0	Fuel system: Min. 350 litre fuel tank at the base of DG set by 19mm M.S. pipe (C Class) with fuel fitting NRV etc. with effective locking arrangement.	
13.0	Sami Rotary Diesel Pump	One
14.0	Clearance from Various department	One Job
15.0	Testing & Commissioning	One Job

Guaranteed Technical Particulars

(To be furnished by the bidders)

(A)	Alternator		
1.	Name of manufacturer	:	
2.	Brand Name	:	
3.	Factory Address	:	
4.	Reference Standard	:	
5.	Frequency	:	
6.	Rated Voltage	:	
7.	No. of phases	:	
8.	Rated speed	:	
a)	No load	:	
b)	Rated load	:	
9.	Phase sequence (Viewed from driving end)	:	
10.	Power factor	:	
11.	Rated output (KW/KVA)	:	
12.	Rated Current	:	
13.	Direction of rotation		

14.	Excitation system		
15.	Duty type		
16	Class of Insulation	:	
17.	Temperature rise	:	
18.	Efficiency at rated voltage and frequency and 0.8 pf	:	
a)	In full load	:	
b)	1/3 load	:	
c)	$\frac{3}{4}$ load	:	
19	Short circuit rating (Peak)	:	
20	Over speed limit	:	
21	Limits of vibration	:	
22	Type of enclosure	:	
23	Cooling system	:	
24	Variation in	:	
a)	Voltage	:	
b)	Frequency	:	
25	Fly wheel effect of rotating parts	:	
26	Cyclic irregularity	:	
27	Irregularity of wave from %	:	
28	Overload withstand capacity	:	
a)	Momentary	:	
b)	Intermittent	:	
C)	Sustained	:	
29.	Motor starting ability (Current / duration)	:	
	<u>PRIME MOVER</u>	:	
1.	Name of the engine manufacturer	:	
2.	Type of engine	:	
3.	Model and number of cylinders	:	
4.	IS rating	:	
a)	Rating A (With overload)	:	
b)	Rating B (Without overload)	:	
5.	Rating at site condition	:	
6.	Direction of rotation	:	
7.	No. & arrangement of cylinders	:	
8.	Whether two stroke or four stroke	:	
9.	Bore (mm)	:	
10.	Stroke(mm)	:	
11.	Cubic capacity(Litres)	:	

12.	Nominal Compression Ration	:	
13.	BMEP Developed	:	
14.	Mean piston speed	:	
15.	Muffler (silencer) type	:	
16.	Filter type and make	:	
a)	Air	:	
b)	Fuel	:	
c)	Lubricating Oil	:	
17.	Recommended fuel oil specification	:	
18.	Fuel oil tank capacity	:	
19.	Lubricating oil specification	:	
20.	Mode of starting, apparatus required	:	
21.	Specific fuel consumption in Litres per hour under standard reference conditions as per IS. 10000 part- II.	:	
a)	At rated output	:	
b)	At 110% of rated load	:	
c)	At 75% of rated load	:	
d)	At 50% of rated load	:	
e)	At 25% of rated load	:	
22.	Lubricating oil consumption at 100% load in litre/ engine operating hour.	:	
23.	Weight of engine	:	
24.	Overall dimension of engine	:	
25.	Performance curves as per IS-10000(part-VI) 1980 at Standard reference condition.	:	
26.	Accessories on engine as tested and for which a power allowance has been made in the manufacturers calculation of the site rating.	:	
27.	Voltage of electrical system	:	
28.	List of equipment and tools that will normally be supplied	:	
29.	List of supplementary equipment	:	
30.	Schedule of recommended maintenance and overhaul periods.	:	
31.	Maximum permissible back pressure in the exhaust system and maximum permissible intake depression.	:	
32.	Method of cooling and capacity of the cooling system with specific rates of water and oil circulation.	:	
33.	The maximum load that can be suddenly applied to the engine while it is running it is at full rated speed, at no load and at normal running temperatures.	:	
34.	The transient and permanent speed changes	:	

	that will result from the application of this load.		
35.	The transient and permanent speed rise resulting from full load being thrown off.	:	
36.	The transient and permanent speed change of load, both off and on, by all steps of 25 percent of the rated full load.	:	
37.	The steady state speed band recovery time to this speed band from all the conditions stated above.	:	
38.	Aspiration	:	
	<u>ACOUSTIC ENCLOSURE</u>	⋮	
1.	Name of Acoustic Enclosure manufacturer	:	
2.	Enclosure material	:	
3.	Insulation materials	:	
4.	Type of shutters	:	
5.	Overall dimension LXBXH	:	
6.	Noise level to be achieved	:	
7.	Maximum rise in inside temperature above ambient at full load	:	
8.	Provision of illumination inside the enclosure	:	
9.	Handling / Lifting facilities	:	

Engine : Cummins / Kirloskar/ Greaves / Caterpillar / Valvo make
 Alternator: Stamford / KEC / Crompton / Valvo make
 L.T Switchgear- L&T / Siemens/ M.G make
 Cable- **as per OPTCL vendor**,
 Relays to be of numerical type



**ODISHA POWER TRANSMISSION CORPORATION
LIMITED**

TECHNICAL SPECIFICATION

FOR

FIRE PROTECTION SYSTEM

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

TECHNICAL SPECIFICATION FOR

FIRE PROTECTION SYSTEM

1.00.00 INTENT OF SPECIFICATION

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

- a. Hydrant System
 - b. High Velocity Water (H.V.W) Spray System
 - c. Fire Detection and alarm System
 - d. Portable Fire Extinguishers
 - e. Wheel/ Trolley mounted Fire Extinguishers
- 1.00.01 It is not the intent to completely specify all details of design and construction. Nevertheless, the system design and equipment shall conform in all respects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Owner. The system design shall also conform to TAC/ NFPA norms.
- 1.00.02 The scope of work include complete earthwork (i.e. excavation, backfilling etc.) for the entire buried piping for the system, valve pits and pipe supports for buried, entrenched and over ground piping.
- 1.00.03 The equipment offered shall comply with the relevant Indian Standards. The equipment conforming to any other approved international standards shall meet the requirement called for in the latest revision of relevant Indian Standard or shall be superior. The Deluge valves, HVW spray nozzles & quartzoid bulb detectors shall have the approval of any of the following agencies;
- a. UL of USA.
 - b. F M of USA
 - c. LPCB of UK or
 - d. VDS of Germany,

- 1.00.04 Ambient temperature for design of all equipment shall be considered as 50°C.
- 1.00.05 The piping and instruments diagram for Hydrant and HVW spray system for 400kV substations is enclosed. The successful bidder shall prepare detailed layout and piping drawing based on this drawing and other drawings such as road, drainage, cable trench, switch yard layout, etc. as furnished by the Employer during detailed engineering. The typical drawings for location of fire detectors and fire extinguishers in control cum administrative building is also enclosed and shall be followed for execution.
- 1.00.06 Equipment under the fire protection system should be supplied from the suppliers approved by OPTCL (A list of approved vendors is enclosed at Appendix-V). All equipment shall conform to the data sheets attached in **APPENDIX-I** and/or relevant subsections/clauses of this specification. In case of contradiction between data specification sheets and relevant subsections/clauses, then stipulations of the data sheets will prevail.

2.00.00 DESIGN AND CONSTRUCTION

2.01.00 Hydrant System

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

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

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

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

H.V.W. spray type fire protection essentially consists of a network of projectors and an array of heat detectors around the Transformer/Reactor to be protected. On operation of one or more of heat detectors, Water under pressure is directed to the projector network through a Deluge valve from the pipe network laid for this system. This shall be provided for transformers and reactors in 765kV and 400kV substations. Wet detection initiation system shall be employed for automatic operation. The system shall be designed in such a way that the same can be extended to protect additional Transformer/ Reactor to be installed in future. However, for the purpose of design it shall be assumed that only one Transformer/ Reactor will be on fire. The main header pipe size in the yard shall be 250mmNB and the branch to the equipment (shall not be more than 20metres length) shall be of the same size as of deluge valve.

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

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

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

2.02.03 **Deluge Valve**

Deluge Valve shall be water pressure operated manual reset type. The Deluge valve shall be closed water tight when water pressure in the heat detector pipe work is healthy and the entire pipe work shall be charged with water under pressure upto the inlet of the Deluge valve. On fall of water pressure due to opening of one or more heat detectors, the valve shall open and water shall rush to the spray water network through the open Deluge valve. The valves shall be manually reset to initial position after completion of operation. Each Deluge Valve shall be provided with a water motor gong which shall sound an alarm when water after passing through the Deluge valve, is tapped through the water motor. Each Deluge valve shall be provided with a local panel with provision of opening of Deluge valve from local and remote from control room/ remote centre. In addition to this, each valve shall be provided with local operation latch. Deluge valves of 100mmNB size shall be used if the flow requirement is $\leq 200\text{m}^3/\text{hr}$ and 150mmNB size shall be used for flow requirement $>200\text{m}^3/\text{hr}$. 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. Annunciations of the hydrant & HVW spray systems shall be provided in fire water pump house and repeated in 400 kV control room. The outdoor piping for the system in general shall be laid above ground on concrete pedestals with proper supporting arrangement. However, at road/rail crossings, in front/access of buildings, places where movement of cranes/vehicles is expected and at any other place where above ground piping is not advisable, the pipes shall be laid underground. Such locations shall be finalised during detailed engineering. The whole system will be kept pressurised by providing combination of air vessel and jockey pump of 10.8M³/hr. capacity at 80MWC. The capacity of air vessel shall not be less than 3m³. Minor leakage will be met by Jockey pump. One additional jockey pump shall be provided as standby. All pumps shall be of horizontal centrifugal type. Pumps and air vessel with all auxiliary equipment will be located in firewater pump house. A pressure relief valve of suitable rating shall be provided in water header to release excess pressure due to atmospheric temperature variations. Operation of all the pumps shall be automatic and pumps shall be brought into operation at preset pressure. Fire pumps shall only be stopped manually. Manual start/stop provision shall be provided in local control panel.

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

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

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

2.06.00 Instrumentation and Control System

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

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

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

- | | | |
|----|---|-------|
| 1. | TPN switch | 1 No. |
| 2. | Auto/manual switch | 1 No. |
| 3. | Start/Stop Push buttons
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 | 1 No. |

- selecting either jockey pump
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 employer's event logger. Remote operation facility to open the Deluge valve from control room/ remote centre shall also be provided.

2.06.03 Annunciation Panels

a) Location: Fire Water Pump House

- i) Indicating lamps showing power supply "ON".
- ii) Annunciation windows complete with buttons. Details are as follows:

<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 - Projects'.

5.00.00 **HORIZONTAL CENTRIFUGAL PUMPS**

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

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

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

5.02.00 General Performance Requirements

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

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

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

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

5.02.05 **Drive Rating**

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

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

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

5.03.00 Design & Construction

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

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

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

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

5.03.05 **Impeller**

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

5.03.06 **Wearing Rings**

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

5.03.07 **Shaft**

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

5.03.08 Shaft Sleeves

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

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

5.03.10 Bearings

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

5.03.11 Stuffing Boxes

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

5.03.12 Shaft Couplings

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

5.03.13 Base Plates & Sole Plate

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

5.03.14 Material of Construction

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

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

5.03.15 **Balancing**

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

5.03.16 specification shall be interchangeable.

5.04.00 Tests and Inspection

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

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

5.04.03 **Material of Construction**

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

- 5.04.04 Where stage inspection is to be witnessed by Employer, all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication, by Employer's Inspector who shall stamp the material. In case mill test certificates for the material are not available, the Contractor shall carry out physical and chemical tests at his own cost from a testing agency approved by the Employer, as per the requirements of specified material standard. The samples for physical and chemical tests shall be drawn up in presence of Employer's inspector who shall also witness the tests.
- 5.04.05 Shaft shall be subjected to 100% ultrasonic test and machined portion of the impeller shall be subject to 100% DP test. On finished shaft DP test will also be carried out.
- 5.04.06 **Hydraulic test at shop**
All pressure parts shall be subjected to hydraulic testing at a pressure of 150% of maximum pressure generated by the pump at rated speed or 200% of total dynamic head whichever is higher, for a period not less than one (1) hour.
- 5.04.07 **Performance test at shop**
Pumps shall be subjected to routine tests to determine the performance of the pumps. These tests shall be conducted in presence of Employer/Engineer's representative as per the requirements of the Hydraulic Institute Standards/ASME Power Test Code PTC 8.2/BS-599/I.S.S., latest edition. Routine tests shall be done on all the pumps.
- 5.04.08 Performance tests shall be conducted to cover the entire range of operation of the pumps. These shall be carried out to span 150% of rated capacity upto pump shut-off condition. A minimum of five combinations of head and capacity are to be achieved during testing to establish the performance curves, including the design capacity point and the two extremities of the Range of operation specified.
- 5.04.09 Tests shall preferably be conducted alongwith the actual drives being supplied.
- 5.04.10 The Bidders shall submit in his proposal the facilities available at his works to conduct performance testing. If because of limitations of available facilities, a reduced speed test or model test has to be resorted to establish pump performance, the same has to be highlighted in the offer.

- 5.04.11 In case of model testing, the stipulations of latest edition of Hydraulic Institute Standards shall be binding. Prototype or model tests, however, shall be conducted with the suction condition identical to the field conditions i.e. sigma values of prototype and model is to be kept same.
- 5.04.12 Prior to conducting model testing, calculations establishing model parameters, sizes and test procedure will be submitted to Employer/Engineer for approval.
- 5.04.13 All rotating components of the pumps shall be subjected to static and dynamic balancing tests.
- 5.04.14 The Employer or his authorised representative shall have full access to all tests. Prior to performance tests, the Contractor shall intimate the Employer allowing adequate time so that if the Employer so desires, his representative can witness the test.
- 5.04.15 Report and test certificates of the above tests shall be submitted to the Employer/Engineer for approval.

5.04.16 **Pre commissioning tests.**

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

6.00.00 **DIESEL ENGINES**

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

6.01.00 Design and Construction General

- 6.01.01 The diesel engine shall be of multicylinder type four-stroke cycle with mechanical (airless) injection, cold starting type.
- 6.01.02 The continuous engine brake horse power rating (after accounting for all auxiliary power consumption) at the site conditions shall be atleast 20% greater than the requirement at the duty point of pump at rated RPM and in no case,

less than the maximum power requirement at any condition of operation of pump.

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

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

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

6.01.06 **Starting**

The engine shall be capable of both automatic and manual start. The normal mode of starting is automatic but in the event of failure of automatic start or at the discretion of the operator, the engine can be started manually from the LCP. Since the fire pumping unit driven by the diesel engine is not required to run continuously for long periods and the operation will not be frequent, special features shall be built into the engine to allow it to start within a very short period against full load even if it has remained idle for a considerable period.

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

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

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

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

6.01.11 Governing System:

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

6.01.12 The governor shall offer following features:

- a) Engine should be provided with an adjustable governor capable of regulating engine speed within 5% of its rated speed under any condition of load between shut-off and maximum load conditions of the pumps. The governor shall be set to maintain rated pump speed at maximum pump load.
- b) Engine shall be provided with an over speed shut- down device. It shall be arranged to shut-down the engine at a speed approximately 20% above rated engine speed and for manual reset, such that the automatic engine controller will continue to show an over speed signal until the device is manually reset to normal operating position (Vol.II, NFPA, 1978).

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

6.01.14 Fuel System

The diesel engine will run on High Speed Diesel.

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

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

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

6.01.18 Pipeline carrying fuel oil shall be gradually sloped from the tank to the injection pump. Any valve in the fuel feed pipe between the fuel tank and the engine shall be placed adjacent to the tank and it shall be locked in the open position. A filter

shall be incorporated in this pipeline, in addition to other filters in the fuel oil system. Pipe joints shall not be soldered and plastic tubing shall not be used. Reinforced flexible pipes may also be used.

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

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

6.01.21 Lubricating Oil System

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

6.01.22 Cooling Water System

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

6.02.00 Testing & Inspection

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

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

6.02.03 Material analysis and testing.

6.02.04 Hydrostatic pressure testing of all pressure parts.

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

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

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

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

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

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

6.02.11 Power run test.

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

6.02.13 Measurement of vibration & noise.

(i) Measurement of vibration

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

(ii) Measurement of noise level

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

6.02.14 Adjustment of speed governor as per BS:5514.

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

7.00.00 PIPING, VALVES AND SPECIALITIES

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

7.02.00 **Scope**

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

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

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

7.02.03 Instrument tapping connections, stubs etc.

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

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

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

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

7.03.00 **Design**

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

(a) **Buried Pipes**

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

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

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

(c) Overground pipes normally empty, but periodic charge of water and for detector line for HVW System. Mild steel galvanised pipes as per IS:1239, Part-I

medium grade (for pipes of sizes 150 NB and below) or IS:3589, Fe 410 grade (for pipes of sizes 200 NB and above).

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

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

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

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

7.03.09 Gate/slucice 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/cm² 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 require for this test would be supplied by the Contractor without any extra cost to Employer.

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

10.03.00 **Painting**

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

11.00.00 **INSTRUMENTS**

11.00.01 **Intent of Specification**

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

11.00.02 All field mounted instruments shall be weather and dust tight, suitable for use under ambient conditions prevalent in the subject plant. All field mounted

instruments shall be mounted in suitable locations where maximum accessibility for maintenance can be achieved.

11.01.00 **Local Instruments**

Pressure/ Differential Gauges & Switches.

- 11.01.01 The pressure sensing elements shall be continuous 'C' bourdon type.
- 11.01.02 The sensing elements for all gauges/switches shall be properly aged and factory tested to remove all residual stresses. They shall be able to withstand at least twice the full scale pressure/vacuum without any damage or permanent deformation.
- 11.01.03 For all instruments, connection between the pressure sensing element and socket shall be braced or hard soldered.
- 11.01.04 Gauges shall be of 150 mm diameter dial with die-cast aluminium, stoved enamel black finish case, aluminium screwed ring and clear plastic crystal cover glass. Upper range pointer limit stop for all gauges shall be provided.
- 11.01.05 All gauges shall be with stainless steel bourdon having rotary geared stainless steel movements.
- 11.01.06 Weatherproof type construction shall be provided for all gauges. This type of construction shall be fully dust tight, drip tight, weather resistant and splash proof with anti-corrosive painting conforming to **NEMA- 4**.
- 11.01.07 All gauges shall have micrometer type zero adjuster.
- 11.01.08 Neoprene safety diaphragm shall be provided on the back of the instruments casing for pressure gauges of ranges 0-10 Kg/cm² and above.
- 11.01.09 Scales shall be concentric, white with black lettering and shall be in metric units.
- 11.01.10 Accuracy shall be + 1.0 percent of full range or better.
- 11.01.11 Scale range shall be selected so that normal process pressure is approximately 75 percent of full scale reading. For pressure gauges and pressure switches, the range shall not be less than 0 -16 Kg/cm²
- 11.01.12 All gauges shall have 1/2 inch NPT bottom connection.

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

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

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

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

11.01.18 Necessary accessories shall be furnished.

11.02.00 Timers

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

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

11.03.00 Level Gauges/Indicator/Switches

11.03.01 **Level Gauges**

- i) Gauge glasses shall be used for local level indication wherever shown in the flow diagram.
- ii) Gauge glasses, in general, shall be flag glass type with bolted cover. Body and cover material shall be of carbon steel with rubber lining.
- iii) Level coverage shall be in accordance with operating requirements. Maximum length of a single gauge glass shall not exceed 1.4 M. Should a larger gauge glass be required, multiple gauges of preferably equal length shall be used with 50 mm overlap in visibility.
- iv) Reflex type gauge glasses shall be used for colourless liquids and transparent type gauge glasses shall be used for all liquids having colour.

- v) Each gauge glass shall be complete with a pair of offset valves. Valves shall have union bonnet, female union level connection, flanged tank connection, and vent and drain plug.
- vi) Offset valves shall have corrosion resistant ball-check to prevent fluid loss in the event of gauge glass breakage. Valve body shall have a working pressure of 200 percent of the maximum static pressure at the maximum process fluid temperature. Valve body materials shall be of carbon steel with rubber lining.

11.03.02 Level Indicators

- i) Float type mechanical level gauges with linear scale type indicator shall be offered for measuring level of tanks wherever shown in the flow diagram.
- ii) AISI-316 stainless steel float, guide rope and tape shall be used. Housing shall be of mild steel painted with anti-corrosive painting.
- iii) The scale indicator shall be provided at a suitable height for ease of reading.
- iv) Accuracy shall be + 1% of scale range or better.

11.03.03 Level Switches

- i) Level switches shall be of ball float operated magnetic type complete with cage.
- ii) Materials of construction shall be suitable for process and ambient conditions. The float material shall be AISI-316 stainless steel.
- iii) Actuating switches shall be either hermetically sealed mercury type or snap acting micro-switches. Actuation set point shall be adjustable. ON-OFF differential (difference between switch actuation and de-actuation levels) shall be adjustable. Adjustable range shall be suitable for switch application. All switches shall be repeatable within + 1.0 percent of liquid level change required to activate switch. Contacts shall be rated for 50 watts resistive at 240 V A.C. Number of contacts shall be two NO and two NC for each level switch.

11.04.00 Solenoid Valves

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

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

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

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

11.05.00 Switches, Lamps, Meters Etc.

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

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

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

12.00.00 ELECTRIC MOTORS

12.01.00 General

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

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

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

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

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

12.01.06 Notwithstanding anything stated in this motor specification, the motor has to satisfy the requirement of the mechanical system during normal and abnormal conditions. For this the motor manufacturer has to co-ordinate with the

mechanical equipment supplier and shall ensure that the motor being offered meets the requirements.

12.02.00 **Codes & Standards**

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

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

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

12.03.00 **Design Features**

12.03.01 **Rating and type**

- (i) The induction motors shall be of squirrel cage type unless specified otherwise.
- (ii) The motors shall be suitable for continuous duty in the specified ambient temperature.
- (iii) The MCR KW rating of the motors for 50oC ambient shall not be less than the power requirement imposed at the motor shaft by the driven equipment under the most onerous operation conditions as defined elsewhere, when the supply frequency is 51.5 Hz (and the motor is running at 103% of its rated speed).
- (iv) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously in the system having the following particulars :
 - a) Rated terminal voltage
From 0.2 to 200, KW 415V (3 Phase, solidly earthed)
Below 0.2 KW ,240 V (1 Phase, solidly earthed)
Variation in voltage + 6%.
 - b) Frequency 50 Hz + 3%.
 - c) Any combination of (a) & (b)

12.03.02 **Enclosure**

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

12.03.03 Cooling method

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

12.03.04 Starting requirements

(i) Induction motor

- a) All induction motors shall be suitable for full voltage direct on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.
- b) Motors shall be capable of withstanding the electro-dynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.
- c) The starting current of the motor at rated voltage shall not exceed six (6) times the rated full load current subject to tolerance as given in IS : 325.

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

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

12.03.05 Running requirements

- (i) When the motors are operating at extreme condition of voltage and frequency given under clause no.12.03.01 (iv) the maximum permissible temperature rise

over the ambient temperature of 50oC shall be within the limits specified in IS : 325 after adjustment due to increase ambient temperature specified herein.

- (ii) The double amplitude of motor vibration shall be within the limits specified in IS: 4729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.
- (iii) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.
- (iv) Induction motors shall be so designed as to be capable of withstanding the voltage and torque stresses developed due to the difference between the motor residual voltage and incoming supply voltage during fast changeover of buses. The necessary feature incorporated in the design to comply with this requirement shall be clearly indicated in the proposal.
- (v) Motors shall be capable of developing the rated full load torque even when the supply voltage drops to 70% of rated voltage. Such operation is envisaged for a period of one second. The pull out torque of the induction motors to meet this requirement shall not be less than 205% of full load torque.
- (vi) The motors shall be capable of withstanding for 10 seconds without stalling or abrupt change in speed (under gradual increase of torque) an excess torque of 60 percent of their rated torque, the voltage and frequency being maintained at their rated value.
- (vii) Guaranteed performance of the motors shall be met with tolerances specified in respective standards.

12.04.00 **Construction Features**

12.04.01 **Stator**

(i) **Stator frame**

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

(ii) **Stator core**

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

(iii) Insulation and winding

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

12.04.02 Rotor

- (i) Rotors shall be so designed as to keep the combined critical speed with the driven equipment away from the running speed by atleast 20%.
- (ii) Rotors shall also be designed to withstand 120% of the rated speed for 2 minutes in either direction of rotation.

12.04.03 Terminal box leads

- (i) For motors of 415 Volts and below a single terminal box may be provided for power and accessories leads.
- (ii) Terminal boxes shall be of weatherproof construction designed for outdoor service. To eliminate entry of dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame.
- (iii) Terminal box shall be suitable for top and bottom entry of cables.
- (iv) Unless otherwise approved, the terminal box shall be capable of being turned through 360o in steps in 90o.
- (v) The terminals shall be complete with all accessories for connecting external cables. They shall be designed for the current carrying capacity and shall ensure ample phase to phase to ground clearances.
- (vi) Suitable tinned brass compression type cable glands and cable lugs shall be supplied by the Contractor to match Employer's cable.
- (vii) Terminal box for single core cable shall be of non- magnetic material.
- (viii) Marking of all terminals shall be in accordance with IS : 4728.

12.04.04 Rating Plates

- (i) Rating plates shall be provided for all motors giving the details as called for in IS:325 (for three phase squirrel cage induction motors).
- (ii) In addition to above, the rating plate shall indicate the following :
 - a) Temperature rise in °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 50°C 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

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

(G) DATA SHEET FOR MANUAL CALL POINT

1.0	Manufacturer	OPTCL Approved make
2.0	Construction	Deep drawn sheet steel
3.0	Type	Break glass with push button.
4.0	Operating Voltage	24V DC \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/cm²

9.1 Body 16 kg/cm²

9.2 Seat

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

1.0 Nominal size in mm. 15 to 40 50 to 300

2.0 Make OPTCL Approved make

3.0	Type	Gate/Sluice	
4.0	Number	As per approved system drawings.	
5.0	Material of construction		
5.1	Body	Bronze to IS 318 Grade LTB 2	Grey cast iron, grade FG200 of IS 210.
5.2	Hand wheel	Grey cast iron, grade FG200 of IS 210.	
5.3	Bonnet & Wedge	Bronze to IS 318 Gr.LTB 2	Grey cast iron, grade FG200 of IS 210.
5.4	Stem	High tensile brass, grade HT1 or HT2 of IS:320	Stainless steel
6.0	End connection	Screwed	Flanged
7.0	Standard	IS:778	IS:14846
8.0	Rating	PN 1.6	
9.0	Hydrostatic test pressure	24 kg/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 / cm ²
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/cm ²
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 TRANSMISSION CORPORATION LIMITED



TECHNICAL SPECIFICATION

FOR

33/132/220 KV H.T. XLPE POWER CABLE

(A) TECHNICAL SPECIFICATION FOR 33 kV CROSS LINKED ETHYLENE INSULATED PVC SHEATHED SINGLE CORE, (DIFFERENT CROSS SECTION AREA) COPPER POWER CABLE.

1. SCOPE

This specification covers the design, manufacture, testing, inspection at manufacturer's work, supply & delivery F.O.R. destination of **(DIFFERENT CROSS SECTION AREA)** Single Core XLPE insulated PVC sheathed Cable and single core XLPE cable suitable for solidly grounded system size as per clause(5) mentioned below.

2. PARTICULARS OF THE SYSTEM

The cable should be suitable for use on 50 Cycles, 3 Phases solidly earth neutral system & working voltage of 33kV.

3. STANDARDS

The cable covered under this Specification shall conform in all respects with the latest editions of IS-7098 (Part-2) **2011** & IS-8130-**2013** & IEC: 60502 of the latest version thereof.

4. TECHNICAL PARTICULARS

33kV, Single Core underground XLPE insulated PVC sheathed cable suitable for working potential of 33kV on earthed system manufactured in accordance with IS-7098 (Part-2) **2011** with latest amendments or latest editions thereof. The electrolytic grade copper conductor with formation of segmental type as per IEC-60228, tapped with semi conducting conductor shall comply with requirements specified in IS:8130-**2013**. The insulation shall be chemically cross-linked polyethylene confirming to the physical, electrical and ageing property as required in latest edition of IS-7098 (Part-2) **2011**. Cable shall be provided with both conductor screening and insulation screening. The conductor screening shall be non-metallic and shall be consisting of either a layer of semi-conducting compound or combination of two. The insulation screening shall consist of non-metallic extruded semi conducting compound layer in combination with non-magnetic metallic shield. Armouring shall be arranged over the core and it shall be of non-magnetic material. The material for the Armouring shall be as per relevant ISS. Over the Armouring the cable shall be provided with extruded PVC outer sheath. The composition of PVC compound shall be type ST-2 of IS- 5831-1984 & the colour of outer sheath shall be black or grey. **A conductive layer of graphite shall be provided on outer sheath to facilitate sheath integrity test if required**

5. TESTS

5.1 Type Tests

The equipment offered should be type tested. Type test report should not be more than seven years old, reckoned from the date of bid opening, in respect of the following tests, carried out in accordance with ISS-7098/IEC-871/IEC- 60502, from Govt./Govt. approved test house, shall be submitted along with bid:

- i) Physical tests for insulation and outer sheath. ii) Bending test.
- iii) Di-electrical power factor test.
- iv) Heating cycle test followed by di-electrical power factor as a function of voltage and partial discharge test.
- v) Impulse withstand test.

The remaining type test report as per clause 3 of ISS-7098/IEC-871/IEC-60502 shall be submitted by the successful bidder within three months from the date of placement of order. These type test reports shall be from Govt./Govt. approved test house and shall not be more than seven years old, reckoned from the date of placement of order. The failure to do so will be considered as a breach of contract.

5.2 ROUTINE TESTS AND ACCEPTANCE TESTS

All routine and acceptance tests shall be carried as per relevant ISS in the presence of Nigam's representative.

Following additional tests shall be carried out

1. Convolution and protrusion (as per Annexure A)
2. Sheath integrity test

6. INSPECTION

The material shall be inspected and tested before dispatch by an authorized representative of OPTCL in respect of quality.

7. TEST CERTIFICATES

The supplier shall supply test certificates from a Govt. agency in respect of quality as per IS:7098(part-II) 2011 with latest amendments thereof for approval of the purchaser.

8. PACKING

The cable shall be supplied in non-returnable wooden drum as per IS: 10418:1982 so constructed, as to enable the cable to be transported on each drum. The cable wound on such drum shall be one continuous length. The ends of cables shall be sealed by means of non-hygroscopic sealing material.

9. MARKING

The marking on the drum shall have the following information: -

- a) Reference to Indian Standard & cable code.
- b) Name of the manufacturer & trade name.
- c) Nominal cross section area of conductor for the cables.
- d) Number of core.
- e) Sequential No. at each meter.
- f) Type of the cable & voltage for which it is suitable.
- g) Length of cable on the drum.
- h) Approximate gross weight.
- i) Net weight of the cable.
- j) Drum identification number.
- k) P.O. No. and date.
- l) Consignee's name with designation.
- m) Year of manufacture.

Note: Cable should be marked with ISI Certification mark.

10. DRAWINGS & INSTRUCTION MANUAL

The tenderer shall supply the following drawings with the tender: -

- i) Detailed drawing of the cable showing conductor, screening insulation, Armouring, outer sheath etc.
- ii) Detailed drawing showing jointing of cable and sealing of end boxes.

Copies of instruction manuals for testing, installation jointing operation and maintenance of cables, shall also be submitted with the offer for reference of the purchaser.

11. CONTINUOUS A.C. CURRENT & OTHER DATAS (ALUMINIUM CONDUCTOR):

Conductor sizes in sq.mm.	Continuous A.C. current capacity in Amps at maximum conductor temp. of 90 deg .c. for 33 kV cable						
	When laid direct in the ground	When laid in air	Short circuit current in kA 1sec (I=0.094 x A/sq.rt (t))	A.C resistance at 90 deg in Ohm/Km	D.C resistance at 20 deg in Ohm/Km	Reactance at 50 Hz in Ohm/Km	Capacitance at 50Hz in µF/Km
70	170	220	6.58	0.567	0.443	0.152	0.14
95	200	265	8.93	0.410	0.320	0.145	0.15
120	225	300	11.28	0.325	0.253	0.140	0.16
150	250	340	14.10	0.265	0.206	0.135	0.18
185	280	385	17.39	0.211	0.164	0.130	0.19
240	315	450	22.56	0.162	0.125	0.126	0.21
300	345	500	28.20	0.130	0.100	0.122	0.23
400	385	570	37.60	0.1023	0.0778	0.117	0.25
500	415	640	47.00	0.0808	0.0605	0.113	0.27
630	450	720	59.22	0.0648	0.0469	0.111	0.29
800	485	790	75.20	0.0530	0.0367	0.105	0.34
1000	510	850	94.00	0.0444	0.0291	0.102	0.37

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12. CONTINUOUS A.C. CURRENT & OTHER DATAS (COPPER CONDUCTOR):

Conductor sizes in sq.mm.	Continuous A.C. current capacity in Amps at maximum conductor temp. of 90 deg .c. for 33 kV cable						
	When laid direct in the ground	When laid in air	Short circuit current in kA 1sec (I=0.094 x A/sq.rt (t))	A.C resistance at 90 deg in Ohm/Km	D.C resistance at 20 deg in Ohm/Km	Reactance at 50 Hz in Ohm/Km	Capacitance at 50Hz in µF/Km
70	215	280	10.01	0.343	0.268	0.152	0.14
95	255	335	13.59	0.248	0.193	0.145	0.15
120	285	380	17.16	0.197	0.153	0.140	0.16
150	310	430	21.45	0.159	0.124	0.135	0.18
185	345	485	26.46	0.127	0.0991	0.130	0.19
240	390	560	34.32	0.0976	0.0754	0.126	0.21
300	420	620	42.90	0.0778	0.0601	0.122	0.23
400	455	690	57.20	0.0678	0.0470	0.117	0.25
500	480	750	71.50	0.0489	0.0366	0.113	0.27
630	510	820	90.10	0.0391	0.0283	0.111	0.29
800	540	840	114.40	0.0319	0.0221	0.105	0.34
1000	550	940	143.00	0.0268	0.0176	0.102	0.37

13. TESTS AND TESTING FACILITIES:

13.1 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.

13.2 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.

13.3 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. In addition, **test for convolution and protrusion shall be carried out as per Annexure- "A"**

13.4 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 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.

13.4.1 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.

13.4.2 The manufactured cable will be acceptable only after such a sample test is successfully carried out at CPRI /ERDA or at suppliers works and approved by the Purchaser.

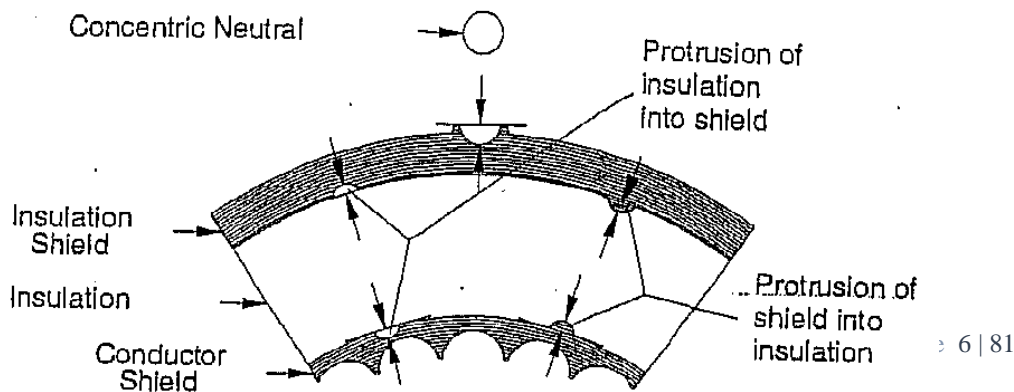
13.5 TESTING FACILITIES

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.

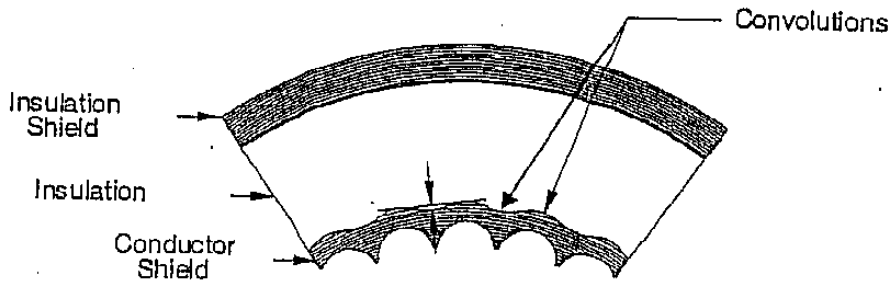
ANNEXURE A

Item (For XLPE/TR XLPE insulation)	Clause of AEIC CS8	Unit	Requirement
Protrusions into insulation from conductor screen	3.2	mm	≤ 0.076
Protrusions into conductor screen	3.2	mm	≤ 0.18
Strand Convolutions	3.3	mm	≤ 0.18
Protrusions into insulation from insulation screen	5.2	mm	≤ 0.13
Protrusions into insulation screen	5.2	mm	≤ 0.18

Procedure to Measure Protrusions and Indentations



Procedure to Measure Convolutions



14 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.

15 LIST OF STANDARDS

(All amended up to date)

SR.NO.	STANDARD NO.	TITLE
1.	IS: 8130 ,IEC 60228:	Conductors for insulated electric cables and flexible cords.
2.	IS :7098 (Part 2) ,IEC 60502:	XLPE PVC sheathed cable for working voltages from 3.3 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/Polypropylene 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.

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8. IS :10462 (Part I) –1983 : Fictitious calculation method for determination of dimensions of protective coverings of cable.

16.0 TECHNICAL DATA FOR 33kV SINGLE CORE 300 SQMM & 630 SQMM, XLPE INSULATED, COPPER CONDUCTOR ARMoured CABLE

Sl. No.	Name of the Particulars	1CX300 SQMM	1CX630 SQMM
1	Type of cable	Copper Conductor ,XLPE Insulated	Copper Conductor ,XLPE Insulated
2	Standard according to which cable has been manufactured and tested	IS: 7098- Part 2, IEC- 60840, IEC- 62067	IS: 7098- Part 2, IEC- 60840, IEC- 62067
3	Rated Voltage (Uo/U)	19/33(36) kV	19/33(36) kV
4	Highest System Voltage which the cable can withstand	36 kV (Um)	36 kV (Um)
5	Maximum Conductor temperature for continuous operation	90 0 c	90 0 c
6	(a) Maximum short time conductor temperature with duration	250 °C for 1 sec.	250 °C for 1 sec.
	(b) Maximum allowable conductor temp. during overload	95°C for 2 hours	95°C for 2 hours
7	Conductor Details		
	Normal Cross-Sectional Area	300 mm ²	630 mm ²
	Material and Grade	Annealed Plain Copper to IS 8130/2013	Annealed Plain Copper to IS 8130/84
	Shape of Conductor	Compacted stranded circular	Compacted stranded circular
	Diameter of Conductor	20 mm (Approx.)	30 mm (Approx.)
	No. of Strands and Diameter of each Strand	53 (Min.) /2.04 mm (Approx.)	55 (Min.) /4.10 mm (Approx.)
	Water swellable powder/yarn/non conducting water blocking tape provided	Yes	Yes
	Conducting water swellable tape with 50% overlap over compacted conductor provided	Yes	Yes
8	Extruded Conductor Screen		
	Material	Extruded Semi-Conducting compound	Extruded Semi-Conducting compound
	Nominal Thickness	0.50 mm (Approx.)	0.5 mm (Approx.)
	Diameter over Conductor screen	26.5 mm (Approx.)	32.2 mm (Approx.)
	Designed maximum stress at conductor screen	3.05 kV/mm	3.05 kV/mm
9	Insulation		
	Material	XLPE	XLPE
	Nominal Thickness	8.80 mm	8.80 mm
	Minimum thickness at any point	7.1 mm	7.1 mm

	Diameter over insulation	37.5 mm(Approx)	50.0 mm(Approx)
	Designed maximum stress	1.90 kV/mm	1.90 kV/mm
	Detail of vulcanization process		
	Extrusion method	Triple Extrusion Process	Triple Extrusion Process
	Curing method	Dry Cured	Dry Cured
	Cooling method	Water cooling	Water cooling
	CO/ or VOI Line	CCV/MCV line	CCV/MCV line
10	Extruded Insulation Screen		
	Material	Extruded Semi-Conducting XLPE	Extruded Semi-Conducting XLPE
	Thickness	1.0 mm	1.0 mm
	Diameter over insulation screen	39.5 mm (Approx.)	52.2 mm (Approx.)
	Strippable/ Bonded	Bonded	Bonded
11	Conducting Longitudinal Water Sealing		
	Material	Water Swellable Tape applied with 50% overlap.	Water Swellable Tape applied with 50% overlap.
	Thickness	0.3 mm (Approx.)	0.3 mm (Approx.)
12	Metallic Sheath/ Screen		
	Material	Copper	Copper
	No. of strands	64	55
	Diameter of each Strand (Nom/Min)	2.0 mm	2.8 mm
	Diameter of Cable after stranding	50 mm (Approx.)	59 mm (Approx.)
	Armour coverage	Full coverage. Armour wires shall be applied as closely as practicable. Overall gap between armour wires should be less than diameter of single wire. Min coverage required 90 % with supporting calculations	Full coverage. Armour wires shall be applied as closely as practicable. Overall gap between armour wires should be less than diameter of single wire. Min coverage required 90 % with supporting calculations
13	Non-conducting Longitudinal Water Sealing		
	Material	Water Swellable Tape applied with 50% overlap.	Water Swellable Tape applied with 50% overlap.
	Thickness	0.3 mm (Approx.)	0.3 mm (Approx.)
14	HDPE Outer Sheath		

	Type	Extruded HDPE Type ST-7	Extruded HDPE Type ST-7
	Colour	Black	Black
	Thickness (Nom/Min)	2.6 mm (Nominal)/2.11 mm (Min. Spot)	2.6 mm (Nominal)/2.11 mm (Min. Spot)
	Conductive Coating Provided	Graphite Coating	Graphite Coating
15	Nominal overall Diameter of cable	51 mm (Approx.)	72 mm (Approx.)
16	Nominal Overall Weight of Cable per Meter	5.46 kg/m (Approx)	12.0 kg/m (Approx)
17	Standard Drum Length with Tolerance	500m±5%	500m±5%
18	Minimum Bending Radius allowable during installation	1180 mm (during installation) 944 mm (after laying)	1180 mm (during installation) 944 mm (after laying)
19	Short Circuit Current Rating of Conductor with maximum conductor temperature at the commencement of fault 1Sec. Duration (90°C)	42.90 kA	90.09
20	Maximum Continuous Current Rating of a Circuit Comprising of 3 nos. Single Core Cable laid in trefoil formation at a depth of 1.05 M.		
	Soil Temperature	300 C	300 C
	Ambient Temperature	400 C	400 C
	Soil Thermal Resistivity	150°C Cm/W	150°C Cm/W
	System of Bonding	Solidly earthed at both ends	Solidly earthed at both ends
	Laid in ground (at a depth of 1.05 m)	445A	580A
	Laid in dusts	380A	500A
	Installed in Air	650A	920A
21	Short Time Overload capacity with Duration of cable installed as per conditions mentioned in Item no.22 (2 hours)		
	Laid in ground (at a depth of 1.05 m)	543A	708A
	Laid in dusts	473A	610A
	Installed in Air	826A	1168A
22	Maximum AC Resistance at 90°C	0.078 ohm/km	0.040 ohm/km
23	Equivalent Star Reactance of a Circuit comprising of 3 Nos. of Single Core cable laid in Trefoil Formation	0.111	0.115
24	Maximum Charging Current per Conductor at Nominal Voltage 1.64 AI km	1.43 A/Km (at 19kV)	1.91 A/Km (at 19kV)
25	Loss in Metallic Screen of a Circuit comprising of 3 nos. of Single Core Cable installed in Trefoil Formation as per item no. 22	13.53 W/m	22.38 W/m
26	Maximum Current in Metallic Screen when the cable is installed as per item no. 22 (Circulating Current)	88A	110A
27	Derating factor of Cable installed as per Item No.22 under following conditions Ambient		

	Temperature		
	35°C	As Attached file	As Attached file
	45°C	As Attached file	As Attached file
28	Group derating factor of Cable Circuits installed as per Item no. 22 under following conditions		
	Laid 100 mm. apart	As Attached	As Attached
	Laid 250 mm. apart	As Attached	As Attached
29	Induced voltage in metallic screen when Conductor is carrying 100 Amps(V/Km)	5	5
30	Circulating current in metallic screen when conductor is carrying 100 Amps	34A	34A
31	Test Voltages		
	Impulse Withstand Voltage at 90°C	170kVp	170kVp
	Rated Power Frequency Withstand Voltage (kV)	63 kV for 5 minutes	63 kV for 5 minutes
	Water penetration test as per IEC 60502-2 on core	Yes Water penetration test as per IEC 60502-2	Yes Water penetration test as per IEC 60502-2
	Abrasion Test on HOPE Outer sheath as per IEC 60229	Yes (Physical Abrasion test as per IEC 60229 clause 4.1.2.1)	Yes (Physical Abrasion test as per IEC 60229 clause 4.1.2.1)
	Recommended Test Voltage after installation	Comply with Clause 20 as per IEC 60502-2	Comply with Clause 20 as per IEC 60502-2
32	Details of Drum		
	Material and Weight of Drum	Wooden or Steel Reel/ 500 kg (Approx.)	Wooden Reel/ 500 kg (Approx.)
	Weight of Drum with Cable	4500 kg (Gross Weight) (Approx.)	6300 kg (Gross Weight) (Approx.)
	Flange Diameter of Drum	2150 mm (Approx.)	2750 mm (Approx.)
	Barrel Width of Drum	1100 mm(Approx.)	1100 mm(Approx.)
	Spindle hole Diameter	120 mm (Approx.)	120 mm (Approx.)
33	Safe Pulling force	5kg/mm ² of CU area.	5kg/mm ² of CU area.
34	Inner sheath		
	Material	PVC Compounded ST-2	PVC Compounded ST-2
	Extruded or Wrapped	Extruded	Extruded
	Min. Thickness (in mm)	0.5	0.5
35	Armour		
	Material	Aluminium Wire	Aluminium Wire

		as per IS:8130	as per IS:8130
	Type of Armouring	Round wire Armour	Round wire Armour
	Nominal Diameter in (mm)	2.5	2.5
36	The following details shall be embossed/ Printed on outer sheath at regular interval not exceeding one metre. (a) Manufacturer's Name or Trade name (b) Year of Manufacture (c) Voltage grade of Cable i.e. 19/33kV (d) Cable Code i.e. 2XWa2Y (e) Number of cores & cable size e.g. 300 Sq mm (Cu) 1 core 630 Sqmm (Cu) 1 core		
	Sequential length marking shall also be provided on outer sheath by inkjet printing.		
	Cable shall be supplied in steel drums		

17.0 GUARANTEED TECHNICAL PARTICULARS FOR 33 KV CABLE: (To be filled up by the bidder & submission of the same during approval)

Sl. No.	Name of the Particulars	1CX300 SQMM	1CX630 SQMM
1	Type of cable		
2	Standard according to which cable has been manufactured and tested		
3	Rated Voltage (Uo/U)		
4	Highest System Voltage which the cable can withstand		
5	Maximum Conductor temperature for continuous operation		
6	(a) Maximum short time conductor temperature with duration		
	(b) Maximum allowable conductor temp. during overload		
7	Conductor Details		
	Normal Cross-Sectional Area		
	Material and Grade		
	Shape of Conductor		
	Diameter of Conductor		
	No. of Strands and Diameter of each Strand		
	Water swellable powder/yarn/non conducting water blocking tape provided in intermediate layers of conductor?		
	Conducting water swellable tape with 50% overlap over compacted conductor provided		
8	Extruded Conductor Screen		
	Material		
	Nominal Thickness		
	Diameter over Conductor screen		
	Designed maximum stress at conductor screen		

9	Insulation		
	Material		
	Nominal Thickness		
	Minimum thickness at any point		
	Diameter over insulation		
	Designed maximum stress		
	Detail of vulcanization process		
	Extrusion method		
	Curing method		
	Cooling method		
	CO/ or VOI Line		
10	Extruded Insulation Screen		
	Material		
	Thickness		
	Diameter over insulation screen		
	Strippable/ Bonded		
11	Conducting Longitudinal Water Sealing		
	Material		
	Thickness		
12	Metallic Sheath/ Screen		
	Material		
	No. of strands		
	Diameter of each Strand (Nom/Min)		
	Diameter of Cable after stranding		
	Armour coverage		
13	Non-conducting Longitudinal Water Sealing		
	Material		
	Thickness		
14	HDPE Outer Sheath		
	Type		
	Colour		
	Thickness (Nom/Min)		
	Conductive Coating Provided		
15	Nominal overall Diameter of cable		
16	Nominal Overall Weight of Cable per Meter		
17	Standard Drum Length with Tolerance		
18	Minimum Bending Radius allowable during installation		
19	Short Circuit Current Rating of Conductor with maximum conductor temperature at the commencement of fault 1Sec. Duration (90°C)		
20	Maximum Continuous Current Rating of a Circuit Comprising of 3 nos. Single Core Cable laid in trefoil formation at a depth of 1.05 M.		
	Soil Temperature		
	Ambient Temperature		

	Soil Thermal Resistivity		
	System of Bonding		
	Laid in ground (at a depth of 1.05 m)		
	Laid in dusts		
	Installed in Air		
21	Short Time Overload capacity with Duration of cable installed as per conditions mentioned in Item no.22 (2 hours)		
	Laid in ground (at a depth of 1.05 m)		
	Laid in dusts		
	Installed in Air		
22	Maximum AC Resistance at 90°C		
23	Equivalent Star Reactance of a Circuit comprising of 3 Nos. of Single Core cable laid in Trefoil Formation		
24	Maximum Charging Current per Conductor at Nominal Voltage 1.64 AI km		
25	Loss in Metallic Screen of a Circuit comprising of 3 nos. of Single Core Cable installed in Trefoil Formation as per item no. 22		
26	Maximum Current in Metallic Screen when the cable is installed as per item no. 22 (Circulating Current)		
27	Derating factor of Cable installed as per Item No.22 under following conditions Ambient Temperature		
	35°C		
	45°C		
28	Group derating factor of Cable Circuits installed as per Item no. 22 under following conditions		
	Laid 100 mm. apart		
	Laid 250 mm. apart		
29	Induced voltage in metallic screen when Conductor is carrying 100 Amps(V/Km)		
30	Circulating current in metallic screen when conductor is carrying 100 Amps		
31	Test Voltages		
	Impulse Withstand Voltage at 90°C		
	Rated Power Frequency Withstand Voltage (kV)		
	Water penetration test as per IEC 60502-2		
	Abrasion Test on HOPE Outer sheath as per IEC 60229		
	Recommended Test Voltage after installation		
32	Details of Drum		
	Material and Weight of Drum		
	Weight of Drum with Cable		
	Flange Diameter of Drum		

	Barrel Width of Drum		
	Spindle hole Diameter		
33	Safe Pulling force		
34	Inner sheath		
	Material		
	Extruded or Wrapped		
	Min. Thickness (in mm)		
35	Armour		
	Material		
	Type of Armouring		
	Nominal Diameter in (mm)		
36	The following details shall be embossed/ Printed on outer sheath at regular interval not exceeding one metre. (a) Manufacturer's Name or Trade name (b) Year of Manufacture (c) Voltage grade of Cable i.e. 19/33kV (d) Cable Code i.e. 2XWa2Y (e) Number of cores & cable size e.g. 300 Sq mm (Cu) 1 core 630 Sqmm (Cu) 1 core		
	Sequential length marking shall also be provided on outer sheath by inkjet printing.		
	Cable shall be supplied in steel drums		

18.0 33 kV CABLE JOINTING KITS: SPECIFICATION OF CABLE KITS:

The distribution system in which the cables along with the Straight through and end termination kits joints are expected to perform reliably over a period of 30-35 years, is a five phase, 3-wire System operating at 33 KV with solidly earthed neutral at the source neutral terminal with maximum possible continuous voltages being 36KV, and cable conductor temperatures up to 90°C on a continuous basis and This specification defines the requirements for 33KV Straight through and end termination kits jointing Cable Joints kits for underground 33 kV XLPE insulated power cables. The requirements cover the material properties of the components used in the Cable Joints as well as the performance of these products after installation on cables. Heat shrinkable components are based on polymeric materials and are to be supplied in an expanded state. Heating of these components to a temperature generally above 120°C would activate their elastic memory and cause these components to recover or shrink down on a substrate within a specific application range.

Service Conditions:

under short circuit conditions up to 250°C.

The Service conditions include ambient temperatures range from -5°C to 50°C, height of installation up to 700 m above sea level, dusty, industrially polluted as environments, humidity levels up to 95% and heavy average rainfall of 600 mm (annually).

18.1 GENERAL REQUIREMENTS

All materials used and products provided under this specification must be in accordance with the standards listed below of this specification

18.2 REFERENCES:

1. Standard Number ESI-09-13- Performance Specification for high voltage, heat shrinkable components for use with high voltage solid cables up to an including 33,000 volts.

2. IS 13573 Type Test and Performance Requirements for cable Terminations and Joints on XLPE Cables from 6.6 KV to 33 KV ratings.
3. IEC 61238-1 : Compression and Mechanical Connectors for Power Cables with copper or aluminum conductors - Tests Materials and Requirements.

All materials components and products offered shall be of the latest designs, incorporating any improvements in materials and installation procedures knowledge of which has been gained through the manufacturers' research or experience.

The jointing materials and components shall be offered in the form of kits. The kits shall be supplied complete with all necessary tubings components (mechanical connectors/ earthing/ cable preparation etc) to form a ready to energize joint / termination.

18.3 QUALITY, ENVIRONMENTAL MANAGEMENT SYSTEM AND LABORATORY ACCREDITATION:

The kits shall be offered from the factory having a valid ISO 9001:2000 Quality Management System(QMS) certificate for the goods offered. The goods shall include the shrinkable and moulded components, as well as connectors.

Units of measurement

In all correspondence, in all technical schedules and drawings metric units of measurement shall be used.

18.4 PACKING AND MARKING

The joint/termination kit shall be properly packed with all the shrinkable tubings, moulding components and connectors, lugs, other accessories as required to form a self contained kit. The packing shall be of such design as to prevent moisture and dust ingress and shall also protect the contents against mechanical damage.

External packing shall carry a label with the following information clearly marked:

- Name of Manufacturer
- Manufacturers reference
- Year of Manufacture/ Purchase order No.
- Expiry date whenever applicable

The kits shall also include the following:

- a) Installation Instruction sheet manuals containing complete step by step instructions in the English language.
- b) A check list stating the quantities and description of components contained in the kit shall be supplied in each kit.

Each component of the kit shall be separately packed in polyethylene and component name/part number shall be marked on the polyethylene packing.

All materials and components comprising the kit shall be clearly and permanently marked in a prominent position with the supplier's/manufacturer's name, product identification, batch number and year of manufacture. The batch number shall allow for full traceability of manufacture including the new materials which make up the polymeric compounds used in extrusion and moulding processes. Extruded components (tubing and wrap-arounds) shall additionally be marked with their expanded and fully recovered internal diameter. They may alternatively be marked with the upper and lower diameters of their range of application.

Markings on extruded components shall be repeated along the length with gaps not exceeding 200mm. Components which cannot be marked shall have the above information provided on immediate packaging.

Packed kits shall be packed in carton boxes which shall be placed in wooden pallets in order to facilitate fork-lift handling.

18.5 STORAGE

Components and kits shall be capable of being stored without deterioration in an ambient air temperature 5°C to 50°C when protected from direct sunlight.

Inspection and testing

All materials covered by this Specification shall be subject to inspection and test by the Authority during manufacture and before final despatch from manufacturer's works. The approval of the Authority of any such inspection or test will not, however, prejudice the right of the Authority to reject the materials or any part thereof, if it does not comply with the specification when erected or does not give complete satisfaction in service. The contractor shall make available to the Authority for the inspection and testing all required personnel and offer facilities (equipment, testing instruments etc.) at no cost to the Authority. The Authority may, however, use his own instruments and apparatus as a check.

Before any part of the jointing materials is packed or despatched from the manufacturers works, all tests called for are to have been successfully and satisfactorily carried out in the presence of the Inspector and a certificate issued to that effect by the Inspector in writing.

Adequate notice is to be given when any part of the jointing materials is ready for inspection or test and every facility is to be provided by the Contractor and his subcontractors to enable the Inspector to carry out the necessary inspection and witness the tests. Duplicate copies of all principal Test Records and Test Certificates are to be supplied to the Inspector for all tests carried out in accordance with the provisions of this specification.

The jointing materials and all component parts thereof are to be fully tested in accordance with the provisions of the latest relevant standards as stated in paragraph 2.0 of this Specification or as may be agreed in writing with the Inspector. Test Certificates are to be forwarded to the Purchaser together with the invoices.

Guarantee.

The Straight through and end termination kits jointing kits shall be guaranteed for five years from the date of supply.

18.6 SAMPLES

Bidders are required to submit with their BIDs two No's samples of the kits offered as to be delivered in case of order. The kits shall include the installation instructions.

BIDs without samples shall not be considered. The samples shall be returned to the Bidders, after the award, at their own expenses.

18.7 TRAINING

Bidders are required to provide training for OPTCL staff and also to the available outsourced cable jointers for at least 10 man days in phase wise over the period of the contract, at dates that will be decided at a later stage. All expenses i.e trainers wages, living expenses. Training materials i.e cables and jointing materials shall be provided by shall be covered by the Bidder.

18.8 TECHNICAL REQUIREMENTS

The technical requirements described below refer to heat shrinkable, elastic and moulded products (separable connectors).

18.9 DESIGN AND TECHNOLOGY

Product design shall be based on the use of heat-shrinkable or elastic tubings and moulded parts to provide for the functions of high voltage insulation, electrical stress control, electrical screening, sealing and environmental protection as necessary. The use of tapes to provide primary insulation, screening or primary stress control is not acceptable.

BIDERS shall submit evidence with their BIDs that designs are based on sound engineering principles, accumulated know-how and satisfactory service experience.

Design shall aim at minimizing the number of component parts and the time and skill required for satisfactory installation.

For joints single anti tracking tube design is required, which shall provide both anti tracking and stress control grading.

Anti-track and weather-resistant tubing shall be used in outdoor Straight through and end termination kits kits in all positions where the material surface is subject to electrical stress. Mastics or adhesives used as sealants for these tubings must be similarly anti-track and weather-resistant.

All necessary sealants shall be provided pre-coated on the internal surfaces of tubings and moulded parts. Sealant surfaces shall be protected by release paper as necessary.

Screening of conductor connectors shall be achieved with *single* co-extruded dual wall tubing/Trippl wall tubing comprising an inner insulating layer and an outer conducting layer. Separate or additional insulating and conducting tubings are not acceptable. The insulating layer shall provide an insulation thickness at least 30% more than the cable insulation.

18.10 LUGS AND CONNECTORS

Mechanical shear bolt type

Mechanical shear bolt type connectors shall be used as follows:

They shall have the following characteristics/features:

- (i) They shall be in accordance with EN 61238-1.
- (v) Connectors shall be of the water block type, and the shear bolt heads to be hexagonal.
- (vi) Lugs on aluminium cores shall be provided with oxidation inhibiting compound, or any other approved means for inhibiting oxidation.
- (vii) Bolts of the shear bolt type shall be suitable for M12 bolt

Installation Instructions

Detailed installation instructions with drawings for all joints and terminations offered, including all parts, shall be provided with the BID documents in English language.

The successful BIDER shall provide installation instructions in English language.

Component types

For heat shrinkable materials:

- (i) The tubing components (such as internal insulating tubing, stress control tubing, anti-track tubing, external protective tubing) shall conform to the requirements given of EA TS 09
The moulded components shall conform to the requirements given in List 2 of EA TS 09-13.
- (ii) The sealants shall conform to the requirements given in List 3 of EA TS 09-13 and EA TS 09-11.

Specific requirements for components

Electric stress control for the cable insulation screen ends and over the connectors shall be achieved by tubings.

The stress control material shall have defined impedance characteristic, volume resistivity, and permittivity (dielectric constant). The AC impedance shall remain constant despite of thermal ageing, which will take place due to heating effect within the conductor and the temperature of the environment.

Non tracking erosion and weather resistant, insulating tubing and moulded parts

Bidders must provide proof of weather and track resistance of the polymeric material offered, through actual field studies or through accelerated laboratory studies, to confirm a minimum of 30 years expectancy.

This should include:

- (i) Thermal Endurance - An Arrhenius plot to confirm the life expectancy on continuous

exposure at 90° C.

- (ii) Tracking and Erosion Resistance Test to prove the withstand ability against effects of surface electrical leakage currents.
- (iii) Weathering Data properties.

Track Resistant Sealant is (Insulating and Weather Resistant)

Sealing of the interfaces between components subject to electrical stress shall be achieved by using a track resistant sealant or a hot melt adhesive. This sealant/adhesive shall be pre-coated inside the shrinkable components. **Bidders must provide the following information:**

- (a) The adhesive peel strength the sealant provides between Non tracking tubing and non tracking moulded part.
- (b) The dielectric strength, tracking and erosion resistance of the sealant as per ASTM D2303.

Triple wall co, extruded Tubing

- (a) The Tripple wall tubings are manufactured by means of co extrusion. Further the Bidder shall have

- Proof of accelerated laboratory and long term field usage to confirm the retention of key properties within permissible limits due to thermal ageing. Minimum key properties before and after ageing to be stated.
- Confirmation of the minimum thickness of insulation provided over the connector for the maximum size of conductor for which the tubing is supplied.

The insulation layer shall provide an insulation thickness at least 30% more than the cable insulation.

Void Filling, Stress Relieving Mastic

Bidders must submit:

- (a) Data of the stress relieving mastic, which should include information on the volume resistivity, and permittivity.

The mastic shall provide a void free interface between the stress control layer and the cable insulation as well as the connector and Proof of long term usage in the field to confirm satisfactory performance.

Specific **Requirements for Joints.**

General requirements for joints.

External leakage insulation between the live conductor and earth potential using anti-track and weather resistant material.

Electrical stress control using electrical stress control material over the cores.

Hermetic sealing of the interfaces between the cable accessory and cable surfaces, bushings or cable lugs by use of track resistant adhesive/sealant.

Detail technical characteristics wrap around sleeve if offered must be provided.

Outdoor termination kits shall provide means for protecting the exposed insulation of the conductors from UV radiation.

18.11 TESTS

Type Tests on Components

1. The BIDer shall submit with the BID documents test certificates tested not more than 5 years to prove that shrinkable or elastic or moulded components connectors used for cable joints and termination kits comply with the performance specification as indicated IS 13573 1992 with latest amendments and EATS 09-13. Test certificates shall be submitted with the BID documents.

Routine Tests on Components

BIDers must submit with their BIDs routine tests certificates as per the requirements of EA TS 09-11 and EA TS 09-13.

In addition, during the acceptance testing of the first and any other subsequent consignment, components will be randomly selected by the Inspector from jointing kits and will be subjected to the following routine and type tests, at CPRI.

The cost of testing shall be inclusive of all tests specified at CPRI in the bid cost. Visual examination

- a) Dimension
- b) Flame Retardance
- c) Packing and markings.

Type Tests on 33 kV Straight through and end termination kits kit

The Bidders are required to submit with their BIDs the type test certificates mentioned in the following paragraphs, for Straight through and end termination kits kit
Bidders must submit

- 2. Test certificates certified by CPRI or any international recognized testing laboratory as per IS 13573 1992 with latest amendments not more than 5 years..
- 3. Test certificates certified by CPRI or any international recognized testing laboratory as per EATS 09-13 not more than 5 years.
- 4. Test certificate as per IEC 61238-1 from CPRI or any international recognized Mechanical Connectors testing laboratory not more than 5 years.
- 5. Documentary evidence including graphs showing the effects of temperature and thermal ageing on the impedance of the stress control material offered.
- 4 A technical explanation as to how the correct electrical properties of the material Vs volume resistivity, permittivity and AC impedance, have been derived
- 5 The recommended lengths of the stress control material.
- 6 Proof of accelerated laboratory and long term field usage to confirm the retention of the properties within permissible limits under variations of temperature and thermal ageing
- 7 Full set of dimensioned drawings including installation instructions
- 8 Transport, storage and installation requirements
- 9 Acceptance letter of two samples to be submitted

**18.12 GUARANTEED TECHNICAL PARTICULARS FOR ACCESSORIES:
 Outdoor type Cable end Termination (Sealing End) With unicon tube**

Class of Power Cables		
1	Manufacturer's Name	
2	Country of Manufacture	
3	Class and Type	
4	No. of years the design is in commercial use	
5	Rated Voltage kV	
6	Total Creepage distance (mm)	
7	Maximum conductor size, Al (sq.mm)	
8	Details of terminal connectors	
9	Power frequency voltage 1 min. (kV rms) dry withstand test	
10	Power frequency voltage wet with stand voltage KV & duration	

11	Power frequency voltage 6 H Dry withstand voltage Kv. Rms.	
12	Radio interference voltage (R.I.V) Test (Micro Volts)	
13	Practical discharge (corona) extinction test :	
	a) Extinction voltage Kv rms	
	b) Minimum detector sensitivity PC	
14	Impulse voltage Lightning voltage Dry with stand kV (Crest)	
15	Direct voltage 15 Min. Dry with stand KV	
16	Description of materials used in the terminations with electrical & mechanical particulars	
17	Mounting Structure Details for termination	
18	Electrical & Mechanical Particulars of	
	a) Heat Shrinkable Tubing	
	b) Heat Shrinkable Moulded parts	
	c) Heat Shrinkable adhesives / sealents	
19	Type tested to (standard(s))	
20	Other details	
20.1	Please enclose complete Technical literature	
20.2	Comply with IS	
20.3	Comply with EATS/ESI	
20.4	Comply with IEC	
20.5	Type test report	
20.6	All Drawings	

19.0 INSTALLATION OF 33 kV U.G. CABLES:

19.1 SYSTEM PARTICULARS:

Nominal system voltage	33 kV
Highest system voltage	36.3 kV
Maximum permissible one phase System voltage (both cores insulated)	42 kV
Maximum permissible one phase System voltage (one core earthed)	21 kV
Number of phases	3
Frequency	50 Hz
Method of grounding	Solidly Earthed
Total relay and breaker operation time	15 to 20 cycles
Basic impulse level	170 KVp

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19.2 METHOD OF LAYING:

- 19.2.1 This involves digging a trench in the ground in all types of soils including laterite and rock and laying cable(s) on a bedding of minimum 75-mm sand at the bottom of the trench, and covering with additional sand of minimum 75-mm and protecting it by means of tiles, bricks or slabs. The desired minimum depth of laying from ground surface to the top of the cable shall not be less than 1.2-m. At railway crossings the same shall be measured from bottom of sleepers to the top of pipe.
- 19.2.2 The desired minimum clearances are as follows:
- | | |
|--|-------|
| Power cable to power cable: Clearance not necessary; however, larger the clearance, better would be current carrying capacity. | |
| Power cable to control cables: | 0.2-m |
| Power cable to communication cable: | 0.3-m |
| Power cable to gas/water main: | 0.3-m |
- 19.2.3 RCC Hume pipes or earthenware/stoneware pipes depending on the crossing and load should be used where cables cross roads and railway tracks depending on the requirement, and at each particular location either RCC Hume pipes or stoneware pipes shall be used as directed by the Owner's representative. Spare ducts/pipes for future extension should be provided as per the directions of OPTCL. Such spare ducts/pipes shall be sealed off. The inner diameter of the ducts/pipes shall not be less than 225 mm. The ducts/pipes shall be mechanically strong to withstand forces due to heavy traffic when they are laid across the roads/railway tracks.
- 19.2.4 The power cable should not be laid above the telecommunication cable, to avoid danger to the life of the person, digging to attend to the fault in telecommunication cable. For identification of power cables, the cable protective cover, such as bricks or RCC slabs shall be marked as "OPTCL". The likely interference to the existing telecommunication cables should be avoided by referring to and coordinating with the appropriate telecommunication authorities.

19.3 ROUTE PLANS:

Tentative cable route plans will be furnished to the contractors, indicating the roads, position of substations and road crossings. The exact route survey and alignment will be decided on evaluating the findings by excavating trial holes by the contractor / subcontractor. The work should be taken upon only after OPTCL's Engineers approve the final route. The OPTCL reserves the right to change, alter deviate the route on technical reasons. It is the responsibility of the contractor to conduct necessary detailed route survey and submit of proposals to the owner for approval.

19.4 TRIAL HOLES:

The Bidder shall excavate trial holes, for alignment purpose at appropriate distance apart as warranted by the local conditions, keep a record of the findings and close the trial holes properly to avoid hindrance / accidents to pedestrian traffic. The final route / alignment of the cable shall be decided based on the finding of the trial holes.

It is the responsibility of the bidder to maintain as far as possible the required statutory clearances from other utility services.

Any damage caused, inadvertently to any utility services shall be set right & it is the sole responsibility of the contractor to do the same to the satisfaction of the concerned utility.

19.5 LAYING OF CABLES:

The contractor shall excavate the cable trench using manual and mechanical modes. An air compressor driven pneumatic drill or equivalent mechanical excavating tool will be essential if the crossing is to be made with minimum delay. Where paved footpaths are to be dug to excavate the cable trench, care must be taken to carefully remove the pavement slabs and store them properly and relay them properly after the work is completed.

The contractor shall take all precautions while excavating the trench to protect the public / private property and to avoid any accidental damage. Any accidental damage should immediately be reported to the concerned utility.

The contractor is liable to pay for all damages caused by his workmen. The sides of the excavated trench shall, wherever necessary be well shored up with timber and sheeting and use of danger boards wherever required. The depth of the cable trench shall be 1.2 m.

The width shall be sufficient for easy handling of the cables during the laying operations depending upon the method of laying employed. For road crossings and railway crossings the same shall be 1.0 m. At other places the width varies from 0.45m to 1.0 m depending on number of cables to be laid in the trench.

The excavated material shall be properly stored to avoid obstruction. The bottom of the excavated trench should be carefully leveled and freed from pebbles / stones. Any gradient encountered shall be gradual.

There is a likelihood of a situation demanding that more than one cable is required to be run in the same trench. The contractors shall agree to increase the width of the trench to accommodate more than one cable.

The arrangement of cable trench duly indicating the position of cable, sand cushion, back fill and concrete finishing shall be as per sketch enclosed. It should be noted that the excavation required for laying the cable shall be finished accordingly by providing the sand cushion, back fill etc.

19.6 PAVING OUT OF THE CABLE:

The pulling shall be done by hand and in such a manner as to provide good bedding for the protective cable covers like tiles or bricks. The maximum permissible pulling force on XLPE armored cables shall not exceed $P = 9 D^2$ Newton where P is the pulling force in Newton and D is the outer diameter of the cables in mm. However the normal values of pulling force shall be around 15 to 20 percent of this force when laid in trenches, 20 to 40 percent with one or two 90 degree bends in trenches, 50 to 60 percent when the bends are 3 or more. The cables shall have a minimum of 0.3-m clearance from the communication cables or water supply mains whenever they are encountered.

The excavated cable trench shall be drained of all water and bed surface shall be smooth, uniform and fairly hard before laying out the cable. The cable shall be pulled in the trench only on cable rollers spaced out at uniform intervals to prevent damage to cable.

The laying out process shall be smooth and steady, without subjecting the cable to abnormal tension. The cable laid out shall be smoothly and evenly transferred to the ground after providing sand cushion and shall never be dropped. All snake bends in the cable shall be straightened out.

19.7 FLAKING:

Wherever it is not possible to lay off the entire cable drum length, the cable should be cut and properly sealed and if it is necessary to remove the cable from the drum, it should be properly flaked, in the form of figure 8. Such cable lengths should be properly stored at site.

19.8 SAND CUSHION:

When the cable has been properly straightened the trench shall be covered with 75mm thick layer of good quality clean sand cushion. Then the cable shall be lifted and placed over the sand cushion. Again, another layer of sand 75mm thick should be laid and gently pulled on to the top of the cable to form a depth of 75mm from the top of the cable. The minimum envelope cushion around the cable shall not be less than 150 mm.

19.9 CABLE COVERING TILES:

The earthen ware cable covers / tiles shall be of burnt clay and so made and fired that they shall be true in shape, well burnt in kilns throughout and free from detrimental cracks. Except for the interlocking features straight covers shall be rectangular in plan with the underside flat.

The size of RCC covers should be 250mm long x 350mm wide. The thickness at the outer edge should be 50mm. The average breaking load shall be not less than 135Kg. The tiles should be laid side-by-side without any gap in between.

19.10 PREVENTION OF DAMAGE DUE TO SHARP EDGES:

After the cable has been laid in the trench and until the cable is covered with its protective covering, no sharp metal tool shall be used in the trench or placed in such a position that may fall into the trench.

Rollers used during laying of the cables shall have no sharp projecting parts liable to damage the cables.

While pulling cable through Hume pipes/stoneware pipes/G.I. pipes/M.S. pipes, the cable shall be protected to avoid damage due to sharp edges.

Warning tape:

A pre warning, Red color plastic / PVC tape, 250 mm wide 150 microns thick, two runs shall be laid at approximate 500mm above the cable specified depth, throughout the Trenched cable route. The tape shall carry the legend printed in black continuously as under

CAUTION / OPTCL / 33 KV CABLES ARE BELOW. With a 'SKULL AND BONE' Signs
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The cables shall never be bent, beyond the specified bending radius

19.11 CABLES OVER BRIDGES:

Wherever the cable route crosses bridges the cable shall be laid in the ducts, if provided, by removing and replacing the R.C.C. covers and filled with sand cushion.

In the absence of the cable ducts over bridges, the cable shall be laid in suitable size RCC/steel/G.I. pipes or as directed by the engineer In-charge and the pipe covered by cement concrete if necessary to protect from direct sunrays and Masonry/RCC supports at suitable intervals, wherever required as decided by the Engineer in charge and/or stipulations of concerned Highway/Railway/local authorities.

19.12 CABLE CROSSING OPEN DRAINS WITH LONG SPAN:

Wherever the cable has to cross open drains, with a long span, the cable shall be laid in suitable size RCC closed duct/GI pipe/ hume pipe properly jointed with suitable collars. The GI pipe/hume pipe shall be firmly supported on pillars, columns, or suitable support of R.C.C. foundation & walls in CC 1:1½ : 3 to the required depth & width as required at site and directions & drawings as per technical specifications & procedures of PWD.

Wherever the U.G. cable has to cross the sewerage or water supply line the U.G. cable has to be taken below them maintaining adequate clearance. Further wherever the U.G. cable runs parallel to the telephone cable a separation distance of at east 300-mm shall be maintained. The cable should be taken inside Hume Pipes wherever required.

The cables shall be laid in Hume pipes/stoneware pipe wherever the cable and trench crosses private roads, gates, etc. In order to avoid inconvenience the stoneware pipe should be laid first after excavation and excavated trench shall be back filled, compacted and surface properly redone to restore that original condition.

19.13 ROAD CROSSINGS:

The road cutting whether cement concrete, asphalt or macadam road shall be taken after obtaining approval from civic authorities, Police, Telecom authorities and work should be planned to be completed in the shortest possible time. Where necessary the work shall be planned for night time or light traffic time. . In the excavated trench across the road the GI pipe or hume pipe (NP3 class) of appropriate size shall be laid, excavation back filled compacted and surface shall be redone in shortest time to allow the traffic on the road.

19.14 FOOTPATH CUTTING:

The pavement slabs shall be removed, neatly stacked on side before starting excavation.

19.15 REINSTATMENT:

After the cables and /or pipes have been laid and before the trench is filled in all joints and cable positions should be carefully plotted and preserved till such time the cable is energized and taken over by the engineer in charge. The requisite protective covering will then be provided, the excavated soil replaced after removing large stones and well rammed in successive layers of not

more than 20cm in depth, where necessary the trench being watered to improve consolidation. It is advisable to leave a crown of earth not less than 50 mm and not more than 100 mm in the center and tapering towards the sides of the trench.

The temporary reinstatement of roadways should be inspected at regular intervals, more frequently during the wet weather and immediately after overnight rain. If trench is to be closed overnight and settlement should be made good by further filling to the extent required, such temporary reinstatement should then be left for a time so that soil thoroughly settles down.

After the subsistence has ceased the trench may be permanently reinstated and the surface restored to the best possible condition.

19.16 CIVIL AND STRUCTURAL WORKS:

The scope of civil works include:

- (a) Earth excavation and cable laying, removal of excavated earth, design, supply and provide plain and / or reinforced cement concrete for the cable trenches, back filling, de-watering of trenches. The surplus earth should be disposed off suitably at all leads/lifts. Excavation should be done in all types of soils laterite or rock either manually or using machines as per site requirements & instructions.
- (b) The design of cable duct/pipe ducts for crossing drains, roads, Railways, Highways, canals etc., shall be suitably done and rates quoted shall include complete supplies and erection as per relevant schedules. The Masonry work / concrete work should be done as per standard PWD practices and specifications & instructions of engineer-in-charge.
- (c) Design, fabrication, supply & erection of galvanized steel structures for cable end terminations.
- (d) Supply of all consumables and sundry materials not included in the specifications in detail but are necessary to meet the intent of the project.

Codes and standards: Unless otherwise stated, latest editions of the following standards are applicable.

- 1) IS: 1255: Installation and maintenance of power Cable.
- 2) IS : 5820: Specification for pre-cast concrete cable cover.
- 3) IS : 209 : Quality of zinc for galvanizing.
- 4) IS : 2062 : Structural steel.
- 5) IS : 456 : Plain and reinforced cement concrete.
- 6) IS : 800 : Use of structural steel in general building construction.
- 7) IS : 2016 : Plain washers
- 8) IS : 2633: Zinc coating on galvanized steel.
- 9) IS : 3063 : Spring washers.
- 10) IS : 5358: Hot Dip Galvanized coating on fasteners.
- 11) IS : 6639 : Hexagonal bolts for steel structures.
- 12) Any other equivalent International/ National standard

- 19.17 Excavation and measurement in hard rock: Blasting in hard rock shall be done as per IS: 4081 (latest edition). The hard rock excavated shall be stacked, measured and reduced by 40% for voids. Pre-measurement of rock is to be recorded when measured on section. The quantity whichever is less shall be paid.

- 19.18 Back, filling materials: The back filling of excavated trenches around foundation, shall consists of one of the following materials as the Engineer-in-charge may direct in each location.
- i. Selected sieved earth from excavated soil.
 - ii. Selected sieved earth brought from borrow area
 - iii. Sand filling (sieved).

NOTE: Sieved sand shall be strictly used for all the works.

Filling shall be done after the work of laying cables and providing sand cushion is completed. The contractor shall commence concrete finish only after the proper reinstatement and approved by the Engineer-in-charge.

- 19.19 Back filling for cable trench: Back filling shall be done in horizontal layers of thickness not exceeding 300-mm thickness, free from pockets with careful watering where necessary for compaction. The backfill earth shall be riddled free from materials likely to cause damage to the cables. The thermal backfill surrounding the cable shall be as per the design approved by the owner. Surplus available/ New earth after refilling should be disposed off to a place away from site at all leads & lifts.

19.20 Cable route markers/joint markers:

Permanent and durable type, cable route markers/joint indicating blocks should be provided as per the design supplied by the purchaser. The cement concrete shall consist of one part cement, two parts sand, four parts aggregate of size 20 mm and down. The finishing should be given a smooth cover surface of cement mortar and shall have the appropriate legends, 5 mm deep engraved on them as “OPTCL 33 KV CABLE”, or “OPTCL 33 KV CABLE JOINT” as the case may be. Markers shall be of size 700x240x75mm thick RCC and fixed in cement concrete at top of cable trench at 250mts distances.

- 19.21 Pipes: Hume pipes and accessories conforming to the relevant Indian standard specifications shall be used wherever required. All sundry materials like coupling, collars, caps to cover the pipe ends before cable is pulled in shall be provided. Stoneware pipes, shall be of good quality, salt glazed and approved by the Owner’s representative. Hume pipes, stoneware pipes, can also be used where the cable passes through the passage or driveways of public and private buildings as per the directions of the Owner’s representative for each particular location. The size of the pipe shall be at least 225 MM. The pipe joint shall be done by using proper sleeves so as to get tight fitting. Suitable steel rope will be drawn in pipe to pull the cable. Before drawing the cable, wire brush to be drawn through pipe to clean the burrs and steel ball (sphere) shall be pushed through pipe to know whether pipe is smooth for drawing the cable. G.I pipes of suitable size shall be used wherever required as per site requirement G.I pipes shall be of “**B**” grade.

- 19.22 SAND:** The sand used for filling should be sieved, free from pebbles and approved quality. Only river sand should be used. The depth & width of sand filling should correspond to the details shown in the drawing.

- 19.23 RCC Work:** RCC work required for supports to hume pipe /G.I. Pipes & others shall be of required size and depth constructed as per PWD specifications. The foundations should be of RCC as per design and drawing (to be furnished by the bidder) and got approved. Care to be taken to divert/bailout water wherever necessary during constructions. All RCC work should be of 1:1½ :3 proportion. The surface of supporting wall should be neatly plastered and finished suitable clamps should be provided for holding the pipes in position.

19.24 **CONCRETE:** All plain concrete/RCC provided should correspond to relevant IS codes. Concrete mixing should be done with machines. Curing should be as per codal requirements. All plain concrete should be of 1:2:4 proportions. Before laying concrete at top of cable trenches, the back fill earth should be thoroughly compacted with water. The Concrete should be compacted and nearly finished to correspond to the road level.

19.25 Precast RCC slabs/ or interlocking stones for cable protection at top shall be provided as per drawing and design with wedge shaped notches on one side and protruding wedges on the other to facility interlocking and placing RCC shall be of M20 grade and shall be provided in stretches of concrete roads and such others reaches specified and decided during execution. Interlocking stones of approved quality should be provided wherever instructed.

19.26 CABLE AND JOINT MARKERS:

Permanent means of indicating the positions of joints on site should be provided. During the course of permanent reinstatement cable and joint markers, should be laid directly above the route of the cable and the position of the joint respectively.

Wherever it is not possible to place the marker directly over the cable route or the joint, the marker should be suitably placed near the cable route or joint on which the distance of the cable route or joint at right angles to and parallel to the marker should be clearly indicated.

The position of fixing the markers will be at the discretion of the Engineer In-charge.

19.27 JOINTING OF CABLES:

GENERAL: It shall be noted that the U.G. cables are of XLPE insulation and needs special care in jointing. The cable jointer and his assistant shall have experience in making joints/terminations. Jointing work should commence as soon as two or three lengths of cables have been laid. All care should be taken to protect the factory-plumbed cap/seal by laying the end solid in bitumen until such time as the jointing is commenced.

Jointing of cables in carriage ways, drives, under costly paving, under concrete or asphalt surfaces and in proximity to telephone cables and water mains, should be avoided whenever possible.

JOINT PITS: The joint pits should be of sufficient dimensions as to allow jointers to work with as much freedom of movement and comfort as possible. The depth of the pit should be at least 0.3-m below the cables proposed to be jointed. The sides of the pit should be draped with tarpaulin sheet to prevent loose earth from falling on the joint during the course of making. The pit should be well shored with timber, if necessary. An overlap of about 1.0-m of the cables to be jointed may be kept, for allowance to adjust the position of the joint. When two or more cables are laid together the joints shall be arranged to be staggered by 2 to 2.5 m.

SUMP PITS: When jointing cables in water logged ground or under monsoon conditions, a sump pit should be excavated at one end of the joint pit in such a position so that the accumulating water can be pumped or baled out by buckets without causing interference to the jointing operation.

TENTS: A tent should be used in all circumstances wherever jointing work is carried out in the open irrespective of the weather conditions. The tent should be so covered as to have only one entrance and the back facing the direction of the wind. The tent cover should be properly weighted or tied down on the sides.

19.28 PRECAUTIONS BEFORE MAKING A JOINT OR CUTTING A CABLE: The cable end seals should not be opened until all necessary precautions have been taken to prevent circumstances arising out of rainy/inclement weather conditions, which might become uncontrollable. The cable seals should be examined to ascertain if they are intact and also that the cable ends are not damaged. If the seals are found **broken or the lead** sheath punctured, the cable ends should not be jointed until after due examination and testing by the engineer in charge of the work.

MEASUREMENT OF INSULATION RESISTANCE: Before jointing is commenced the insulation resistance of both sections of the cable to be jointed should be checked by insulation resistance testing instrument. An insulation resistance-testing instrument of 2.5/5 kV shall be used. The insulation resistance values, between phases and phase to earth shall be recorded. The actual jointing operation shall start only after the approval of the engineer in charge of works.

PRECAUTIONS TO BE TAKEN ON LIVE CABLES IN SERVICE: Sometimes it becomes necessary that a H.V. cable, which is in service, be cut for making a straight joint with a new cable. In such cases work on joint should start only after the in service cable is properly identified, isolated, discharged, tested and effectively earthed. Search coils, interrupters or cable-identifying instruments should be used for this purpose.

IDENTIFICATION NUMBERS / COLORS AND PHASING: The cables should be laid and jointed number to number or color to color shown on the core identifying marks and prevent cross jointing. In all cases, the cables should be tested and phased out, and more particularly so when the cable terminates at Ring Main Unit/Sub-Station.

MAKING A JOINT: The Heat shrinkable joints used shall conform to the specification vide Annex 2. The contractor should furnish all the technical particulars of these joints and obtain approval only in case they are found superior to the heat shrinkable joints. Epoxy based joints are not permitted. Comprehensive jointing instructions obtained from the manufacturer of joint kits shall be meticulously followed. The connection of the earth wires should be done using flexible bonds connected to cable sheath using clips or soldering. Aluminum conductor strands shall be joined by mechanical compression method, using suitable die and sleeve with a good quality tool. The joints shall conform to specification as per IS 13573.

TRANSITION JOINTS: Wherever straight through joints will have to be made with existing cables under the following conditions the contractor shall arrange such type of joints and execute them with skilled jointers:

- (1) Between cables having two different types of insulation viz., paper and XLPE.
- (2) Between cables having two different types of conductor material, viz., copper and aluminum.
- (3) Or a combination of the above.

The transition joints shall conform to IS: 13705 - Transition joints for cables for working voltages from 11 kV up to and including 33 KV _ performance requirements and type tests.

19.29 CABLE TERMINATIONS: Cable terminations required are both indoor and outdoor type and invariably be of heat shrinkable type conforming to the specifications vide Annex 2. All the technical particulars to establish the superiority in the performance of these joints shall be furnished while seeking approval. The terminations shall conform to specifications as per IS: 13573. The instructions furnished by the manufacturer of termination boxes/kits should strictly be followed.3

Wherever a cable rises from the trench to end in a termination, to be finally connected to an overhead line or a transformer, the following instructions should be complied with:

- i) One coil to be made and left in the ground for future needs.
- ii) The rise of cable, immediately from the ground level should be enclosed in suitable diameter GI pipe to a height of 2 m.
- iii) The balance portion of the cable should be neatly curved, in 'S' shape.
- iv) The cable and pipe should be properly fastened by using appropriate clamps/support. The hardware of clamps shall be painted with red oxide and enamel paint or galvanized.
- v) The lugs on the termination shall be compressed with a suitable compression tool.

EARTHING AND BONDING:

The metal sheath and Armor should be efficiently bonded and earthed at all terminals to earth electrodes provided. The cross sectional area of the bond shall be such that the resistance of each bond connection shall not exceed the combined resistance of an equal length of the metal sheath and Armor of the cable.

19.29 TESTING BEFORE AND AFTER LAYING AND JOINTING:

All new cables should be tested for insulation resistance before jointing with a 2.5 kV megger. After satisfactory results are obtained cable jointing and termination work should commence. Records of this shall be maintained.

All cables after laying and jointing works are completed should be tested systematically and insulation and pressure tests should be made on all underground cables.

All test results should be recorded in tabular form in logbooks kept for the purpose.

The cable cores should be tested for: -

- i) Continuity;
- ii) Absence of cross phasing;
- iii) Insulation resistance to earth; Insulation resistance between conductors.
- iv) Conductor Resistance (dc) measured with a suitable bridge.
- v) Capacitance. Using Capacitance Bridge.

19.30 H.V. TESTS:

After the laying and jointing work is completed, a high voltage test should be applied to the cable to ensure that the cable has not been damaged during or after the laying operations and there is no defect in the jointing.

The high voltage tests should be as per IS 1255 or as per international standards. The H.V. testing instruments shall be brought by the bidder. The dc test voltage to be applied after installation and before commissioning between any conductor and metallic sheath/screen/armor shall be 60 kV.

19.31 TESTING AND RECORD OF CABLE CONSTANTS:

When the cable is ready, just before commissioning, the cable constants, viz., the resistance, capacitance and inductance of each conductor should be determined and recorded, along with frequency at which the values of capacitance and inductance are determined.

19.32 GUARANTEE:

All cable joints/termination done by the contractor shall be guaranteed for 24 months from the date of energization of the complete cable. In the event of failure during the guarantee period, the restoration work shall be done free of cost by the contractor within 24 hours of giving notice or else the expenditure incurred by OPTCL to re-do the joint/termination will be recovered from the performance guarantee amount with the OPTCL. (See Performance guarantee clause in special Conditions of contract.)

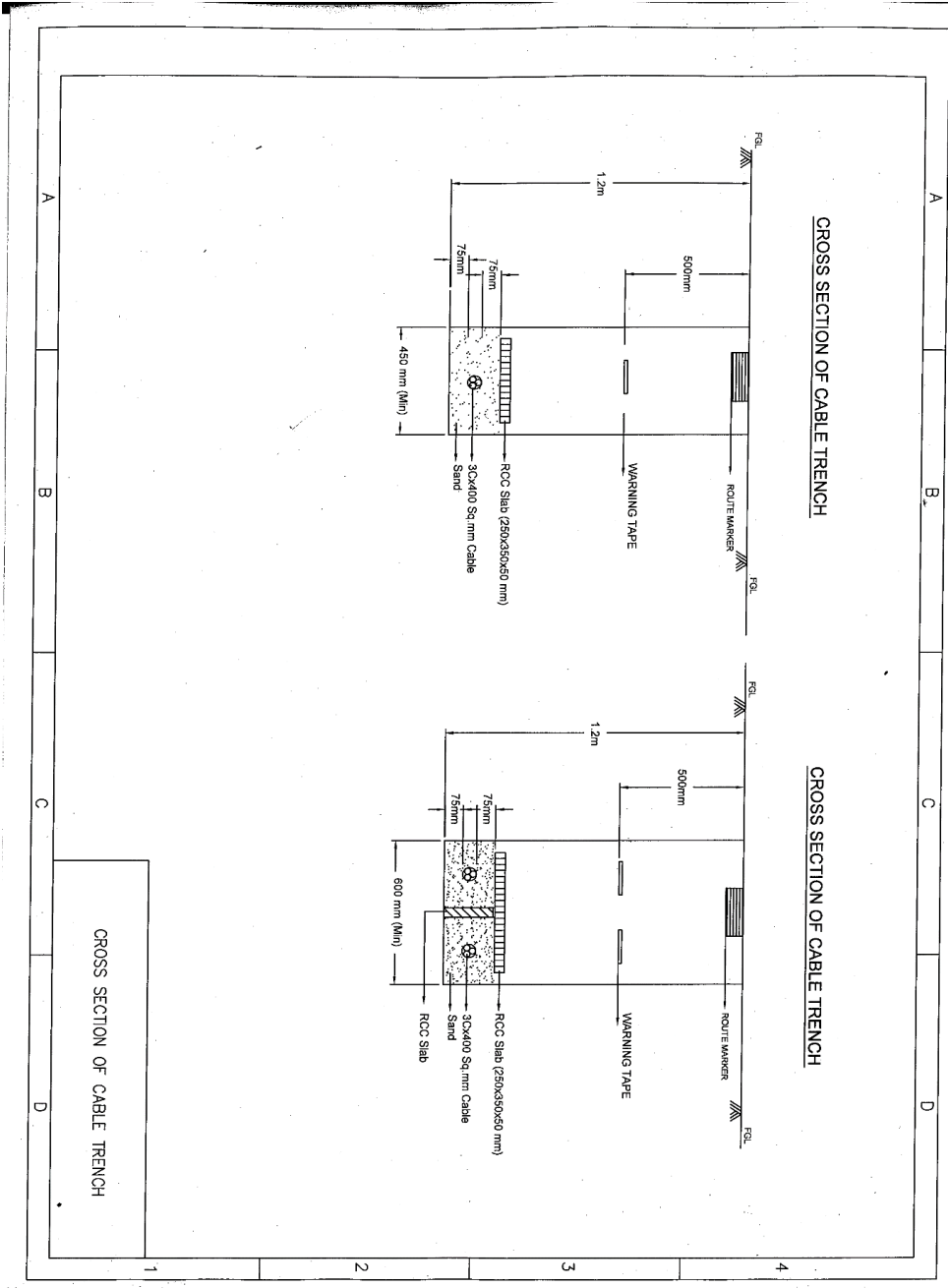
19.33 CABLE RECORDS:

Accurate neat plans/sketches, drawn to suitable scale (1 cm = 10M) should be prepared and furnished by the contractor after the completion of each work.

All relevant information should be collected at site, during the progress of work and preserved for preparation of drawings.

The following essential data should be incorporated on all drawings.

- a) Size, type of cable or cables.
- b) Location of the cable in relation to prominent land mark property. Kerb-line, etc., with depths.
- c) The cross section showing where cables are laid in pipes or ducts, giving their sizes, type and depths.
- d) Position and type of all joints.
- e) Location of other cables which run alongside or across the cable route.
- f) Position and depths of all pipes, ducts, etc., which are met as obstruction to the cable route.
- g) Accurate lengths from joint to joint and
- h) Manufacturers name and drum number of the cable, between sections/joint to joint.
- i) Year and month of laying



B) TECHNICAL SPECIFICATION FOR 132 kV XLPE (CROSS LINKED POLYETHYLENE) INSULATED POWER CABLE:

1.1 SCOPE

1.1.1 The scope under this section covers design, manufacturer, testing, packing, supply, delivery and laying of 132kV XLPE, insulated power cable including integrated testing and commissioning, technical support, supervision of maintenance, training of Employer's staff and documentation for a complete System necessary to deliver the requirements of this Specification.

1.2 STANDARDS:

Unless otherwise specified, the cables shall conform, in all respects, to IEC-60840 and IS:7098 (Part-III)/1993 with latest amendment or latest edition for cross linked polyethylene insulated PVC sheathed cable for working voltage of 132 kV.

The following standard specifications of latest version updated to as on date of opening of this bid document will govern supply, laying testing and commissioning of cables and their accessories that are being used in this Contract. In case of conflict between such codes and/or standards and the specification, the specifications shall govern.

Sr. No	Title of Specification	Specification No.
1	Cross linked polyethylene insulated Thermoplastic sheathed cables	IEC: 60502-2 IEC: 60840, IEC: 62067
2	Conductors for insulated cables.	IEC : 60228
3	Test on cable over Sheath which have a special protective function and are applied by extrusion	IEC 60229
4	HDPE pipes	BIS 4984
5	Power cables with extruded insulation and their accessories for rated voltage above 30 kV and up to 150 kV- Test Methods & requirements	IEC 60840
6	Power Cables with extruded insulation and their accessories for rated voltages above 150kV.	IEC: 62067
7	Impulse test on cables & their accessories.	IEC 60230
8	Cyclic and emergency rating of cable	IEC 60852-2

Sr. No	Title of Specification	Specification No.
9	Common test methods for insulating and sheathing material of electrical cables.	IEC 60811
10	Electric test methods for Electric cables – Test methods for Partial Discharge measurements on lengths of extruded power cables.	IEC 60885

1.3 PRINCIPAL PARAMETERS:

- 1.3.1 132 KV (E) grade XLPE single core power cable conductor electrolytic grade copper of single length, with formation of stranded compacted circular **water blocked** conductor for size up to 630/800/1000 Sqmm and segmental type for size above 1000mm² as per IEC-60228, tapped with high **penetration** semi conducting **water blocking** tape, shielded with extruded semi-conducting layer, insulated with dry gas cured cross linked polyethylene (XLPE) insulation, insulation screened with extruded semi- conducting layer, lapped with a combination of **foam type** semi- conducting water swellable Corrugated Aluminium armoured and black HDPE ST7 with **baked on** graphite coating or extruded conductive layer overall cable, confirming to IEC-standards for construction and also confirming to IS:7098 (Part-III)/1993 or any latest amendments thereof. **Cable shall be preferred of FIPC type. Alternatively, 48 F OFC shall be quoted (Optional).**
- 1.3.2 Outer sheathing should be designed to afford high degree of mechanical protection and should also be heat, oil chemicals and weather resistant.
- 1.3.3 The cable should be suitable for laying in covered trenches and/or underground for outdoor
- 1.3.4 The sheath/screen bonding system shall provide a continuous current path through the cable sheath and jointing kits and shall be bonded. The bonding ends shall be suitably earthed with/without SVL as per approved configuration/design. The sheath voltage under full load condition shall not exceed the voltage specified/allowed in relevant standard for safety of personal as well as satisfactory working of cable **i.e 65 v**. Sheath shall be solidly grounded at suitable location with or without SVL. Bidder must indicate details of configuration proposed along with sufficiency calculation with the bid so as to limit induced voltage of sheath within 65V. **Detailed calculation supporting selection of SVL and bonding cable size and rating with margin of protection to be submitted with bid.**

Note: Method of LILO of integrated fiber at each joint for sensing purpose, jointing

methodology, Power cable termination to FMS connection method to be submitted for a FIPC cable

1.3.5 CABLE PARAMETERS

Sr. No.	System Particulars	132kV
i)	Voltage Grade (Uo/U)	76/132
ii)	No. of Cores	Single
iii)	Size (mm ²)	630mm ² , 800mm ² ,1000mm ² , 1200 mm ²
iv)	Nominal system voltage KV	132
v)	Highest system voltage KV	145
vi)	System Frequency Hz	50
vii)	Variation in Frequency	+ 3%
viii)	Fault level individually for i) Conductor ii) Metallic Sheath	31.5 KA for1sec 31.5 KA for 1sec
ix)	Maximum allowable temperature	
	a) Design continuous operation at rated full load current, the max. temp. of conductor shall not	90
	b) The conductor temperature after a short circuit for 1.0 sec shall not exceed. °C	250
x)	Basic insulation level (1.2/50 Micro Second Wave)	625 KVP
xi)	30-min. power frequency withstand voltage (rms)	190 KV
xii)	System earthing	Effectively earthed

1.4 OPERATION CHARACTERISTICS:

- One/Two Three-phase feeders, each consisting of 1 runs of 4 Single core cables, feed power at 132 kV
- In normal situation, each cable will have to be designed to carry a continuous current, to deliver a rated power of Transformers and its designed overload.
- The cable should be designed for a suitable current carrying capacity under normal situation, and which will cater for the above overload capabilities also, will be required.

1.5 GENERAL TECHNICAL REQUIREMENTS:

1.5.1 CONDUCTOR:

The cable conductor shall be made from electrolytic grade copper with formation as stranded compacted circular conductor for size upto 1000 sqmm and segmental type as per IEC-60228 for the size above 1000mm².The conductor shall confirm to IS:8130/2013. Conductor should be water blocked. Water blocking to be achieved by combination of water blocking yarn and non-conducting water blocking tapes in intermediate layers of conductor.

1.5.2 CONDUCTOR SCREEN:

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A Conductor screen made of semiconducting compound shall be provided over the conductor, by extrusion. The extruded coat shall be continuous, with a constant mean depth, without bump, perfectly adhering to the insulation envelope. A **high penetration resistant** semiconducting **water blocking** tape(s) shall be provided below the extruded semi-conducting conductor screen to prevent penetration of the compound into the underlying conductor with **min 50 % overlap**. The conductor having a semi-conducting screen shall ensure perfectly smooth profile and avoid stress concentration. The conductor screen shall be extruded in the same operation as the insulation; the semi-conducting polymer shall be cross-linked. Minimum thickness of the conductor screen shall be **0.8 mm**. The electric resistivity of the conductor screen shall not be more than 5000 Ω cm at 20°C and not more than 25000 Ω cm at the working rated temperature.

1.5.3 INSULATION:

The Insulation envelope shall be of cross-linked polyethylene (XLPE) insulation applied by extrusion should be suitable for 132kV system voltage. The nominal thickness of insulation shall not be less than **18 mm**, subject to **only positive tolerances (no negative tolerance is accepted)** as per IEC 60840. The manufacturing process shall ensure that the Insulation shall be applied by extrusion and vulcanized using dry curing process to form a compact homogenous body free from micro voids and contaminants. The insulation compound shall be of high quality, heat, moisture, ozone and corona resistant. The insulation shall withstand mechanical and thermal stressed under steady state and transient operating conditions. The extrusion method should give very smooth interface between semi-conducting screen and insulation.

1.5.3.1 The voltage gradient in the rated working conditions shall be

- a) equal to or less than 6kV/mm at the level of internal semiconductor.
- b) Equal to or less than 3kV/mm at the level of external semiconductor

1.5.3.2 The mechanical characteristics shall be as follow:

- a) In delivery condition:
 - 1) minimal traction resistance : 12.5 Mpa
 - 2) minimal elongation before breaking : 200%
- b) After ageing of 240 h at 135°C:
 - 1. maximal variation of traction resistance : □ 25%
 - 2. maximal variation of elongation before breaking : □ 25%

1.5.3.3 The isolating envelope shall comply with the hot condition elongation test:

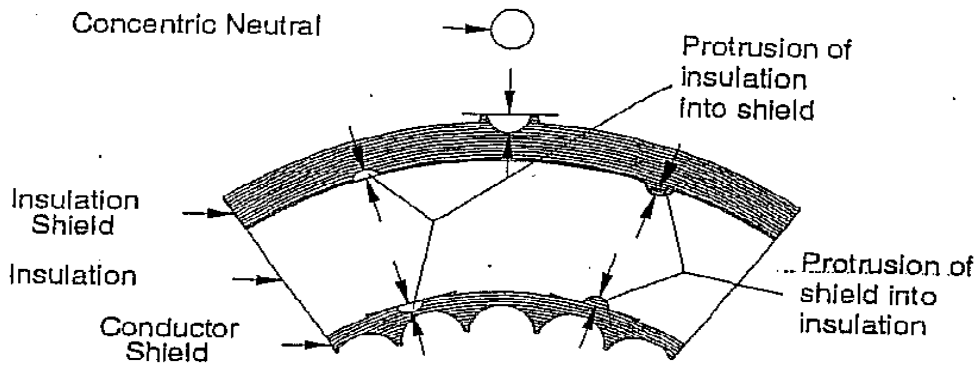
- a) temperature : (200)°C
- b) on load duration : 15 minutes
- c) mechanical constraint : 0.2 Mpa
- d) maximal elongation on load : 100%
- e) maximal elongation after cooling : 15%

1.5.3.4 Test for surface irregularities shall be carried out as below

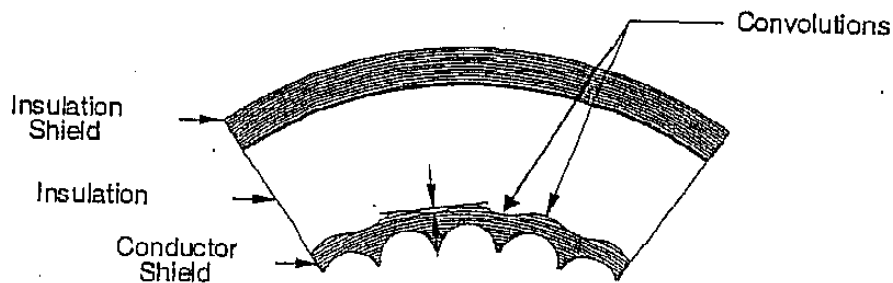
Item (For XLPE/TR XLPE insulation)	Clause of AEIC	Unit	Requirement
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	CS8		
Protrusions into insulation from conductor screen	3.2	mm	≤ 0.076
Protrusions into conductor screen	3.2	mm	≤ 0.18
Strand Convolutions	3.3	mm	≤ 0.18
Protrusions into insulation from insulation screen	5.2	mm	≤ 0.13
Protrusions into insulation screen	5.2	mm	≤ 0.18

Figure 1
Procedure to Measure Protrusions and Indentations



Procedure to Measure Convolutions



1.5.4 INSULATION SCREEN:

To confine electrical field to the insulation, non-magnetic semi- conducting shield shall be put over the insulation. The insulation shield shall be extruded in the same operation as the
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conductor shield and the insulation by suitable extrusion process (triple extrusion). The XLPE insulation shield should be bonded type. It shall be lapped by Foam type semiconducting tape with min thickness of 1 mm. Metallic screening shall be provided. The metallic screen shall be of Seamless/*Seam welded Corrugated Aluminum* having fault current capacity 31.5KA for 1-sec with initial temperature of screen as 80 and final temperature as 250 degC calculated by adiabatic method. Supporting calculations shall be submitted with bid.

1.5.6.1 ANTI CORROSIVE LAYER

An anticorrosive layer of Bitumen compound followed by tape shall form the anti-corrosive layer

1.5.7 OUTER SHEATH:

The outer extruded semiconducting layer sheath shall be embossed/printed red/yellow/blue colour or similar (as per phase). Suitable semi conducting layer coated on black HDPE ST7 with baked on graphite coating or extruded conductive layer confirming to IEC: 60840, shall be applied over corrugation with suitable additives to prevent attack by rodents and termites. The outer sheath should have embossing/ indelible Printing at every one meter for Supplier Name, buyer's name, PO No, Voltage grade, size, type etc.

1.5.7.1 The Mechanical Characteristics shall be as follow :

- c) - In delivery condition
 - 1) - minimal traction resistance : 12.5 Mpa
 - 2) - minimal elongation before breaking : 200%
- d) - After ageing of 240 h at 135°C:
 - 1) - traction resistance:
 - 2) - minimum value : 12.5MPa
 - 3) - maximum variation : • 25%
 - 4) - elongation before breaking:
 - 5) - minimum value : 200%
 - 6) - maximum variation : 25%

1.5.7.2 The variation is the difference between the medium value obtained after ageing and the medium value without ageing, expressed in percentage of the last.

1.5.7.3 Fiber specification for integration in Power cable (Optional)

Fiber used in the power cable or supplied separately in the OFC shall be as per below specification.

Attenuation	≤ 0.35 dB/km at 1310 nm (Typical ≤ 0.34 dB/km) ≤ 0.35 dB/km at 1383nm (Typical ≤ 0.34 dB/km) # ≤ 0.21 dB/km at 1550 nm (Typical ≤ 0.20 dB/km) ≤ 0.23 dB/km at 1625 nm (Typical ≤ 0.22 dB/km)
Mode field diameter	8.6 ± 0.4 μ m at 1310 nm
Cable cutoff wavelength	≤ 1260 nm
Zero dispersion wavelength	1300 nm to 1324nm
Zero dispersion slope	≤ 0.092 ps/nm ² .km
Dispersion at 1550 nm	≤ 18.0 ps/nm.km
PMD Individual Fiber*	≤ 0.1 ps/ \sqrt km
PMD LDV	≤ 0.06 ps/ \sqrt km
Cladding diameter	125 ± 0.7 μ m
Core-clad concentricity error	≤ 0.5 μ m
Cladding non-circularity	≤ 0.8 %
Coating diameter	242 ± 5 μ m
Coating-cladding concentricity error	≤ 10 μ m

* Individual PMD values may change when cabled

After hydrogen aging according to IEC-60793-2-50 regarding the B1.3 fiber category

Mechanical Characteristics

Proof Test Levels	≥ 100 kpsi (0.7GN/m ²). This is equivalent to 1% strain
Coating strip force(Force to mechanically strip the dual coating)	≥ 1.3 N (0.3 lbf) and ≤ 5.0 N (1.1lbf)
Fiber curl	≥ 4 m

Macro bend loss: The maximum attenuation with bending does not exceed the specified values with the following deployment conditions

Deployment condition	Wavelength	Induced attenuation
10 turn, 15 mm radius	1550 nm	≤ 0.03 dB
10 turn, 15 mm radius	1625 nm	≤ 0.10 dB
1 turn, 10 mm radius	1550 nm	≤ 0.10 dB
1 turn, 10 mm radius	1625 nm	≤ 0.20 dB
1 turn, 7.5 mm radius	1550 nm	≤ 0.20 dB
1 turn, 7.5 mm radius	1625 nm	≤ 0.50 dB

Environmental Characteristics

Temperature dependence Induced attenuation, -60°C to +85°C at 1310, 1550, 1625 nm	≤ 0.05 dB/km
Temperature humidity cycling Induced attenuation, -10°C to +85°C and 95% relative humidity at 1310, 1550, 1625 nm	≤ 0.05 dB/km
High temperature and humidity aging 85°C at 85% RH, 30 days Induced attenuation at 1310, 1550, 1625 nm due to aging	≤ 0.05 dB/km
Water immersion, 30 days Induced attenuation due to water immersion at 23±2°C at 1310, 1550, 1625 nm	≤ 0.05 dB/km
Accelerated aging (Temperature), 30days Induced attenuation due to temperature aging at 85±2°C at 1310,1550,1625 nm	≤ 0.05 dB/km

Other Performance Characteristics*

Effective group index of refraction	1.4678 at 1310 nm 1.4685 at 1550 nm 1.4689 at 1625 nm
Attenuation in the wavelength region from 1285 - 1330 nm in reference to the attenuation at 1310 nm	≤ 0.03 dB/km
Attenuation in the wavelength region from 1525 - 1575 nm in reference to the attenuation at 1550 nm	≤ 0.02 dB/km
Point discontinuities at 1310 nm & 1550 nm	≤ 0.05 dB
Dynamic fatigue parameter (N _a)	≥ 20

1.5.8 CONSTRUCTION:

1.5.8.1 All materials used in the manufacture of cable shall be new unused and of finest quality. All materials should comply with the applicable provision of the tests of the specification. IS, IEC, Indian Electricity Rules, Indian Electricity Act and any other applicable statutory provisions rules and regulations.

1.5.9 CURRENT RATING:

The cable will have current ratings and de-rating factors as per relevant standard IEC.

1.5.9.1 The one-second short circuit rating values each for conductor, & screen shall be furnished and shall be subject to the purchaser's approval.

1.5.9.2 The current ratings shall be based on maximum conductor temperature of 90 deg. C with ambient site condition specified for continuous operation at the rated current.

1.5.9.3 SIZE:

The different sizes of cable shall be 132 kV Single Core

- a) 630mm²
- b) 800mm²
- c) 1000mm²
- d) 1200mm²

1.5.10 OPERATION:

1.5.10.1 Cables shall be capable of satisfactory operation under a power supply system frequency variation of plus minus 3% voltage variation of plus, minus 10% and combined frequency

voltage variation of 10% (absolute sum).

1.5.10.2 Cable shall be suitable for laying in ducts or buried under ground.

1.5.10.3 Cable shall have heat and moisture resistance properties. These shall be of type and design with proven record on transmission network service.

1.5.11 LENGTHS: The cable shall be supplied in standard drum lengths as below:

Size of cable	Standard Drum Length
a) Single Core, 630mm ² , 800mm ² , 1000mm ² , 1200 mm ²	500 meters <u>±</u> 5% tolerance and <u>±</u> 2% overall tolerance in total quantity of cable.

1.5.11 IDENTIFICATION MARKING:

Identification of cables shall be provided externally at three meters' intervals to identify as under:-

- i) 'Name of Manufacture'
- ii) 'Year of manufacture'
- iii) 'Voltage grade' to be printed/embossed at the interval of one meter-length. The identification, by printing or embossing shall be done only on the outer sheath. Name of purchaser shall also be embossed.
- iv) PO No
- v) Scheme

1.6.0 TESTS

1.6.1 Type Tests

The equipment offered should be type tested as a cable system with terminations and both type of joints. Type test report should not be more than five years old, reckoned from the date of bid opening, in respect of the following tests, carried out in accordance with ISS-7098/IEC-871, from Govt./Govt. approved test house, shall be submitted along with bid:

- i) Physical tests for insulation and outer sheath.
- ii) Bending test.
- iii) Di-electrical power factor test.
- iv) Heating cycle test followed by di-electrical power factor as a function of voltage and partial discharge test.
- v) Impulse withstand test.

The remaining type test report as per clause 3 of ISS-7098/ IEC-871/ IEC-60840 shall be submitted by the successful bidder within three months from the date of placement of order. These type test reports shall be from Govt./Govt. approved test house and shall not be more than five years old, reckoned from the date of placement of order. The failure to do so will be considered as a breach of contract.

1.6.2 ROUTINE TESTS AND ACCEPTANCE TESTS

All routine and acceptance tests shall be carried as per relevant ISS in the presence of Employer's representative.

Following additional tests shall be carried out in routine tests

- a) Fiber continuity (For FIPC)
- b) Optical loss measurement (for FIPC: 1 sample)

1.7 INSPECTION

The material shall be inspected and tested before dispatch by an authorised representative of the Owner in respect of quality. The inspecting officer shall also satisfy himself about the correctness of length of cables. In case the supplier is not in a position to get these tests carried out at his works, such tests may be got carried out by him at any Govt. recognized test agency at his own expense.

In addition to acceptance tests stipulated by relevant IS/IEC, following additional tests need to be carried out

Measurement of gap below Corrugation

- a) Measurement of thickness of Foam type semiconducting water swellable tape
- b) Measurement of protrusions and convolutions
- c) Sheath integrity test
- d) Wafer boil test
- e) 4 hours voltage test on 3.5 m sample (once in PO)
- f) Volume resistivity (once in PO)
- g) Fiber continuity

1.8 TEST CERTIFICATES

The supplier shall supply test certificates from a Govt. agency in respect of quality as per IS: 7098(part-II) 1985 with latest amendments thereof for approval of the purchaser.

1.9 PACKING

The cable shall be supplied in non-returnable wooden drum as per IS:10418:1982 so constructed, as to enable the cable to be transported on each drum. The cable wound on such drum shall be one continuous length. The ends of cables shall be sealed by means of non-hygroscopic sealing material.

1.10 MARKING

The marking on the drum shall have the following information: -

- a) Reference to Indian Standard & cable code.
- b) Name of the manufacturer & trade name.
- c) Nominal cross section area of conductor for the cables.
- d) Number of core.
- e) Sequential No. at each meter.
- f) Type of the cable & voltage for which it is suitable.
- g) Length of cable on the drum.
- h) Approximate gross weight.
- i) Net weight of the cable.
- j) Drum identification number.
- k) P.O. No. and date.
- l) Consignee's name with designation.
- m) Year of manufacture.

1.11 DRAWINGS & INSTRUCTION MANUAL

The tenderer shall supply the following drawings with the tender: -

- i) Detailed drawing of the cable showing conductor, screening insulation, Armouring, outer sheath etc.
- ii) Detailed drawing showing jointing of cable and sealing of end boxes.

Copies of instruction manuals for testing, installation jointing operation and maintenance of cables shall also be submitted with the offer for reference of the purchaser.

1.12 TECHNICAL & GUARANTEED PARTICULARS:

The tenderer shall furnish guaranteed technical particulars as per the tender specification. Particulars, which are subject to guarantee, shall be clearly marked. Offer not containing this information will not be considered.

1.13 TERMINATION KITS AND STRAIGHT THROUGH JOINTS

The entire necessary Straight through joints and Sealing Ends for 132 kV shall be supplied and erected. The Straight through joints and Sealing Ends wherever required shall be moulded Type or equivalent, of reputed make with shear head type mechanical connectors of proven technology & make.

1.14 ISO Accreditation

The cable shall be manufactured by a company having ISO accreditation for quality. The manufacturing process of XLPE cable shall consist of conductor screen, insulation & insulation screen shall be extruded in a single process.(triple extrusion) and cross linked by VCV Process (Vertical Continuous Vulcanization process) dry curing technology to ensure homogeneity and absence of micro voids. The cables shall be manufactured by "Dry Curing" Process. It is mandatory that bidder should submit Plant Installation Certificate for VCV Line and for Metallic sheath machineries indicating the year of installation and other details along with bid

The Employer may decide to visit the works of cable manufacturer to confirm the manufacturing process mentioned.

PART II

TECHNICAL SPECIFICATION FOR LAYING, TESTING AND COMMISSIONING OF 132kV XLPE UNDERGROUND POWER CABLE

SECTION-1: SPECIFICATION FOR LAYING OF CABLE

1.1 GENERAL

1.1.2 The Cable Laying works shall be executed according to the rules of the Art pertaining to professional grade and generally in compliance with International Standards and Indian Standards.

1.1.3 The EHV Cables between the Power Supply Authorities Substation and the DMRC RSS shall be laid in ground depending upon the site conditions of the selected route, any of the following paying conditions, may be adopted.

1.1.4 Cable Laying Cases

Case 1 - Direct buried, with all cables laid in flat formation.

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- Case 2 – Direct buried, with the cables (3) of each circuit laid in trefoil formation and side by side in one trench.
- Case 3 – Laid in underground duct.
- Case 4 – Laid in Trench less piping.
- Case 5 – Laid in abutment crossing
- Case 6 – Laid in Rail Track crossing
- Case 7 – Laid in Air, supported on piers/walls, for nallah-crossing

1.1.5 Details of Case 2 :

The trench for carrying the cables shall be at least 1.8m deep and 1.1m wide, which may vary as per site conditions with the approval of employer. Each of the 2 feeders shall consist of 3 single-core cables, and laid in trefoil formation. Cables shall be laid at a depth of 1.7m below the ground level and over a 100 mm bed of coarse sand. Trench is to be filled with sand upto a depth of 1100mm below the ground level. Warning concrete slabs of at least 50mm thickness shall then be laid above the sand. Trench shall then be filled with earth upto a depth of 300 mm below the ground level. A warning net shall then be laid above the earth filling (at 300 mm depth below the ground level). A warning tape shall also be laid appropriately with Purchaser's Name marked on it. The top space of 300 mm shall be suitably filled with compacted Boulder and Bitumen/Jelly and given a final finish matching the surroundings. The cables shall be tied through locking belts after 2 meters each for keeping the cables intact in case of trefoil formation. At locations, where there is change of level of laying, the cables shall be tied through locking belts after 1 meter each.

1.1.6 Details of Case 3

In specific locations, the Employer may require the cables to be laid in underground ducts. The underground ducts shall be laid where road construction or formation is under construction or where water logging stretch is expected or as per the specific site condition.

1.1.7 Details of Case 4 & 6

On all road/rail crossings and at other specific locations, cable laying shall be through trenchless drilling and the cables shall be passed through High Density Polyethylene (HDPE) Pipes or G.I. Pipes of appropriate diameter and thickness (Case-4). One spare HDPE pipe shall be laid for each feeder of 3 cables at the road/rail crossings.

1.1.8 Details of Case 5 & 7

On all abutment crossing or in air, supported on piers/walls, for Nallah crossing and at other specific locations, cable laying shall be on the galvanized steel structures which can withstand wind velocity of 160kmph, supported on piers and have sufficient structural strength. The minimum average weight of zinc coating should be 1000g/m² (RDSO). The cables should be well protected by providing MS sheet of thickness 8mm at least fastened with nuts and bolts & tag welded on all sides to be protected from any pilferages. The arrangement shall render cable absolutely safe from any natural calamity. The cable shall not be exposed or get affected due to stray fire caused in the vicinity. Indicative arrangement is shown in the drawing.

1.1.9 Spare Cables and Pipes

When cables are laid in pipes, in addition to the pipes carrying the cables, at least one spare pipe

(minimum 200 mm dia), without cable shall also be provided. In the case cables laid in underground ducts (Case 3) and cables laid in Trenchless piping (Case 4), spare HDPE pipes, one for each circuit, shall be provided. In addition to pipes for power cables, 2 additional pipes, each of not less than 100 mm dia, shall be provided to carry control and monitoring cables, one operational and one spare (As indicated in the Interfacing Requirements, other cables such as pilot wire for pilot wire protection, if required, copper-core or optic fibre cables for control and monitoring, tele-communication etc, supplied by other Suppliers.

1.1.10 Cable protection at changeover location

The cable path, when changing from buried in ground to underground duct or trenchless piping shall be adequately protected by proper sealing in concrete or other suitable means of sufficient mechanical strength to avoid cable from suffering damage due to heat/fire/water ingress etc.

1.1.11 Pulling Chambers

Pulling chambers shall be provided, as necessary, along the route. Such pulling chambers shall be 4m long, 3m wide and at least 2.5m deep. The masonry structure should be of adequate strength with water proofing to avoid any accumulation of seepage of water inside. The edges of RCC covers and masonry shall be lined in GI angles to achieve a long service life.

1.1.12 Route Markers

The route shall be appropriately marked by suitable retro-reflective cable markers, at suitable intervals and positions of straight through joints shall be indicated by suitable boards.

2.0.0 CABLE ACCESSORIES AND BONDING

2.1.0 Straight Through Joints

2.1.1 The straight through Joints should be HEAT SHRINKABLE type or cold shrink type of proven technology and make, suitable for underground buried cables. The joint should comprise of stress control sleeves, insulating sleeves and co-extruded dual wall Tubing comprising of an insulating and semi-conducting layer. A mechanical connector with shear head bolts shall make the conductor connection.

2.1.2 The product should be type tested as per IEC /KEMA specifications

2.1.3 GENERAL SPECIFICATIONS

- a. The product offered should be proven and should be in use in India for a minimum period of 5 years for the same voltage class. List of past supplies in India to be furnished. Performance certificates to be submitted along with the offer.
- b. The product offered should have unlimited shelf life.
- c. Offers should be supported with type test certificates from test laboratories of repute, as per IEC/ KEMA specifications, failing which the offers shall be ignored.

2.1.4 General Specifications for Joints and Terminations for 132 kV XLPE Cables

The Terminations (Outdoor Sealing ends) and Straight Through Joints for 132 kV cables shall be of 'Heat-shrinkable, " type or cold shrink type of proven technology and make, suitable for 132 kV (E) grade or higher, Single core 400 sq mm or higher, XLPE Insulated, Aluminium sheathed cables. The Indoor termination for use in the GIS Substation.

2.2.0 Bonding

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2.2.1 Suitable bonding methods viz., Single End, Both End and Cross Bonding shall be used.

2.2.2 Link boxes with & without SVL shall be used as required.

3.0.0 TESTING AND INSPECTION

7.1.0.1.1 TYPE-TESTS

7.1.0.2 General

All the equipment which are used for this work shall be of proven design and standards to achieve a very high level of reliability in service. An equipment is considered to be proven if it is in successful operation at least for a period of two years. Irrespective of the fact that the summary of type test reports was submitted for 132kV (E) or higher grade Single core, XLPE insulated, Copper conductor Aluminium Sheathed cable along with the bid, the Supplier shall furnish a summary of type test reports for all the equipment listed below except those equipment which are yet to be type tested being under development within three (3) months period from the date of signing the contract.

7.1.0.3 Heat Shrinkable type or cold shrink type of proven technology and make straight through joint suitable for 132 kV (E) grade Single Core 400 sq. mm or above size XLPE insulated cable with Aluminum sheath.

7.1.0.4 Heat Shrinkable type or cold shrink type of proven technology and make cable terminations (indoor & outdoor) suitable for 132 kV (E) grade

7.1.0.5 The cable and cable accessories intended to be used for this work shall be

(i) Type-tested within the last ten (10) years period prior to the date of bid opening. (ii) Proven in service for at least two (2) years as on the date of bid opening.

7.1.0.6 Submission of Performance Certificates

As a proof of satisfactory performance of following equipments during last two years from the bidder /JV partner /sub Supplier from whom Bidder intends to supply them.

7.1.0.7 Heat shrinkable " type or cold shrink type of proven technology and make straight through joint suitable for 132 kV (E) grade or above grade, Single Core 400 sq. mm or above size XLPE insulated cable with Aluminum sheath.

7.1.0.8 Heat shrinkable " type or cold shrink type of proven technology and make cable terminations (indoor & outdoor) suitable for 132 kV (E) grade

7.1.1 Type Test Results

Summary of type test results of the above mentioned equipment will be in the following format:

Sl.No.	Equipment	Manufactured By	Rating	Governing specification for type test	Name of type test	Month/Year conducted	Testing Lab/Testing House/In House	Result/Remark

7.1.1.1 If the type tests of any equipment being supplied for this work are not yet conducted by the Supplier then all the type tests as per the relevant IEC shall be conducted at his expense in the

presence of employer's representative either at manufacturer's works having requisite facilities and approved by independent laboratory like CPRI, KEEMA, Netherland or CESI Italy, or at KEEMA, Netherlands or CESI, Milano, Italy.

7.1.1.2 Details of 'Make of Cables/Accessories

The bidder shall submit to the employer the proposed "make" of all the above equipment in the bid form along with other details such as rating, quantity in use, place of installation number of years in satisfactory operation, summary of type test reports of required rating of 132kV or higher grade, Aluminum/copper conductor, XLPE insulated, Aluminum or Copper sheath cable along with the bid so as to decide the 'make' of the items. Based on the information thus furnished the employer shall decide the 'make' of the items to be used for the work. The plant & equipment being supplied against this bid shall conform to relevant IEC standards.

7.1.1.3 Rejection of Type Test Report

When the Employer rejects any specific type test report for a particular equipment stating the grounds for such rejection, the Supplier shall re-conduct the relevant type tests as per the specification in the presence of Employer's representatives before the item is supplied by him. Such type test shall be conducted by the Supplier at his own expense at the manufacturer's works approved by CPRI, KEMA Netherland or CESI Italy in the presence of Employer's representative.

7.1.1.4 Type Test Reports

The type test reports of the equipment shall be of the tests carried out either at the manufacturer's works having requisite facilities or at CPRI, KEEMA, Netherlands, CESI, Milano, Italy during the last ten (10) years period as on the date of bid opening. If any type test report is older than 10 years, the type tests will have to be repeated at Supplier's cost. Employer shall waive some of these tests in case of equipment / sub assemblies where the manufacturer can establish to the satisfaction of employer that such tests have already been carried out earlier or where the equipment have been proved in service. In such a case, manufacturer shall submit complete test reports along with necessary certification.

7.2.0 ROUTINE TESTS

Routine tests shall comprise of visual inspection of the items and all the routine tests as per specification. All these tests shall be conducted in the presence of Employer's nominated representative at the manufacturer's works. Routine test shall be carried out as per specification IEC 60840 latest version.

7.2.1.1 General

The following tests shall be carried out on each manufactured length of cable:

- a) Partial discharge test (see 5.2.2);
- b) Voltage test (see 5.2.3);
- c) Electrical test on over sheath of the cable, if required (see 5.2.4).

7.2.1.2 The order in which these tests are carried out is at the discretion of the manufacturer. The main insulation of each prefabricated necessary shall undergo partial discharge (see 5.2.2) and voltage (see 5.2.3) tests according to either 1), 2) or 3) below:

- 1) On accessories installed on cable;

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- 2) By using a host accessory into which a component of an accessory is substituted for test;
- 3) By using a simulated accessory rig in which the electrical stress environment of a main insulation component is reproduced.

7.2.1.3 In cases 2) and 3), the test voltage shall be selected to obtain electrical stresses at least the same as those on the component in a complete accessory when subjected to the test voltages specified in 5.2.2 and 5.2.3

7.2.1.4 NOTE: The main insulation of prefabricated accessories consists of the components that come in direct contact with the cable insulation and are necessary to control the electric stress distribution in the accessory. Examples are pre-moulded or pre-cast elastomer or filled epoxy resin insulating components that may be used singly or jointly to provide the necessary insulation or screening of accessories.

7.2.1.5 Partial discharge test

The partial discharge test shall be carried out in accordance with IEC 60885-3 for cables, except that the sensitivity as defined in IEC 60885-3 shall be 10pC or better. Testing of accessories follows the same principles, but the sensitivity shall be 5pC or better. The test voltage shall be raised gradually to and held at 1.75 U₀ for 10 s and then slowly reduced to 1.5 U₀. There shall be no detectable discharge exceeding the declared sensitivity from the test object at 1.5 U₀.

7.2.1.6 Voltage test

The voltage test shall be made at ambient temperature using an alternating test voltage at power frequency. The test voltage shall be raised gradually to 2.5 U₀ and then be held for 30 min between the conductor and metallic screen/sheath. No breakdown of the insulation shall occur 60840 @ IEC: 2004 Electrical test on over sheath of the cable When the test is required by the particular contract, the cable over sheath shall be subjected to the electrical test specified in Clause 3 of IEC 60229.

7.3.0 Acceptance tests

7.3.1 General

Acceptance tests for the power cable & its accessories shall be carried out wherever the same is mentioned in the relevant specification governing the cable and its accessories. All the acceptance tests as mentioned in the governing specification to which the product is manufactured shall be conducted in the presence of Employer's nominated representative by the Supplier at their manufacturing works. The following tests shall be carried out on samples which, for the tests in terms b) and g), may be drum lengths of cable, taken to represent batches:

- a) Conductor examination (see 5.3.4);
- b) Measurement of electrical resistance of conductor and of metallic screen (see 5.3.5);
- c) Measurement of thickness of insulation and over sheath
- d) Measurement of thickness of metallic sheath
- e) Measurement of diameters, if required
- f) Hot set test for XLPE, EPR and HEPR insulations Measurement of capacitance
- g) Water penetration test, if applicable
- h) Tests on components of cables with a longitudinally applied metal foil

7.3.2 Frequency of tests

The sample tests in items a) to h) of 5.3.1 shall be carried out on one length from each batch (manufacturing series) of the same type and cross-section of cable, but shall be limited to not more than 10% of the number of lengths in any contract, rounded to the nearest whole number. The frequency of the tests in items l) and j) of 5.3.1 shall be in accordance with agreed quality control procedures. In the absence of such an agreement, one test shall be made for contracts with a cable length above 20 km.

7.3.3 Repetition of tests

If the sample from any length selected for the tests falls in any of the tests in 5.3.1, further samples shall be taken from two further lengths of the same batch and subjected to the same tests as those in which the original sample failed. If both additional samples pass the tests, the other cables in the batch from which they were taken shall be regarded as having complied with the requirements of this standard. If either fail, this batch of cables shall be regarded as having failed to comply.

7.3.4 Conductor examination

Compliance with the requirements of IEC 60228 for conductor construction, or the declared construction, shall be checked by inspection and measurement when practicable. Measurement of electrical resistance of conductor and metallic screen The cable length, or a sample thereof, shall be placed in the test room, which shall be maintained at a reasonably constant temperature for at least 12 h before the test. If there is a doubt that the conductor or metallic screen temperature is not the same as the room temperature, the resistance shall be measure after the cable has been in the test room for 24 h. Alternatively, the resistance can be measured on a sample of conductor or metallic screen, conditioned for at least 1 h in a temperature controlled liquid bath.

7.3.5 Additional Acceptance Tests

The following additional acceptance tests shall be carried out.

1. Additional acceptance tests (1 sample/offered lot) shall be carried out for Ovality & Eccentricity.
2. Tensile strength and Elongation on insulation and over sheath before and after ageing and Thermal Stability on outer sheath of power cable.
3. finish and length measurement shall be carried on one length of each size of offered lot of power cables.

7.3.6 Short Circuit Test :

Short Circuit test for Power Cables will be conducted by the Supplier on the cable at Manufacturer's works having requisite facilities approved by KEMA Netherlands or CESI Italy or at KEEMA, Netherlands or CESI Milano, Italy & shall be witnessed by the Employer's authorized representative.

7.3.7 TEST CERTIFICATES

Three copies of the test certificates of successful type tests if any carried out on cables and cable accessories shall be furnished to the Employer within fifteen days after completion of such type tests. Three copies of successful acceptance & routine tests carried out on cables and cable accessories and the certificate of inspection issued by the Employer's representative shall be furnished within 15 days, after the completion of tests by the Employer's representative.

7.3.8 RESPONSIBILITY OF SUPPLIER FOR DELIVERY/SUPPLY

(a) All defects detected as a result of testing / inspection shall be rectified by the manufacturer at his own expense and shall be documented and corrected prior to shipment. If in opinion of Employer, a repeat of the test is required after such rectification, this shall also be carried out at the expense of the Supplier.

(b) No cable / accessory shall be supplied until Employer has inspected the same to his satisfaction and accepted. However, such inspection and/or acceptance certificate shall not relieve the Supplier of his responsibility for furnishing the cables and cable accessories conforming to the requirements of the contract nor prejudice any claim, right or privilege which the Employer may have because of the use of defective or unsatisfactory items. Should the Employer waive the right to inspect any item, such waiver shall be obtained by the Supplier from the Employer in writing and such a waiver shall not relieve the Supplier in anyway from his obligation under the contract.

(c) Only after obtaining clearance from the Employer, the Supplier shall despatch the items to site.

7.3.9 INSPECTION OF ERECTION WORK

All erection work will be subject to inspection by the Employer or his representative to ensure that the work is done in accordance with the specification and approved drawing.

7.3.10 INSPECTION AND TESTS OF COMPLETELY LAID CABLE

7.3.10.1 General

As soon as the work is completed and ready for inspection and testing, the Supplier shall advise the Employer in writing. Tests will be carried out by the Employer jointly with the Supplier. Testing equipments and staff required for the tests shall be provided by the Supplier free of charge. The Supplier shall take full responsibility for these tests interalia his other responsibilities. The Supplier shall notify the manufacturer of cable and cable accessories regarding likely date of pre-commissioning tests, one month in advance so that their representative may be available at site at the time of conducting the tests. It shall be Supplier's responsibility to ensure that the cable and it's accessories are commissioned as per laid down procedures.

7.3.11 Pre commissioning Tests for the facility as a whole The following site tests shall be conducted on a completed power cable installation as per specification IEC 60840 latest version.

(i) Visual Inspection and Continuity Check Visual inspection shall include check for satisfactory workmanship Continuity check shall be carried out on the cable to ensure that the cable is continuous.

(ii) DC voltage test of the over sheath The test shall be conducted as per Clause 15.1 of IEC 60840.

(iii) AC voltage test for the installation. The test shall be conducted as per Clause 15.2 of IEC 60840.

(iv) the insulation resistance of the cable shall be checked before & after the HV test on cable. The core resistance shall be measured and the value corrected in accordance with clause 5 of IEC 60228.

(v) The cable must be discharged on completion of DC High Voltage Test and the cable shall be kept earthed until it is put into service. The values obtained during these tests shall be in conformity with the values obtained during inspection of the materials at the manufacturer's works.

7.3.12 PROFORMA FOR TESTS

The Supplier shall submit the results of tests in quadruplicate in an approved proforma within 7 days

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from the date of completion of the tests but before actual commissioning of the cable. The proforma shall be developed by the Supplier and got approved from Employer within three (3) months from the effective date of the contract.

7.3.13 TECHNICAL DATA FOR 132kV SINGLE CORE 1000 & 630 SQMM XLPE INSULATED, ARMoured CABLE:

Sl. No	Name of the Particulars	Desired Value	
		1000 sqmm	630 sqmm
1	No. of cores	1(Single)	1(Single)
2	Size (in mm ²)	1000	630
3	Voltage Grade(in kV)	76/132(145) kV	76/132(145) kV
4	Type of cable	2XA2Y	2XA2Y
5	Standard according to which cable has been manufactured and tested	IS: 7098- Part 3, IEC-62067, Testing as per IEC- 60840.	IS: 7098- Part 3, IEC-62067, Testing as per IEC- 60840.
6	Permissible Voltage & Frequency variation for satisfactory operation.		
	Voltage	+ 10%	+ 10%
	Frequency	+ 5%	+ 5%
7	Maximum rated conductor temperature	90 ⁰ C	90 ⁰ C
8	Max. allowable conductor temperature during short circuit	250 ⁰ C	250 ⁰ C
9	Conductor Details		
	(a) Normal Cross-Sectional Area	1000 mm ²	630 mm ²
	(b) Material and Grade	Annealed Plain Copper to IS 8130/84	Annealed Plain Copper to IS 8130/84
	(c) Shape of Conductor	Compacted stranded circular	Compacted stranded circular
10	Conductor Screen		
	(a) Material	Extruded Semi-Conducting XLPE as per IS-7098 Pt 3/93	Extruded Semi-Conducting XLPE as per IS-7098 Pt 3/93
	(b) Nominal Thickness	1.5 mm (Approx.)	1.5 mm (Approx.)
11	Insulation		
	(a) Material	Cross linked Polyethylene to IS-7098 Pt 3/93	Cross linked Polyethylene to IS-7098 Pt 3/93
	(b) Nominal Thickness	18.0 mm	18.0 mm
12	Insulation Screen		

	(a) Material	Extruded Semi-Conducting XLPE (SC) layer followed by water swellable SC tapes	Extruded Semi-Conducting XLPE (SC) layer followed by water swellable SC tapes
	(b) Min. Thickness	1.0 mm followed by water swellable SC tapes	1.0 mm followed by water swellable SC tapes
	(c) Longitudinal Water Sealing	Semiconducting water blocking tape(s) with 50% over lap	Semiconducting water blocking tape(s) with 50% over lap
13	Metallic Sheath		
	(a) Material	Seam Welded/Corrugated Aluminium sheath with anti corrosion protection	Seam Welded/Corrugated Aluminium sheath with anti corrosion protection
	(b) Thickness	3.0 mm	2.0 mm
	(c) Short Circuit current of metallic screen for 1 sec (kA)	>40	>40
14	Outer Sheath		
	(a) Material	Extruded HDPE Type ST-7 to IS-7098 (P-III)/93	Extruded HDPE Type ST-7 to IS-7098 (P-III)/93
	(b) Colour	Black	Black
	(c) Thickness (Nom/Min)	4.0 mm	4.0 mm
	(d) Conducting layer over outer sheath	Graphite Coating	Graphite Coating
15	Nominal overall Diameter of cable	115 mm (Approx.)	107 mm (Approx.)
16	Nominal Overall Weight of Cable per Meter	25.9 kg/m (Approx)	16.3 kg/m (Approx)
17	Standard Drum Length with Tolerance	500m±5%	500m±5%
18	Minimum Bending Radius allowable during installation	20 x OD	20 x OD
19	Safe Pulling force	5kg/mm ² of CU area.	5kg/mm ² of CU area.

20	(a) Impulse Withstand	650kVp	650kVp
21	(b) One minute Power Frequency Withstand Voltage (kV)	190kV for 30 sec	190kV for 30 sec
22	Short circuit current for one second(kA)	143	90.10
	Max conductor DC resistance at 20°C	0.0176 ohm/km	0.0283 ohm/km
	Approx. AC resistance at 90°C	0.0233 ohm/km	0.0356 ohm/km
	Max. capacitance	0.309 microF/km	0.229 microF/km
23	Continuous Current Rating for cable laid in close trefoil formation	BEB/ SPB	BEB/ SPB
	(i) In ground at 30°C ground temp, Depth of laying 1.0 m, Thermal Resistivity of soil 150°C Cm/W	655/795	655/795
	(ii) In free air at 40° C Ambient Air Temperature	1095/1305	1095/1305
	BEB: Sheath both end bonded SPB: Sheath single point/ Cross bonded		
	1. The following details shall be embossed/ Printed on outer sheath at regular interval not exceeding one metre. (a) Manufacturer's Name or Trade name (b) Year of Manufacture (c) Voltage grade of Cable i.e. 127 / 220kV (d) Cable Code i.e. 2XA2Y (e) Number of cores & cable size e.g. 1000 Sqmm (Cu) 1 core/630 Sqmm (Cu) 1 core		
	2. Sequential length marking shall also be provided on outer sheath by inkjet printing.		
	3. Cable shall be supplied in steel drums		

7.3.14 GUARANTEED TECHNICAL PARTICULARS FOR 132 KV CABLE:

Sl. No.	Name of the Particulars	1CX630 SQMM/1x800 sq.mm	1CX1000 SQMM/1x1200 sq.mm
1	Type of cable		
2	Standard according to which cable has been manufactured and tested		
3	Rated Voltage (Uo/U)		
4	Highest System Voltage which the cable can withstand		
5	Maximum Conductor temperature for continuous operation		
6	(a) Maximum short time conductor temperature with duration		
	(b) Maximum allowable conductor temp. during overload		
7	Conductor Details		
	Normal Cross-Sectional Area		
	Material and Grade		
	Shape of Conductor		
	Diameter of Conductor		
	No. of Strands and Diameter of each Strand		
	Water swellable powder/yarn provided		
	Conducting water swellable tape with 50% overlap over compacted conductor provided		
8	Extruded Conductor Screen		
	Material		
	Nominal Thickness		
	Diameter over Conductor screen		
	Designed maximum stress at conductor screen		
9	Insulation		
	Material		
	Nominal Thickness		
	Minimum thickness at any point		
	Diameter over insulation		
	Designed maximum stress		
	Detail of vulcanization process		
	Extrusion method		
	Curing method		
	Cooling method		
CO/ or VOI Line			
10	Extruded Insulation Screen		
	Material		
	Thickness		
	Diameter over insulation screen		
	Strippable/ Bonded		

11	Conducting Longitudinal Water Sealing		
	Material		
	Thickness		
12	Metallic Sheath/ Screen		
	Material		
	No. of strands		
	Diameter of each Strand (Nom/Min)		
	Diameter of Cable after stranding		
	Armour coverage		
13	Non-conducting Longitudinal Water Sealing		
	Material		
	Thickness		
14	HDPE Outer Sheath		
	Type		
	Colour		
	Thickness (Nom/Min)		
	Conductive Coating Provided		
15	Nominal overall Diameter of cable		
16	Nominal Overall Weight of Cable per Meter		
17	Standard Drum Length with Tolerance		
18	Minimum Bending Radius allowable during installation		
19	Short Circuit Current Rating of Conductor with maximum conductor temperature at the commencement of fault 1Sec. Duration (90°C)		
20	Maximum Continuous Current Rating of a Circuit Comprising of 3 nos. Single Core Cable laid in trefoil formation at a depth of 1.05 M.		
	Soil Temperature		
	Ambient Temperature		
	Soil Thermal Resistivity		
	System of Bonding		
	Laid in ground (at a depth of 1.05 m)		
	Laid in dusts		
	Installed in Air		
21	Short Time Overload capacity with Duration of cable installed as per conditions mentioned in Item no.22 (2 hours)		
	Laid in ground (at a depth of 1.05 m)		
	Laid in dusts		
	Installed in Air		
22	Maximum AC Resistance at 90°C		
23	Equivalent Star Reactance of a Circuit comprising of 3 Nos. of Single Core cable laid in Trefoil Formation		
24	Maximum Charging Current per Conductor		

	at Nominal Voltage 1.64 AI km		
25	Loss in Metallic Screen of a Circuit comprising of 3 nos. of Single Core Cable installed in Trefoil Formation as per item no. 22		
26	Maximum Current in Metallic Screen when the cable is installed as per item no. 22 (Circulating Current)		
27	Derating factor of Cable installed as per Item No.22 under following conditions Ambient Temperature		
	35°C		
	45°C		
28	Group derating factor of Cable Circuits installed as per Item no. 22 under following conditions		
	Laid 100 mm. apart		
	Laid 250 mm. apart		
29	Induced voltage in metallic screen when Conductor is carrying 100 Amps(V/Km)		
30	Circulating current in metallic screen when conductor is carrying 100 Amps		
31	Test Voltages		
	Impulse Withstand Voltage at 90°C		
	Rated Power Frequency Withstand Voltage (kV)		
	Water penetration test as per IEC 60840		
	Abrasion Test on HDPE Outer sheath as per IEC 60229		
	Recommended Test Voltage after installation		
32	Details of Drum		
	Material and Weight of Drum		
	Weight of Drum with Cable		
	Flange Diameter of Drum		
	Barrel Width of Drum		
	Spindle hole Diameter		
33	Safe Pulling force		
34	Moisture barrier		
	Material		
	Min. Thickness (in mm)		
35	Metallic sheath		
	Material		
	Type of corrugation		
	Gap (in mm)		
	Min & nom thickness		
	Diameter above metallic sheath		
	Anti Corrosive layer		
	Material		
Tape			
36	The following details shall be embossed/ Printed on outer sheath at regular interval not exceeding one metre.		

	(a) Manufacturer's Name or Trade name (b) Year of Manufacture (c) Voltage grade of Cable i.e. 132 kV (d) Cable Code (e) Number of cores & cable size e.g. 630 Sq mm (Cu) 1 core 1000 Sqmm (Cu) 1 core		
	Sequential length marking shall also be provided on outer sheath by inkjet printing.		
	Cable shall be supplied in steel drums		

C) TECHNICAL SPECIFICATION FOR 220 kV XLPE (CROSS

LINKED POLYETHYLENE) INSULATED POWER CABLE:

1.1 SCOPE

1.1.1 The scope under this section covers design, manufacturer, testing, packing, supply, delivery and laying of 220 kV XLPE, insulated power cable including integrated testing and commissioning, technical support, supervision of maintenance, training of Employer's staff and documentation for a complete System necessary to deliver the requirements of this Specification.

1.2 STANDARDS:

Unless otherwise specified, the cables shall conform, in all respects, to **IEC 62067 and IS:7098 (Part-III)/1993** with latest amendment or latest edition for cross linked polyethylene insulated , metallic sheathed & PVC or Polythylene sheathed cable for working voltage of 220 kV.

The following standard specifications of latest version updated to as on date of opening of this bid document will govern supply, laying testing and commissioning of cables and their accessories that are being used in this Contract. In case of conflict between such codes and/ or standards and the specification, the specifications shall govern.

Sr. No	Title of Specification	Specification No.
1	Cross linked polyethylene insulated Thermoplastic sheathed cables	IEC: 60502-2 IEC: 60840, IEC: 62067
2	Conductors for insulated cables.	IEC : 60228
3	Test on cable over Sheath which have a special protective function and are applied by extrusion	IEC 60229
4	HDPE pipes	BIS 4984
5	Power cables with extruded insulation and their accessories for rated voltage above 150 kV- Test Methods & requirements	IEC 60840
6	Power Cables with extruded insulation and their accessories for rated voltages above 150kV.	IEC: 62067

7	Impulse test on cables & their accessories.	IEC 60230
8	Cyclic and emergency rating of cable	IEC 60852-2
9	Common test methods for insulating and sheathing material of electrical cables.	IEC 60811
10	Electric test methods for Electric cables – Test methods for Partial Discharge measurements on lengths of extruded power cables.	IEC 60885

1.3 PRINCIPAL PARAMETERS:

1.3.1 220 KV (E) grade XLPE single core power cable conductor electrolytic grade copper of single length, with formation of stranded compacted circular **water blocked** conductor for size up to 1000 Sqmm and segmental type for size above 800mm² as per, as per IEC-60228, tapped with high **penetration** semi conducting **water blocking** tape, shielded with extruded semi-conducting layer, insulated with dry cured cross linked polyethylene (XLPE) insulation, insulation screened with extruded semi- conducting layer, insulated core lapped with a combination of semi- conducting water swell able and Corrugated Aluminium sheath (acting as a screen and also as a mechanical protector) and black HDPE ST7 (as per IEC 62067 – 2011) with graphite coating or extruded conductive layer overall cable confirming to IS:7098 (Part-III)/1993 or any latest amendments thereof. **Cable shall be preferred of FIPC type. Alternatively, 48 F OFC shall be quoted (Optional).**

1.3.2 Outer sheathing should be designed to afford high degree of mechanical protection and should also be heat, oil chemicals and weather resistant.

1.3.3 The cable should be suitable for laying in covered trenches and/or underground for outdoor
The sheath/screen bonding system shall provide a continuous current path through the cable sheath and jointing kits and shall be bonded. The bonding ends shall be suitably earthed with/without SVL as per approved configuration/design. The sheath voltage under full load condition shall not exceed the voltage specified/allowed in relevant standard for safety of personal as well as satisfactory working of cable **i.e 65 v**. Sheath shall be solidly grounded at suitable location with or without SVL. Bidder must indicate details of configuration proposed along with sufficiency calculation with the bid so as to limit induced voltage of sheath within 65V. **Detailed calculation supporting selection of SVL and bonding cable size and rating with margin of protection to be submitted with bid.**

NOTE: Method of LILO of integrated fiber at each joint for sensing purpose, jointing methodology, Power cable termination to FMS connection method to be submitted for a FIPC cable

1.3.5 CABLE PARAMETERS

Sr. No.	System Particulars	220kV
i)	Voltage Grade (Uo/U)	127/220 kV
ii)	No. of Cores	Single
iii)	Size (mm ²)	630mm ² , 800mm ² ,1000mm ² , 1200 mm ²
iv)	Nominal system voltage KV	220
v)	Highest system voltage KV	245
vi)	System Frequency Hz	50
vii)	Variation in Frequency	± 3%
viii)	Fault level individually for i) Conductor ii) Corrugated Aluminium sheath	40 kA for1sec 40 kA for1sec
ix)	Maximum allowable temperature	
	a) Design continuous operation at rated full load current, the max. temp. of conductor shall not exceed. °C	90
	b) The conductor temperature after a short circuit for 1.0 sec shall not exceed. °C	250
x)	Basic insulation level (1.2/50 Micro Second Wave)	1050 KVP
xi)	System earthing	Effectively earthed

1.4 OPERATION CHARACTERISTICS:

- One/more Three-phase feeders, each consisting of 1 runs of 3/4 Single core cables, feed power at 220 kV.
- In normal situation, each cable will have to be designed to carry a continuous current, to deliver a rated power of Transformers and its designed overload.
- The cable should be designed for a suitable current carrying capacity under normal situation, and which will cater for the above overload capabilities also, will be required.

1.5 GENERAL TECHNICAL REQUIREMENTS:

1.5.1 CONDUCTOR:

The cable conductor shall be made from electrolytic grade copper with formation as stranded compacted circular conductor for size upto **1000 sqmm** and segmental type as per IEC-60228 for the size above **1000mm²**. The conductor shall confirm to IS:8130/2013. **Conductor should be water blocked. Water blocking to be achieved by combination of water blocking yarn and non-conducting water blocking tapes in intermediate layers of conductor.**

1.5.2 CONDUCTOR SCREEN:

A Conductor screen made of semiconducting compound shall be provided over the conductor, by extrusion. The extruded coat shall be continuous, with a constant mean

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depth, without bump, perfectly adhering to the insulation envelope. A **high penetration resistant** semiconducting **water blocking** tape(s) shall be provided below the extruded semi-conducting conductor screen to prevent penetration of the compound into the underlying conductor with **min 50 % overlap**. The conductor having a semi-conducting screen shall ensure perfectly smooth profile and avoid stress concentration. The conductor screen shall be extruded in the same operation as the insulation; the semi-conducting polymer shall be cross-linked. Minimum thickness of the conductor screen shall be **nominal 0.80 mm (minimum)**. The electric resistivity of the conductor screen shall **as per IS 7098 (part 3)**.

1.5.3 INSULATION:

The Insulation envelope shall be of cross-linked polyethylene (XLPE) insulation applied by extrusion should be suitable for **220 kV system** voltages. The nominal thickness of insulation **shall not be less than 27 mm (minimum** subject to **only positive tolerances (no negative tolerance is accepted)** as per IEC 60840. The manufacturing process shall ensure that the Insulation shall be applied by extrusion and vulcanized using dry curing process to form a compact homogenous body free from micro voids and contaminants. The insulation compound shall be of high quality, heat, moisture, ozone and corona resistant. The insulation shall withstand mechanical and thermal stressed under steady state and transient operating conditions. The extrusion method should give very smooth interface between semi-conducting screen and insulation.

1.5.3.1 The nominal thickness of insulation shall not be less than **27 mm (minimum)** (IS 7098 (part 3)).

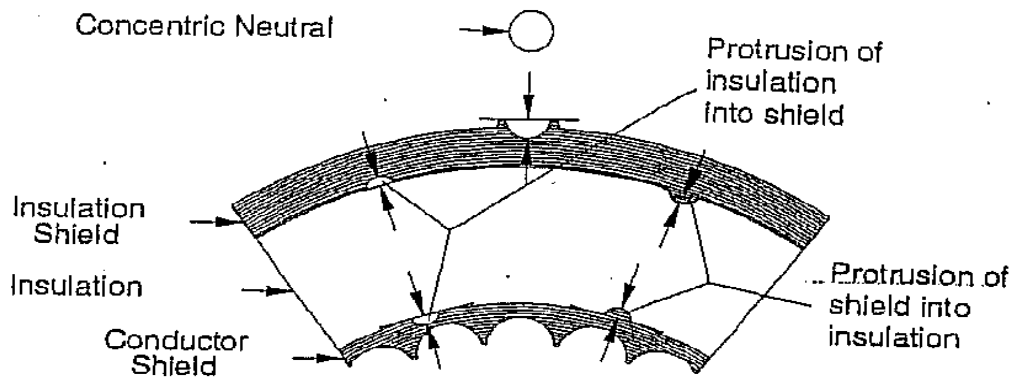
1.5.3.2 The mechanical characteristics shall be as per **IS 7098 (Part 3)** :

1.5.3.3 The isolating envelope shall be as per **IS 7098 (Part 3)** :

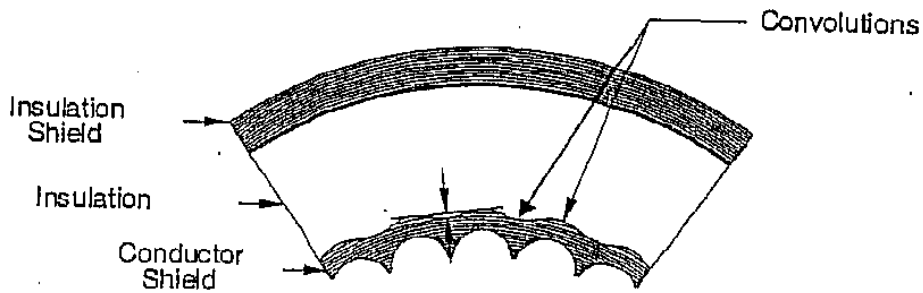
1.5.3.4 Test for surface irregularities shall be carried out as below

Item (For XLPE/TR XLPE insulation)	Clause of AEIC CS8	Unit	Requirement
Protrusions into insulation from conductor screen	3.2	mm	≤ 0.076
Protrusions into conductor screen	3.2	mm	≤ 0.18
Strand Convolutions	3.3	mm	≤ 0.18
Protrusions into insulation from insulation screen	5.2	mm	≤ 0.13
Protrusions into insulation screen	5.2	mm	≤ 0.18

Figure 1
Procedure to Measure Protrusions and Indentations



Procedure to Measure Convolutions



1.5.4 INSULATION SCREEN:

To confine electrical field to the insulation, non-magnetic semi- conducting shield shall be put over the insulation. The insulation shield shall be extruded in the same operation as the conductor shield and the insulation by suitable extrusion process (triple extrusion). The insulation shield shall be extruded in the same operation as the conductor shield and the insulation by suitable extrusion process (triple extrusion). The XLPE insulation shield should be bonded type. It shall be lapped by Foam type semiconducting tape with min thickness of 1 mm. Metallic screening shall be provided by **Aluminium Sheath**.

1.5.6 Metallic sheath:

The metallic screen shall be of Seamless/*Seam welded Corrugated Aluminum* having fault current capacity 40KA for 1-sec with initial temperature of screen as 80 and final temperature as 250 degC calculated by adiabatic method. Supporting calculations shall be submitted with bid

1.5.6.1 ANTICORROSIVE LAYER.

An anticorrosive layer of Bitumen compound followed by tape shall form the anti-corrosive layer

1.5.7 OUTER SHEATH:

The outer extruded semiconducting layer sheath shall be embossed/printed red/yellow/blue colour or similar (as per phase). Suitable semi conducting layer coated on black HDPE ST7 with baked on graphite coating or extruded conductive layer confirming to IEC: 60840, shall be applied over corrugation with suitable additives to prevent attach by rodents and termites. The outer sheath should have embossing/indelible Printing at every one meter for Supplier Name, buyer's name, PO No, Voltage grade, size, type etc.

1.5.7.1 The Mechanical Characteristics shall be as follow :

- a) - In delivery condition
 - 1) - minimal traction resistance : 12.5 Mpa
 - 2) - minimal elongation before breaking : 200%
- b) - After ageing of 240 h at 135°C:
 - 1) - traction resistance:
 - 2) - minimum value : 12.5MPa
 - 3) - maximum variation : \square 25%
 - 4) - elongation before breaking:
 - 5) - minimum value : 200%

6) - maximum variation : 25%

1.5.7.2 The variation is the difference between the medium value obtained after ageing and the medium value without ageing, expressed in percentage of the last.

1.5.7.3 Fiber specification for integration in Power cable

Fiber used in the power cable or supplied separately in the OFC shall be as per below specification.

Attenuation	≤ 0.35 dB/km at 1310 nm (Typical ≤ 0.34 dB/km) ≤ 0.35 dB/km at 1383nm (Typical ≤ 0.34 dB/km) # ≤ 0.21 dB/km at 1550 nm (Typical ≤ 0.20 dB/km) ≤ 0.23 dB/km at 1625 nm (Typical ≤ 0.22 dB/km)
Mode field diameter	8.6 ± 0.4 μ m at 1310 nm
Cable cutoff wavelength	≤ 1260 nm
Zero dispersion wavelength	1300 nm to 1324nm
Zero dispersion slope	≤ 0.092 ps/nm ² .km
Dispersion at 1550 nm	≤ 18.0 ps/nm.km
PMD Individual Fiber*	≤ 0.1 ps/ \sqrt km
PMD LDV	≤ 0.06 ps/ \sqrt km
Cladding diameter	125 ± 0.7 μ m
Core-clad concentricity error	≤ 0.5 μ m
Cladding non-circularity	≤ 0.8 %
Coating diameter	242 ± 5 μ m
Coating-cladding concentricity error	≤ 10 μ m

* Individual PMD values may change when cabled

After hydrogen aging according to IEC-60793-2-50 regarding the B1.3 fiber category

Mechanical Characteristics

Proof Test Levels	≥ 100 kpsi (0.7GN/m ²). This is equivalent to 1% strain
Coating strip force(Force to mechanically strip the dual coating)	≥ 1.3 N (0.3 lbf) and ≤ 5.0 N (1.1lbf)
Fiber curl	≥ 4 m

Macro bend loss: The maximum attenuation with bending does not exceed the specified values with the following deployment conditions

Deployment condition	Wavelength	Induced attenuation
10 turn, 15 mm radius	1550 nm	≤ 0.03 dB
10 turn, 15 mm radius	1625 nm	≤ 0.10 dB
1 turn, 10 mm radius	1550 nm	≤ 0.10 dB
1 turn, 10 mm radius	1625 nm	≤ 0.20 dB
1 turn, 7.5mm radius	1550 nm	≤ 0.20 dB
1 turn 7.5mm radius	1625 nm	≤ 0.50 dB

Environmental Characteristics

Temperature dependence Induced attenuation, -60°C to +85°C at 1310, 1550, 1625 nm	≤ 0.05 dB/km
Temperature humidity cycling Induced attenuation, -10°C to +85°C and 95% relative humidity at 1310, 1550, 1625 nm	≤ 0.05 dB/km
High temperature and humidity aging 85°C at 85% RH, 30 days Induced attenuation at 1310, 1550, 1625 nm due to aging	≤ 0.05 dB/km
Water immersion, 30 days Induced attenuation due to water immersion at 23±2°C at 1310, 1550, 1625 nm	≤ 0.05 dB/km
Accelerated aging (Temperature), 30days Induced attenuation due to temperature aging at 85±2°C at 1310,1550,1625 nm	≤ 0.05 dB/km

Other Performance Characteristics*

Effective group index of refraction	1.4678 at 1310 nm 1.4685 at 1550 nm 1.4689 at 1625 nm
Attenuation in the wavelength region from 1285 - 1330 nm in reference to the attenuation at 1310 nm	≤ 0.03 dB/km
Attenuation in the wavelength region from 1525 - 1575 nm in reference to the attenuation at 1550 nm	≤ 0.02 dB/km
Point discontinuities at 1310 nm & 1550 nm	≤ 0.05 dB
Dynamic fatigue parameter (N _d)	≥ 20

1.5.8 CONSTRUCTION:

1.5.8.1 All materials used in the manufacture of cable shall be new unused and of finest quality. All materials should comply with the applicable provision of the tests of the specification and any other applicable statutory provisions rules and regulations (IS, IEC, Indian Electricity Rules, Indian Electricity Act).

1.5.9 CURRENT RATING:

The cable will have current ratings and de-rating factors as per relevant standard IEC.

1.5.9.1 The one-second short circuit rating values each for conductor, Metal sheath shall be furnished and shall be subject to the purchaser's approval.

1.5.9.2 The current ratings shall be based on maximum conductor temperature of 90 deg. C with ambient site condition specified for continuous operation at the rated current.

1.5.9.3 SIZE:

The different sizes of cable shall be 220 kV Single Core

- a) 630mm²
- b) 800mm²
- c) 1000mm²
- d) 1200mm²

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1.5.10 OPERATION:

1.5.10.1 Cables shall be capable of satisfactory operation under a power supply system frequency variation of plus minus 3% voltage variation of plus, minus 10% and combined frequency voltage variation of 10% (absolute sum).

1.5.10.2 Cable shall be suitable for laying in ducts or buried under ground.

1.5.10.3 Cable shall have heat and moisture resistance properties. These shall be of type and design with proven record on transmission network service.

1.5.11 LENGTHS: The cable shall be supplied in standard drum lengths as below: Size of cable Standard Drum Length

a) **Single Core, 1000 sq.mm** **500 meters ± 2% tolerance**

1.5.11 IDENTIFICATION MARKING:

Identification of cables shall be provided externally at three meters' intervals to identify as under: -

- i) 'Name of Manufacture'
- ii) 'Year of manufacture'
- iii) 'Voltage grade' to be printed/embossed at the interval of one meter-length.
The identification, by printing or embossing shall be done only on the outer sheath.
- iv) Name of purchaser shall also be embossed.

1.6.0 TESTS

1.6.1 Type Tests

The equipment offered should be type tested as a cable system with terminations and both type of joints. Type test report should not be more than seven years old, reckoned from the date of bid opening, in respect of the following tests, carried out in accordance with **IEC 62067**, from Govt./Govt. approved test house, shall be submitted along with bid:

- i) Physical tests for insulation and outer sheath.
- ii) Bending test.
- iii) Di-electrical power factor test.
- iv) Heating cycle test followed by di-electrical power factor as a function of voltage and partial discharge test.
- v) Impulse withstand test.

The remaining type test report as per **IEC 62067** shall be submitted by the successful bidder. These type test reports shall be from Govt. /Govt. approved test house and shall not be more than five years old, reckoned from the date of issue of tender notification. The failure to do so will be considered as a non-responsive.

1.6.2 ROUTINE TESTS AND ACCEPTANCE TESTS

All routine and acceptance tests shall be carried as per relevant ISS in the presence of Employer's representative.

Following additional tests shall be carried out in routine tests (Optional)

- a) Fiber continuity (For FIPC)
- b) Optical loss measurement (for FIPC: 1 sample)

1.7 INSPECTION

The material shall be inspected and tested before dispatch by an authorised representative of the Owner in respect of quality. The inspecting officer shall also satisfy himself about the correctness of length of cables. In case the supplier is not in a position to get these tests carried out at his works, such tests may be got carried out by him at any Govt. recognized test agency at his own expense.

In addition to acceptance tests stipulated by relevant IS/IEC, following additional tests need to be carried out

Measurement of gap below Corrugation

- a) Measurement of thickness of Foam type semiconducting water swellable tape
- b) Measurement of protrusions and convolutions
- c) Sheath integrity test
- d) Wafer boil test
- e) 4 hours voltage test on 3.5 m sample (once in PO)
- f) Volume resistivity (once in PO)
- g) Fiber continuity

1.8 TEST CERTIFICATES

To be submitted.

1.9 PACKING

The cable shall be supplied in returnable Steel drum as per so constructed, as to enable the cable to be transported on each drum. The cable wound on such drum shall be one continuous length. The ends of cables shall be sealed by means of non-hygroscopic sealing material. The Top end shall be provided with Suitable Pulling eye.

1.10 MARKING

The marking on the drum shall have the following information: -

- a) Reference to Indian Standard & cable code.
- b) Name of the manufacturer & trade name.
- c) Nominal cross section area of conductor for the cables.
- d) Number of core.
- e) Sequential No. at each meter.

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- f) Type of the cable & voltage for which it is suitable.
- g) Length of cable on the drum. h) Approximate gross weight.
- i) Net weight of the cable.
- j) Drum identification number.
- k) P.O. No. and date.
- l) Consignee's name with designation.
- m) Year of manufacture.

1.11 DRAWINGS & INSTRUCTION MANUAL

The tenderer shall supply the following drawings with the tender: -

- i) Detailed drawing of the cable showing conductor, screening insulation, Armouring, outer sheath etc. ii) Detailed drawing showing jointing of cable and sealing of end boxes.

Copies of instruction manuals for testing, installation jointing operation and maintenance of cables shall also be submitted with the offer for reference of the purchaser.

1.12 TECHNICAL & GUARANTEED PARTICULARS:

The tenderer shall furnish guaranteed technical particulars as per the tender specification. Particulars, which are subject to guarantee, shall be clearly marked. Offer not containing this information will not be considered.

1.13 TERMINATION KITS AND STRAIGHT THROUGH JOINTS

The entire necessary Straight through joints and Sealing Ends for **220 kV** shall be supplied and erected. The Straight through joints and Sealing Ends wherever required shall be Heat Shrink Type or equivalent, of reputed make with shear head type mechanical connectors or cold shrink type of proven technology & make.

1.14 ISO Accreditation

The cable shall be manufactured by a company having ISO accreditation for quality. The manufacturing process of XLPE cable shall consist of conductor screen, insulation & insulation screen shall be extruded in a single process (Triple extrusion) and cross linked by a suitable proven & latest Process having dry curing technology to ensure homogeneity and absence of micro voids. The cables shall be manufactured by "Dry Curing" Process. It is mandatory that bidder should submit Plant Installation Certificate for process Line and for Metallic sheath machineries indicating the year of installation and other details along with bid. The Employer may decide to visit the works of cable manufacturer to confirm the manufacturing process mentioned & decision of accepting the process is the sole discretion of OPTCL.

PART II

TECHNICAL SPECIFICATION FOR LAYING, TESTING AND COMMISSIONING OF 220 kV XLPE UNDERGROUND POWER CABLE SECTION-1 SPECIFICATION FOR LAYING OF CABLE:

1.1 GENERAL

1.1.2 The Cable Laying works shall be executed according to the rules of the Art pertaining to professional grade and generally in compliance with International Standards and Indian Standards.

1.1.3 The EHV Cables between the Power Supply Authorities Substation and the DMRC RSS shall be laid in ground depending upon the site conditions of the selected route, any of the following paying conditions, may be adopted.

1.1.4 Cable Laying Cases

- Case 1 - Direct buried, with all cables laid in flat formation.
- Case 2 - Direct buried, with the cables (3) of each circuit laid in trefoil formation and side by side in one trench.
- Case 3 - Laid in underground duct.
- Case 4 - Laid in Trench less piping.
- Case 5 - Laid in abutment crossing
- Case 6 - Laid in Rail Track crossing
- Case 7 - Laid in Air, supported on piers/walls, for nallah-crossing

1.1.5 Details of Case 2 :

The trench for carrying the cables shall be at least 1.8m deep and 1.1m wide, which may vary as per site conditions with the approval of employer. Each of the 2 feeders shall consist of 3 single-core cables, and laid in trefoil formation. Cables shall be laid at a depth of 1.7m below the ground level and over a 100 mm bed of coarse sand. Trench is to be filled with sand upto a depth of 1100mm below the ground level. Warning concrete slabs of at least 50mm thickness shall then be laid above the sand. Trench shall then be filled with earth upto a depth of 300 mm below the ground level. A warning net shall then be laid above the earth filling (at 300 mm depth below the ground level). A warning tape shall also be laid appropriately with Purchaser's Name marked on it. The top space of 300 mm shall be suitably filled with compacted Boulder and Bitumen/Jelly and given a final finish matching the surroundings. The cables shall be tied through locking belts after 2 meters each for keeping the cables intact in case of trefoil formation. At locations, where there is change of level of laying, the cables shall be tied through locking belts after 1 meter each.

1.1.6 Details of Case 3

In specific locations, the Employer may require the cables to be laid in underground ducts. The underground ducts shall be laid where road construction or formation is under construction or where water logging stretch is expected or as per the specific site condition.

1.1.7 Details of Case 4 & 6

On all road/rail crossings and at other specific locations, cable laying shall be through trenchless drilling and the cables shall be passed through High Density Polyethylene (HDPE) Pipes or G.I. Pipes of appropriate diameter and thickness (Case-4). One spare HDPE pipe shall be laid for each feeder of 3 cables at the road/rail crossings.

1.1.8 Details of Case 5 & 7

On all abutment crossing or in air, supported on piers/walls, for Nallah crossing and at other specific locations, cable laying shall be on the galvanized steel structures which can withstand wind velocity of 160kmph, supported on piers and have sufficient structural strength. The minimum average weight of zinc coating should be 1000g/m² (RDSO). The cables should be well protected by providing MS sheet of thickness 8mm at least fastened with nuts and bolts & tag welded on all sides to be protected from any pilferages. The arrangement shall render cable absolutely safe from any natural calamity. The cable shall not be exposed or get affected due to stray fire caused in the vicinity. Indicative arrangement is shown in the drawing.

1.1.9 Spare Cables and Pipes

When cables are laid in pipes, in addition to the pipes carrying the cables, at least one spare pipe (minimum 200 mm dia), without cable shall also be provided. In the case cables laid in underground ducts (Case 3) and cables laid in Trenchless piping (Case 4), spare HDPE pipes, one for each circuit, shall be provided. In addition to pipes for power cables, 2 additional pipes, each of not less than 100 mm dia, shall be provided to carry control and monitoring cables, one operational and one spare (As indicated in the Interfacing Requirements, other cables such as pilot wire for pilot wire protection, if required, copper-core or optic fibre cables for control and monitoring, tele-communication etc, supplied by other Suppliers.

1.1.10 Cable protection at changeover location

The cable path, when changing from buried in ground to underground duct or trenchless piping shall be adequately protected by proper sealing in concrete or other suitable means of sufficient mechanical strength to avoid cable from suffering damage due to heat/fire/water ingress etc.

1.1.11 Pulling Chambers

Pulling chambers shall be provided, as necessary, along the route. Such pulling chambers shall be 4m long, 3m wide and at least 2.5m deep. The masonry structure should be of adequate strength with water proofing to avoid any accumulation of seepage of water inside. The edges of RCC covers and masonry shall be lined in GI angles to achieve a long service life.

1.1.12 Route Markers

The route shall be appropriately marked by suitable retro-reflective cable markers, at suitable intervals and positions of straight through joints shall be indicated by suitable boards.

2.0.0 CABLE ACCESSORIES AND BONDING

2.1.0 Straight Through Joints

2.1.1 The straight through Joints should be HEAT SHRINKABLE type or cold shrink type of proven technology and make, suitable for underground buried cables. The joint should comprise of stress control sleeves, insulating sleeves and co-extruded dual wall Tubing comprising of an insulating and semi-conducting layer. A mechanical connector with shear head bolts shall make the conductor connection.

2.1.2 The product should be type tested as per IEC /IS specifications

2.1.3 GENERAL SPECIFICATIONS

a. The product offered should be proven and should be in use in India for a minimum period of 5 years for the same voltage class. List of past supplies in India to be furnished. Performance certificates to be submitted along with the offer.

b. The product offered should have unlimited shelf life.

c. Offers should be supported with type test certificates from test laboratories of repute, as per IEC /IS specifications, failing which the offers shall be ignored.

2.1.4 General Specifications for Joints and Terminations for 220 KV XLPE Cables

Suitable Terminations (Outdoor & Indoor Sealing ends) and Straight through Joints having proven technology of reputed international make & of 220 kV grade or higher for single core 220 kV cables, XLPE Insulated, Aluminium sheathed cables to be used. The Indoor termination for use in the GIS Substation.

2.2.0 Bonding

2.2.1 Suitable bonding methods viz., Single End, Both End and Cross Bonding shall be used.

2.2.2 Link boxes with & without SVL shall be used as required.

3.0.0 TESTING AND INSPECTION:

AS per IS/IEC to be carried out before election.

3.1 TECHNICAL DATA FOR 220kV SINGLE CORE 1000 SQMM XLPE INSULATED, ARMoured CABLE:

Sl. No	Name of the Particulars	Desired Value
1	No. of cores	1(Single)
2	Size (in mm ²)	1000
3	Voltage Grade(in kV)	127/220(245) kV
4	Type of cable	2XA2Y
5	Standard according to which cable has been manufactured and tested	IS: 7098- Part 3, IEC-60840, IEC-60502-2, Testing as per IEC-62067.
6	Permissible Voltage & Frequency variation for satisfactory operation.	

	Voltage	$\pm 10\%$
	Frequency	$\pm 5\%$
7	Maximum rated conductor temperature	90 ⁰ C
8	Max. allowable conductor temperature during short circuit	250 ⁰ C
9	Conductor Details	
	(d) Normal Cross-Sectional Area	1000 mm ²
	(e) Material and Grade	Annealed Plain Copper to IEC 60228
	(f) Shape of Conductor	Compacted stranded circular
	(g) (d) Separator over conductor	Semi-conducting tapes
10	Conductor Screen	
	(c) Material	Extruded Semi-Conducting XLPE compound
	(d) Nominal Thickness	1.5 mm (Approx.)
11	Insulation	
	(c) Material	Cross linked Polyethylene to IEC 62067
	(d) Nominal Thickness	27.0 mm
12	Insulation Screen	
	(d) Material	Extruded Semi-Conducting XLPE (SC) layer followed by water swellable SC tapes
	(e) Min. Thickness	1.0 mm
	(f) Longitudinal Water Sealing	Semiconducting water blocking tape(s) with 50% over lap
13	Metallic Sheath	
	(d) Material	Seam Welded/ Extruded, Corrugated Aluminium sheath with anti corrosion protection
	(e) Thickness	2.3mm
	(f) Short Circuit current of metallic screen for 1 sec (kA)	>40
14	Outer Sheath	
	(e)Material	Extruded HDPE Type ST-7 to IEC 62067

	(f) Colour	Black	
	(g) Thickness (Nom/Min)	4.0 mm	
	(h) Conducting layer over outer sheath	Graphite Coating	
15	Nominal overall Diameter of cable	125 mm (Approx.)	
16	Nominal Overall Weight of Cable per Meter	18.6 kg/m (Approx)	
17	Standard Drum Length with Tolerance	500m±5%	
18	Minimum Bending Radius allowable during installation	20 x OD	
19	Safe Pulling force	5kg/mm ² of CU area.	
20	(c) Impulse Withstand Voltage	1050kVp	
21	(d) One minute Power Frequency Withstand Voltage (kV)	318kV for 30 sec	
22	Short circuit current for one second (kA)	143	
	Max conductor DC resistance at 20°C	0.0176 ohm/km	
	Approx. AC resistance at 90°C	0.0234 ohm/km	
	Max. capacitance	0.17 microF/km	
23	Continuous Current Rating for cable laid in close trefoil formation	BEB	SPB
	(iii) In ground at 30°C ground temp, Depth of laying 1.0 m, Thermal Resistivity of soil 150°C Cm/W	650	820
	(iv) In free air at 40°C Ambient Air Temperature	1100	1345
	BEB: Sheath both end bonded SPB: Sheath single point/ Cross bonded		

3.2 GTP FORMAT:

Sl. No	Name of the Particulars	Value
	Name of the manufacturer	
1	No. of cores	
2	Size (in mm ²)	

3	Voltage Grade(in kV)	
4	Type of cable	
5	Standard according to which cable has been manufactured and tested	
6	Permissible Voltage & Frequency variation for satisfactory operation.	
	Voltage	
	Frequency	
7	Maximum rated conductor temperature	
8	Max. allowable conductor temperature during short circuit	
9	Conductor Details	
	(h) Normal Cross-Sectional Area	
	(i) Material and Grade	
	(j) Shape of Conductor	
	(k) (d) Separator over conductor	
10	Conductor Screen	
	(e) Material	
	(f) Nominal Thickness	
11	Insulation	
	(e) Material	
	(f) Nominal Thickness	
12	Insulation Screen	
	(g) Material	
	(h) Min. Thickness	
	(i) Longitudinal Water Sealing	
13	Metallic Sheath	
	(g) Material	
	(h) Thickness	
	(i) Short Circuit current of metallic screen for 1 sec (kA)	
14	Outer Sheath	
	(i) Material	

	(j) Colour		
	(k) Thickness (Nom/Min)		
	(l) Conducting layer over outer sheath		
15	Nominal overall Diameter of cable		
16	Nominal Overall Weight of Cable per Meter		
17	Standard Drum Length with Tolerance		
18	Minimum Bending Radius allowable during installation		
19	Safe Pulling force		
20	Impulse Withstand Voltage		
21	(e) One minute Power Frequency Withstand Voltage (kV)		
22	Short circuit current for one second(kA)		
	Max conductor DC resistance at 20°C		
	Approx. AC resistance at 90°C		
	Max. capacitance		
23	Continuous Current Rating for cable laid in close trefoil formation	BEB	SPB
	(v) In ground at 30°C ground temp, Depth of laying 1.0 m, Thermal Resistivity of soil 150°C Cm/W		
	(vi) In free air at 40°C Ambient Air Temperature		
	BEB: Sheath both end bonded SPB: Sheath single point/ Cross bonded		

(D) TECHNICAL SPECIFICATION CABLE SEALING END KIT for 220 KV, 132 KV & 33 KV

- (a) Specifications of 245 KV, 145 kV & 33 KV Dry type.
- (b) Termination, Dry type O/D Termination & St through Joints
- (c) Applicable IECs: IEC 60840 for technical data, IEC 62271-209 for dimensioning, EN 50089 for routine tests on Epoxy insulators

1.0 TYPE & MAKE OF CABLE KITS

1.1 SF6 SWITCHGEAR TYPE SEALING END:

1.1.1 For the feeder bays having power cable connections, the suitable cable sealing end enclosures will be supplied by the GIS bidder but 245 KV, 145 kV & 33 KV XLPE cables and cable sealing end terminators with cable cone will not be included in the GIS bidder's supply. Interface between GIS and power cable will be in accordance with IEC 62271-209 (2007-08).

1.1.2 The GIS Plug-in (Dry) type cable sealing end, confirming to IEC: 60840 for termination of the Cables for maximum continuous voltage of 245 KV, 145 kV & 33 KV at SF6 switchgear end will be supplied by the cable manufacturer. The contractor shall be responsible for the preparation of the cable insulation and conductors and correct termination of each cable to these sealing ends.

1.1.3 Bidders are requested to quote cable sealing end with design that helps reducing, if possible, the works on the gas compartments. The cable sealing end shall be of plug-in type that allows easy plugging and unplugging of high voltage power cable without the need of opening the GIS and related time consuming gas works. The supplier of GIS Plug-in (Dry) type Termination will coordinate closely with GIS manufacturer for mounting the epoxy insulator in the GIS cable chamber. The cable contractor will supply only the Plug-in part and associated components.

1.1.4 Cable manufacturer shall furnish large scale general assembly drawings of the SF6 sealing ends, mounting flange details, size of terminal opening in the junction box, weight of terminal including accessories, physical shape and dimensions of all live part, recommended clearances from live parts to the inside surface to permit the SF 6 switch gear manufacturer to design and supply junction boxes of adequate dimensions and construction to permit the installation and maintenance of the terminals without difficulty.

1.1.5 The stress cone made of EPDM rubber shall inhibit possible mechanical stress and deformation of the cable insulation surface during operation and also shall be capable of accommodating minor radial and longitudinal movement without detriment to the dielectric stress in the insulation shield.

1.1.6 Manufacturer shall state the connector clearances required when the assembled cable DC proof test is undertaken for co-ordination with the SF6 switch gear design.

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1.1.7 All supporting structures for the SF6 bus-duct connections between the XLPE cable sealing ends and the GIS shall be supplied by the outdoor GIS supplier. The supplier may specify connecting & supporting arrangements for approval of the purchaser.

1.2 OUTDOOR TYPE SEALING END.

1.2.1 The Dry type cable sealing end (where no oil filling is required in the Termination), conforming to IEC-60840 will be preferred, for maximum continuous voltage of 245 KV, 145 kV & 33 KV cables at the outdoor yard shall be supplied by the cable manufacturer. The contractor shall be responsible for correct termination of each cable to sealing ends, installation of the cable sealing end and providing of terminal connectors for connecting to terminal conductor. The requisite interconnection between line end & sealing end is required to be designed (as per safety and statutory provision aspects) and executed (after approval of Owner) by successful bidder.

1.2.2 The silicone rubber /composite bushing termination of rated capacity, suitable for outdoor installation in heavily polluted atmosphere shall be used. The minimum creepage offered should not be less than 31mm/kV. It should be resistant to UV exposure. The termination stress control shall be by means of stress cone.

1.2.3 The stress cone made of EPDM rubber shall inhibit possible mechanical stress and deformation of the cable insulation surface during operation and also shall be capable of accommodating minor radial and longitudinal movement without detriment to the dielectric stress in the insulation shield.

1.3 STRAIGHT THROUGH JOINTS

1.3.1 The Pre-Moulded type straight through joints for XLPE cable, conforming to IEC 60840 shall be suitable for underground buried installation with incorporated back fill and chances of flooding by water. The straight through joints should be absolutely impervious to the entry of water. The manufacturer shall use the proven technology and design to prevent entry of water or any other liquid inside the straight through joints and cables.

1.3.2 The stress cone made of EPDM rubber shall inhibit possible mechanical stress and deformation of the cable insulation surface during operation and also shall be capable of accommodating minor radial and longitudinal movement without detriment to the dielectric stress in the insulation shield.

1.4 Type tests conducted for offered make cable and accessories separately will be considered for evaluation.

Type test for cable conducted shall be as per IEC 60840 or equivalent/higher standard for 245 KV, 145 kV 1000sqmm, & 33 KV 630 & 300 Sqmm copper cable or above sizes offered make cable & pre moulded joints and end terminations.

i) The above tests should have been conducted from any one of the reputed International Test Laboratories mentioned below.

- a) CPRI, Bangalore .**
- b) STRI Sweden.**
- c) Hydro-Quebec, Canada**
- d) EDF, France.**
- e) KEMA, Holland.**
- f) CESI, Italy.**
- g) IPH, Germany.**
- h) NEETRAC (USA).**

However, the type tests conducted at any other international accreditation test laboratory is also considered, subject to verification of accreditation certification issued by international accreditation board only and for the purpose of conducting type test.

(E) TECHNICAL SPECIFICATION OF LINK BOXES FOR

SI. No	PARTICULARS
1.0	Link boxes and sheath voltage limiters
1.1	General
1.2	Cross Bonding
1.3	Mechanical Design
1.4	Electrical Design
1.5	Applications
1.6	Type Tests
1.7	Dimensions
1.8	Factory Type Tests
1.9	Routine Tests

CROSS BONDING OF EHV CABLES:

1.0 Link boxes and sheath voltage limiters:

1.1 General

Link boxes are used with cable joints and terminations to provide easy access to shield breaks for test purposes and to limit voltage build-up on the sheath. Lightning, fault currents and switching operations can cause over voltages on the cable sheath. The link box optimizes loss management in the cable shield on cables grounded both sides.

1.2 Cross Bonding:

For cross bonding, the cable length is divided into 3 equal sections. Each of the alternating magnetic fields induces a voltage with a phase shift of 120° in the cable shields. The cross bonding takes place in the link boxes. Ideally, the vectorial addition of the induced voltages becomes zero. In practice, the cable length and the laying conditions will vary, resulting in a small residual voltage and a negligible current. Since there is no current flow, there are practically no losses in the screen. The total of the three voltages is zero, thus the ends of the three sections can be grounded. However sections for cross bonding may vary depending on the length of cables.

1.3 Mechanical Design:

VOL-II-TS- 33/132/220 KV Cable : E31

- 1.3.0 Made of stainless steel
- 1.3.1 Compact design
- 1.3.3 Single phase and 3-phase link boxes
- 1.3.4 Hermetically sealed
 - 1.3.4.1 Resists water pressure up to 1 bar (20 psi)
 - 1.3.4.2 Lugs and bonding cables are heat shrink sealed inside and outside

1.3.5 Suitable for different applications

- 1.3.5.0 Single point bonding
- 1.3.5.1 Cross bonding
- 1.3.5.2 Direct grounding
- 1.3.5.3 Grounding through SVL
- 1.3.5.4 Combined direct and SVL grounding
- 1.3.5.5 Cross bonding and transposition

1.4 Electrical Design:

- 1.4.1 Grounding box
- 1.4.2 Link box
- 1.4.3 ZnO sheath voltage limiter
- 1.4.4 3 kV and 6kV protection levels
- 1.4.5 Same outer dimensions for both levels

1.5 Applications:

- 1.5.1 Can be installed in underground pits at a depth of 2mtr and more.
- 1.5.2 Use with single core or concentric bonding lead

1.6 Type Tests:

- 1.6.1 Tested to ANSI/IEEE Std 575-1988 IEEE-Guide for the application of sheath-bonding methods for single conductor cables and the calculation of induced voltages and currents in cable sheaths.
- 1.6.2 Any NABL accredited laboratories..

1.7 Dimensions:

- 1.7.1 Single Phase Link Box: L 300 x W 190 x H 165 (mm)
- 1.7.2 Three Phase Link Box with or Without SVL: L 310 x W 310 x H 255 (mm)

Note: This is Dimensions are indicative only which will be finalized during detailed engineering.

1.8 Factory Type Tests:

- 1.8.1 Water Immersion Test (IP 68- IEC 60529)
- 1.8.2 Impulse Voltage Withstand Test
- 1.8.3 Dust Test
- 1.8.4 Water Jet Test

1.9 Routine Tests:

1.9.1 DC Withstand Test:

25 kV DC voltage is applied for 5 minutes to each cable lug meanwhile all other lugs to be earthed. If exist(s), SVL(s) dismantled during test. In the DC withstand test is no breakdown and flash over.

1.9.2 Insulation Resistance Measurement Test:

5 kV DC voltage is applied for 1 minute to each cable lug meanwhile box itself to be earthed. If exist(s), SVL(s) dismantled during test. At the end of test duration insulation resistance of each link box is greater than 100 MΩ.

1.9.3 Contact Resistance Measurement Test:

50 A DC current will be applied to each contact points which had been squeezed with 40 kN torque. If exist(s), SVL(s) dismantled during test. Contact resistance each contact point is less than 10μΩ.

1.9.4 Water Sealing Test:

All underground type link boxes after manufacturing with cover bolted closed, and phase glands capped, filled with water trough earthing gland will be subject to equivalent 3.0 meter water pressure (0.3 bars) for 15 minutes. VISUALY inspection of external surf. There is no leaks and water spots.

ODISHA TRANSMISSION CORPORATION LIMITED



TECHNICAL SPECIFICATION

FOR

**DIGITAL POWER LINE CARRIER EQUIPMENT, TELEPROTECTION
COUPLER & REMOTE TERMINAL UNIT (RTU)**

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TECHNICAL SPECIFICATION OF DIGITAL POWER LINE CARRIER EQUIPMENT

General

- The PLC equipment shall comply to the standard IEC60495, second edition, 1993.
- For safety, the equipment shall conform to IEC60950-1.
- For EMC and EMI, the equipment shall comply with IEC60255-5,
- IEC61000-4-4/-5/-6/-12/-16, IEC60255-22-1.
- The system shall be of modular design and allow for easy upgrading.
- The PLC equipment shall not use fans or similar for artificial cooling under normal operating condition.

Carrier frequency section.

- The PLC equipment shall support DPLC (Digital PLC) and APLC (Analogue PLC) mode of operation in the same platform, software programmable via PC/Notebook.
- Modulation shall be SSB (Single-Side-Band) for APLC operation, and MCM (Multi-Carrier-Modulation) for DPLC mode of operation. Modulation and coding shall be implemented as software functions in DSP (Digital Signal Processing) technology.
- Transmission mode shall be 2-wire frequency duplex. The nominal carrier frequency shall be programmable from 40 to 500 kHz Minimum preferably however up to 1000 kHz.
- The carrier frequency stability over the stated temperature operating range shall be equal or better than +/- 1ppm.
- The nominal bandwidth BN for transmitting or receiving shall be programmable preferably from 4 kHz to 16 kHz in steps of 4 kHz. Transmit (Tx) and receive (Rx) bands shall be configurable for adjacent or non-adjacent operation.
- Transmit output power shall be the user-programmable for 10,20 or 40W PEP (Peak Envelope Power). 80W PEP transmit power shall be available as an option. The nominal output impedance shall be programmable as 75 or 125 Ohms, unbalanced, or 150 Ohms balance as an option.
- The return loss in transmitter band shall be > 10 dB
- The tapping loss shall be <= 1.5 dB, according to IEC60495.
- The receiver selectivity shall be ≥ 65 dB at 300 Hz from the band edges.
- The AGC range of the receiver shall be 40 dB minimum.

System operation.

- The PLC shall be programmable via PC with HMI/GUI (Graphical User Interface) based on MS-Windows.
- The PLC system shall facilitate the programming and monitoring of the remote terminal from the local terminal using the standard GUI/HMI (Human-Machine-Interface)
- An EMS (Element Management System) shall be incorporated in the HMI for monitoring and programming of the PLC terminals in the network. The EMS shall allow cyclic alarm polling of all the PLC terminals in a network.
- The DPLC shall have the facility to store minimum 256 events and alarm by an internal event recorder in a non-volatile memory.
- The DPLC must have built in test equipments functionality for PLC commissioning and monitoring eg. Received level, AGC, SNR, spectrum analyzer for RX band and test tone generation etc.

Speech and Audio Frequency (AF) signal transmission.

- The PLC shall be configurable for providing up to 3 analogue AF (audio frequency) channels with 4 kHz gross bandwidth each.
- The useful frequency band shall range from 300 Hz to 3720 Hz for each AF channel. In case of multi channel all the channels should operate simultaneously without interference on each other.
- For each channel, a speech low-pass filter shall be configurable with a programmable upper cut-off frequency of 2 kHz to 3.4 kHz in steps of 200 Hz. Speech interfaces shall be configurable as 4-wire E&M, 2-wire FXO or 2-wire FXS.
- It shall be possible to configure 3 analogue speech channels in 8 kHz or in 12 kHz RF-transmission bandwidth.
- Inter-channel cross talk shall be compliant to IEC60495.
- A compandor according to ITU-T G.162 shall be configurable via HMI for each speech channel. Control inputs shall be provided for compandor switching (on/off) by the PABX.
- The frequency band above speech shall be available for the transmission of narrowband modem signals from internal or external modems. The level range of the AF-input-output ports shall be in accordance with IEC60495.
- Digital transmit filters, programmable with respect to bandwidth and center-frequency in steps of 60 Hz, shall be available for each AF channel for the local extraction, insertion and transit-connection of selected Tele-operation frequency bands.
- An equalizer shall be available for each AF channel for equalizing amplitude response distortions of up to +/-12 dB. The equalizer shall be configurable for equalizing group delay distortions. The frequency response before and after equalization shall be displayed in graphical form by means of the GUI (HMI). Equalization of the channel frequency response in both directions shall be possible from one (either) end.
- The PLC shall have local and remote loop back features.

Narrow band Data Transmission.

- The PLC shall provide - as software options - integrated modems for Narrow band data transmission.
- Transmission speed, channel centre-frequencies and the spectral bandwidth shall be programmable in steps for commonly used data rates, ranging from 100 bit/s to 2400 bit/s above speech band.
- The narrow band modems shall be designed for low delay and short recovery times following a link disturbance. In a 4 kHz channel, it shall be possible to transmit preferably up to 2 x 2'400 bps.

Broadband Data Transmission.

- The PLC shall provide - as software option - an integrated modem for broadband/high speed data transmission. Transmission speed and spectral bandwidth shall be programmable via PC/Notebook.
- The speed and transmission bandwidth shall be programmable for at least up to 64 kbit/s in 16 kHz bandwidth. The data rates shall be selectable in steps, compliant with commonly used standardized data rates.
- The system shall support automatic transmission speed adaptation in at least 3 user - defined steps, self-adapting to the prevailing line condition (noise and interference).

- Battery supply -48V DC±15%
- Alarm relay output
 - Potential Free change over contracts
 - System alarm/Cabinet alarm
 - Hardware alarm
 - Link alarm
 - Interface alarm
- Modules of Power supply Single or Doubled (Redundant)

Electromagnetic Compatibility (EMC):

- Emission in accordance with IEC/EN 61000-3-202000 standard, EN 50081-2
- Electrical safety in accordance with IEC/EN 60950-1:2001
- Power frequency magnetic field as per IEC 61000-4-8 level 4 class

Electrostatic Discharge as per IEC 61000-4-2 level 4 class.

TECHNICAL SPECIFICATION OF TELEPROTECTION COUPLER

1. SCOPE:

The specification covers the design, manufacture, testing before despatch, delivery at store and wherever necessary erection / supervision, testing at site and setting to service of the AF coupler at various GRID Sub-Station and Generating Station.

2. BASIC REQUIREMENTS:

- a) All the works shall conform to the IEC recommendation 834-1.
- b) All the materials and equipments offered under this specification shall comply to Indian standards.
- c) the tenderer shall submit separately a list of spares recommended by him for 10 years of operation along with item-wise prices. Supply of such spares during useful life of the equipment shall be guaranteed.
- d) Following drawings shall be supplied with tender:
 - i) Drawing showing outline of complete AF channel and AF coupler equipment.
 - ii) Drawing showing out section view of the equipment.
 - iii) Drawing showing mounting details of all the equipments.
 - iv) Drawing showing the provision of accessories, descriptive literature explaining the basic Principle of operation of the equipments.
 - v) Two sets of instruction / operating manual containing circuit diagram, instruction for erection and commissioning of the equipments, testing schedule, fault tracing procedure shall be supplied along with each equipment.

3. TECHICAL PARTICULARS:

- a) The protection equipment should be plug in type and compatible to be fitted with the carrier sets already in operation under OPTCL.
- b) Tenderer shall offer protection equipment transmitting command within the speech band of the power line carrier set. The time interval that lapses between the instant command that is received from protection relay at the transmitting side and the time this command is passed on to the protection relay at the distant side shall not be more than 10ms.

- c) The equipment shall be suitable for use in conjunction with distance protection system.
- d) The equipment shall be suitable for operation in tropical climate.
- e) The equipment shall consist of two tier bolted together one tier would contain the electronic part transmitter and receiver, while the other tier would house the test and interconnection unit. On the front side socket shall be provided to carry out test measurements.
- f) Equipment should provide full duplex transmission of two non- coded permissive or blocking commands plus two coded prioritized direct tripping commands for the protection of single and double lines including breaker failure protection.
- g) The equipment should be so designed that it should prevent the Circuit breakers from false tripping. The equipment should be Insensitive to corona noise, created by operation of circuit breakers, isolators, switches and electrical surges.
- h) The equipment should be fully microprocessor based.
- i) The equipment should use pilot signal of PLC as guard signal and frequency command signal within the speech band.
- j) The equipment should provide separate frequencies corresponding to the individual commands or command combination in the PLC speech frequency band.
- k) In the command state the equipment should cutoff the guard signal and transmit the command signal within the speech band. At the same time the speech and the data signal on the same channel should be interrupted during the short time of commands transmission.
- l) The output relay of the receiver should operate only when receiver recognizes the missing of guard signal and simultaneously presence of a valid command signal.
- m) The duration of command transfer should not exceed two seconds otherwise the receiver should give alarm.
- n) The equipment should have provision for a cyclic and manual in-service loop test.
- o) The equipment should have facility for counting the tripping of breaker.

4. **BASIC TECHNICAL DATA:**

Blocking Permissive tripping Direct

tripping

a)	Nominal Transmmission timeT0	≤10ms	≤12ms	≤13ms
	Security(Puc)	<1E -04	<1E -06	< 1E -09
	Dependability(SNR/Tac)	>6dB/15 ms	>3dB/19ms	
	>0dB/38ms			
b)	Number of commands	: 4		
c)	Commands duration	:	2 seconds	
d)	S / N Ratio for reliable command reception	:	6 dB	
e)	Primary supply		Internal from the operating carrier set.	
f)	Insulation	:	According to IEC 834-1,IEC-495.	
g)	Ambient condition	:	Adjustable between 0 to 9 dB.	
h)	Guard channel frequency	:	3600 (pilot of carrier set)	
i)	Trip / Test signal frequency Hz.	:	Within the speech band 300 to 2000	
j)	Secure against	:	continuous or impulsive, speech and sweep tones DTMF in-band signaling	
k)	Bandwidth requirement signal	:	NIL ,PLC pilot signal or own guard	
	Guard Signal		above speech band of 2000HZ	
l)	Command input	:	Minimum 2 nos upto coupler type per interface module	
m)	Methods of tripping	:	contact or battery , or dry contact	
n)	Voltage ranges	:	220 VDC	

TECHNICAL SPECIFICATIONS REMOTE TERMINAL UNIT (RTU)

RTU shall be capable of providing all functions specified herein with the addition of the necessary hardware and software modules in the field when required by owner.

The RTU shall be used for real time supervision and control of substation/power plant through owner's regional SCADA systems. LDEM shall be used for local data acquisition, monitoring and control.

1.0 The RTUs shall be capable of performing the following functions:

- (a) Designed around an open ended distributed processing configuration consisting of main processor, peripheral I/O modules, termination panels, power supplies & communication equipment/interface.
- (b) Collecting, processing and transmitting status changes, accumulated values and analog values.
- (c) Time resolution for time tagged events 1 ms
- (d) Receiving and processing digital and analog commands from the master station(s).
- (e) Accepting polling messages from the master station(s)
- (f) Supporting data transmission rates from 100 to 9600 bits per second.
- (g) Supporting minimum four communication ports on outgoing side to interact with multiple Masters on con-current protocols.
- (h) Supporting up to 32 IEDs on a RS 485/RS232 port for communicating with 61850 compliant systems.
- (i) Support Multi-tasking, to enable RTU to concurrently scan input status, whilst executing application program or reporting functions.

- (j) The microprocessor-based common logic should have Compact Flash RAM for storage of configuration files and shall support WEB server diagnosis.
- (k) Function of switching of channels if dual data communication channel is available.
- (l) Supports multiple concurrent protocols including IEC 60870-5- 101 without using any protocol converter as far as practicable. .

The protocol for communication between RTU & Numerical relays shall be IEC 60870-5-103.
- (n) Support Multi-tasking, to enable RTU to concurrently scan input status, whilst executing application program or reporting functions.
- (o) Modbus protocol support.
- (p) PSU of RTU should have capability to drive 2 nos of FSK modem attached with RTU

1.1 Main Processor.

- Advanced 32-bit microprocessor with minimum 40 MHz Processing capabilities.
- Programmable RS-232 Serial ports.
- Communication between Main Processor and I/O Modules shall be on high speed Communication ports of 256 Kbps.
- Three nos. programmable RS 232 serial ports for simultaneous communication with a host of intelligent IEDs at speed of 38.4 Kbps.
- 9600 baud RS 232 maintenance port.
- Optional math co-processor
- Necessary communication module and power supply module shall be provided as part of system requirement.
- I/O Module (Digital and Analogue) shall be provided.
- The Memory capacity of processor shall be with minimum of 2 MB Flash memory adequate enough for satisfactory function of system request.
- The input voltage to the RTU power supply will be provided through 48 VDC /110VDC.

- Self diagnostic shall test memory checksums, RAM test, Configuration verification, Interrupt controller verification, Serial port test, Watchdog and power monitor, Peripheral communication checks, Error logg etc.

1.2 I/O Modules.

The I/O MODULES shall be with separate 16 bit microprocessor based, intelligent, modular unit, capable of data acquisition, control and local data processing.

Each I/O MODULE must be capable of standalone operation for data acquisition and processing so that when it is used in a non-fault tolerant configuration, it will continue its data acquisition, processing and programmable logic functions and subsequently update the Station Level Processor following elimination of the fault.

1.3 **Communication Interface**

The RTUs shall have the capability to support simultaneous communications with multiple independent master stations, a local user maintenance interface and a local logger (printer). Each RTU shall be able to support a minimum of four communication ports. Three of these ports shall be capable of supporting communications to peripheral devices such as multiple SCADA master stations, solid-state meters, microprocessor based relays and remote/local PCs; and the fourth port to be a dedicated maintenance port. The RTU shall simultaneously respond to independent scans and commands from master stations, local logger and local user maintenance interface using a centralized controller and database. The RTU shall support the use of a different communication data exchange rate (bits per second), scanning cycle, and/or communication protocol to each master station. Also, each master station's data scan and control commands may be different for different data points within the RTU's database.

1.3.1 **Modems**

The FSK modem shall not require manual equalization and shall include self test features such as manual mark/space keying, along loop back and digital loop-back. The modems shall provide for convenient adjustment of output level and receive sensitivity. The configuration of tones and speed shall be programmable and maintained in non-volatile memory in the modem.

The modem shall meet the following requirement :

- a) Use CCITT standards including V.24,V.28.V.52 and V.54
- b) Communicate data rates of 100,200,300,600 and 1200 bits per second.

- c) Use CCITT V.23,R35,R.37,R.38a and R.38b standard tones for the selected RTU data rate.
- d) Use frequency shift keying (FSK) modulations.
- e) Use both 2 wire and 4 wire communication lines .
- f) Receive level adjustable from 0 to –40 dBm @ 600ohms
- g) Transmit level adjustable from 0 to -24 dBm @ 600 ohms
- h) Have a minimum sensitivity of -48dBm.

1.3.2 Master Station Communication interface

RTUs shall provide multiple communication ports for possible con-current communication to SCADA system/master stations.

1.3.3 Local User Maintenance computer Interface

The RTUs shall include the interface to support the portable local computer configuration and maintenance/test terminal. The interface shall provide easy access to allow purchaser to use the maintenance terminal at the RTUs installed at the site.

1.4 Master Station Communication Protocol

Shall provide a communication protocol for communicating with master stations using the IEC 60870-5-101 communication standard. The communication protocol shall support all the requirements of this standard. The communication protocol shall be nonproprietary and the contractor shall provide complete description and documentation of the protocol to purchaser for future implementation of additional RTUs due to expansion of power system from supplier at the master stations. The RTU shall also be capable of supporting other communication protocols that may be required to communicate with additional master stations in the future.

1.5 Communication Channel Control

The RTU shall perform as a slave on the communication channel to SCADA systems. The SCADA system master stations shall initiate all communication. Where the RTU must notify the master stations of an unusual condition at the RTU (such as a power fail/restoration or RTU malfunction) or must initiate the transfer of changed data, the notification shall be accomplished within the framework of the periodic data acquisition exchanges.

1.6 Exception Reporting

The RTU communication protocol shall report changes by exception. The communication protocol shall also support an update demand scan of all status data by master stations regardless of the lack of any change in data. The reply to an exception scan request for status points shall consist of an indication of the presence or absence of a change of the status indication points in the RTU. A master station will then request the input of the changed points. The RTU shall continue to indicate exception changes until the master station acknowledges successful receipt of the changed data. The RTU shall report the current state of all status indication points to the master station in response to an update scan even if data has not changed.

1.7 Message security (to be defined in the protocol)

Each RTU communication message shall include an error code, the use of which shall result in a very low probability of an erroneous information frame (data) being accepted as valid. The error code shall be determined and appended to the message for all messages transmitted by the RTU and verified by the RTU for all messages addressed and received by the RTU. Cyclic error detection codes such as Cyclic Redundancy Check (CRC) are required.

High data integrity and consistency is required of the RTU protocols. The protocols used shall provide an adequately low Residual Error Rate (RER), depending on the Bit Error Rate (BER) of the line in use. The minimum required RER is as specified in IEC 870-5-101 protocols with the T-101 profile. This requires the following integrity: BER RER₁₀₋₅ 10-14 10-4 10-10 10-3 10-6. The implemented protocol shall ensure satisfactory performance at Bit Error Rate of 1×10^{-4}

1.8 Analog Inputs

Each analog input shall be furnished with signal conditioning to provide a nominal full-scale voltage to the analog-to-digital (A/D) converter.

The A/D converter and associated signal conditioning shall meet the following minimum characteristics over a 0 Deg C and plus (+) 60 Deg temperature range:

- A. Automatic self-calibration
- B. Full scale accuracy of $\pm 0.1\%$
- C. Linearity of 0.05 per cent full scale
- D. Fourteen bit binary resolution or better; plus one sign bit.

The RTU must scan all analog inputs at a rate of at least once per second and support analog dead-band reporting limits.

Unless otherwise specified, transducers will be provided and installed external to the RTU by the Customer. The transducers are "self-powered" off the sensors. Analog Input Types

The RTU must support the following analog input types: ± 10 VDC, 0 to 1 mA, -1 mA to 1 mA, 0 to 5 VDC, 4 to 20 mA, 0 to ± 5 mA, 0 to 5 mA, and others as requested.

For all 0 to 5 mA transducer inputs, the RTU analog sense must be set up to over range 0 to 6 mA. At 6 mA, the transducer outputs are still linear. The RTU analog inputs must be set to over range 120% on all Customer field analog inputs.

Individually shielded twisted pairs of wires with an overall shield may be used by the Customer for connections between the transducers and the analog inputs at the RTUs. The system shall have high noise immunity from stray circulating currents in the cable shield.

Common-mode noise rejection: 90 dB minimum, 0 to 60 Hz

Normal-mode noise rejection: 60 dB minimums at 60 Hz.

Adjacent channel voltage isolation: withstand the common-mode voltages of any two channels on the same analog input module differing at least 35 volts AC or peak AC.

Programmable Input Ranges Programmable gain instrument amplifier permits programming of voltage input ranges. Ranges are stored in NVRAM on a per point basis. (+/- 1, +/-5, +/- 10 V scale)

Variable scan rate Programmable scan rate of 16.7 to 20 ms (50/60 Hz) on a per module basis
A/D Conversion to provide excellent normal mode rejection characteristics while maintaining good

The RTU shall accommodate Analog input current from transducers, which are isolated, unipolar or bipolar, 2-wire ungrounded differential signals with full resolution.

The Analog input accuracy shall be 99.8% or better at 250 C ambient temperature. Mean accuracy shall drift no more than 0.002% per 0 C within the temperature range of -5 to +55 0

C. Determination of accuracy shall be made while the Analog multiplexer is operating at rated speed.

The Analog-to-digital converter shall have a minimum resolution of + 2048 counts (sign plus 11 data bits). Each input shall have protection and filtering to provide protection against voltage spikes and residual current at 50 Hz, 0.1 ma (peak-to-peak). Overload of up to 50% of the input shall not sustain any failures to the input.

The RTU shall make all appropriate signal level conversion and conditioning to allow full utilization of Analog inputs and meaningful reasonability checking. Including signal conditioning components, the input impedance shall not be greater than 250 Ω . Input scaling shall allow for 20% over range.

1.9 Digital Status Inputs

The digital status input interface shall be capable of accepting isolated wet or dry contact status inputs.

The Contractor shall supply necessary sensing voltage, current limiting, optical isolation, and debounce filtering independently for each digital status input. The Contractor supplied sensing volt shall not exceed 48 VDC. The sensing voltage source shall be isolated from that of the RTUs logic power such that any noise or a short circuit across the sensing supply's output terminals would not disrupt the RTU operation other than the shorted digital status input. 1 ms resolution for time tagged messages is required for fault analysis

The RTU shall store all status changes for retrieval by the master stations. For communication delays or short-term failure of communication with a master station, the RTU shall store a minimum of 2000 status of change events. The RTU shall report any overflow of this status-changed buffer to the master stations.

It shall be possible to configure each status input for one of the following functions:

Single status input

Change of state

Sequence of event (SOE) time tagging with resolution of ± 1 ms.

The SOE buffer capability to store 1024 events.

5. Alarm input
6. Tap position indication using 4-bit BCD coding
7. Trip/block protection signaling.

8. Hysteresis to prevent false state changes due to noise or other conditions.

1.10 Two-State Devices

All switching devices (breakers) shall be supported by a dual-contact status indication. Breakers with re-closing capability shall also be supported with momentary change detection (MCD). All other status indications shall be two-stage single-contact inputs without MCD. Single-contact two-state status point inputs will be from a single normally open (NO) or normally closed (NC) contact. Dual-contact two-state status point inputs will be from two complementary contacts (one NO and one NC). A switching device status is valid only when one contact is closed and the other contact is open. Invalid states shall be reported when both contacts are open or both contacts are closed.

1.11 Momentary Change Detection

Two-state status input points with momentary change detection shall be used by purchaser for points where multiple operations (changes of state) can occur between RTU scans (e.g. breakers with re-closing devices that operate faster than the scan rate). The RTU shall be set to capture contact operations of 20 ms or more duration. Operations of less than 20 ms duration shall be considered no change (contact bounce).

1.12.1 Power Supply Protection

Over voltage and under voltage protection shall be provided within the RTU power supply to prevent the RTU internal logic from being damaged as a result of a component failure in the power supply and to prevent the RTU internal logic from becoming unstable and causing mal-operation as a result of voltage fluctuations.

- ### **1.12 Noise Level**
- The audible noise generated by the RTU equipment shall not exceed 50 dbA : one meter from the enclosure.

1.13 Environmental Requirements

The RTUs will be installed in control buildings without temperature or humidity control. The RTUs shall be capable of operating in ambient temperatures from -5 to $+ 55^{\circ}$ C and relative humidity from 5 to 95%, non-condensing with rate of temperature change of 200 C/hour.

1.14 Maintainability

The RTU design shall facilitate isolation and correction of all failures. The features which promote rapid problem detection, isolation and replacement of failed components, shall be provided as following:

- (a) Self-diagnostic capabilities within each RTU, which can be initiated at the RTU site.
- (b) On-line error detection capabilities within the RTU and detailed reporting to the connected master stations of detected errors.
- (c) Local indication of major RTU failures.

1.15 RTU SOFTWARE REQUIREMENTS

The software provided to support the functions of the RTUs should meet the characteristics described in this section.

Real-Time Executive Software

A real-time operating system shall come with the firmware, characterized by:

- A. Integrated, multi-tasking with structured efficient supervisory layer
- B. Priority scheduling of processes in coordination with other tasks; user applications partitioned into sets of processes
- C. Inter task communication and synchronization
- D. Dynamic memory allocation
- E. Real-time clock to maintain calendar and time, and perform RTU timing functions.
- F. Efficient real-time responsiveness.
- G. During initialization, memory self-diagnostics shall occur and then initialize the system hardware and various I/O devices.
- H. Device drivers will be required for:
 - Managing input and output through the serial communication ports,
 - High-speed link to peripheral boards, and external high-speed port, if needed.
- I. Interrupt controller and interrupt servicing procedure shall prioritize and process hardware interrupts as they occur.

- J. Debugging tools shall allow users, via a PC, to monitor functions, examine memory, perform communication port loop back tests, adjust modem communication port settings, check CPU usage, and process profiling.

1.15.1 Design Characteristics

All software shall be implemented according to established design and coding standards. Purchaser reserves the right to reject any software that does not conform to these standards. Complete and comprehensive documentation shall be provided for all software. The software and the database shall be sized to accommodate growth within the sizing parameters defined for the RTU without requiring software or database regeneration. The design of the software and the database shall not restrict future expansion beyond the sizing parameters. Expansion beyond the original design parameters may require software or database regeneration.

At the time the RTU is accepted, all software delivered must be up to date and in final form, including all standard software changes and field changes initiated by the Contractor or the Contractor's suppliers prior to acceptance. The software documentation must reflect these changes.

1.15.2 Operating System

The Contractor shall use a non-proprietary operating system capable of managing the distributed applications of the RTU. The operating system shall support multi-tasking and multi-programming. The minimum real-time facilities to be provided shall include process, job, database, and memory management, process synchronizing message services for communication between jobs, and device and interrupt handling.

1.15.3 Initialization/Restart Program

Software shall provide automatic restart of the RTU upon power restoration, memory parity errors, hardware failures, and upon manual request. The software shall initialize the RTU and begin execution of the RTU functions without intervention by master station. All restarts shall be reported to the connected master stations.

1.15.4 RTU Operations Monitoring

Software shall be provided to continuously monitor operation of the RTU and report RTU hardware errors to the connected master stations. The software shall check for memory, processor, and input/output errors and failures.

1.15.5 RTU Configuration Support

A RTU Configuration compiler shall generate or modify the database of the RTUs. The database compiler shall provide error detection services and shall produce a printed listing of the input data and the resulting RTU configuration. It shall be possible to maintain the RTU database locally and from a master station using the web server function.

1.15.6 Diagnostic Software

The Contractor shall supply diagnostic software, which monitors and individually tests each of the components of the RTU demonstrating all the capability of RTU as mentioned in this section. The diagnostics shall provide comprehensive user interaction and printout capabilities.

Reference Standard

Vendor shall ensure that equipment and required practices conform to Quality Assurance Standards ISO 9001.

Adhere to Modem standard BELL CCITT.

The RTU shall not be affected by operation of microwave and mobile radio equipment per RFI/EMI Radiation Specification FCC Part 15. Nor should RTU emit radio interference contrary to Department of Communication (Communication Canada) Standards as pertaining to digital apparatus (ICES-003-1991).

Adhere to Standards for SCADA system ANSI C37.1-1979.

Adheres to Surge Withstand Capability (SWC) ANSI C37.90a-1974/78 and IEEE 472- 1974/78; and SWC Fast Transient ANSI C37 90 1-1989; and IEC -255 - 4.

Adhere to Communication Equipment Interface and handshaking standard EIA RS232, 422 485; Definition, Specification, and Analysis of Systems used for Supervisory Control, Data Acquisition, and Automatic Control.

Tests

The RTU and cabling elements of the RTU procurement shall be tested in two parts i.e. type test and routine test as described below.

TYPE TEST:

A minimum of one of each major complete integrated units shall be fully tested to assume full compliance with the functional and technical requirements of the specification. The type test reports for the RTU shall be submitted by the bidder which shall include the tests listed in Table-1.

TABLE-1 List of Type Tests on RTU

Test No	Description of the Test
1	EMI/EMC Immunity tests for RTU
2	Surge immunity test as per IEC 60870-2-1
3	Electrical Fast Transient Burst Test as per IEC-60870-2-1
4	Damped Oscillatory Wave Test as per IEC 60870-2-1
5	Radiated Electromagnetic Filed Test as per IEC 60870-2-1
6	Damped Oscillatory magnetic Field Test as per IEC-60870-2-1
7	Power frequency magnetic field test as per IEC-60870-2-1
Insulating test for RTU	
8	Power frequency voltage withstand test as per IEC 60870-2-1
9	1.2/50 μ s Impulse voltage withstand test as per IEC 60870-2-1
10	Insulation resistance test
Environmental Test for RTU	
11	Dry heat test as per IEC60068-2-2
12	Damp heat test as per IEC60068-2-3

Routine Test

Each complete RTU shall undergo testing to demonstrate compliance with specified requirements, standards and functional capabilities including.

Inventory check and inspection for general construction, cabling connections, drawing conformance and labeling.

Tests of proper functioning of hardware and software by a thorough exercise of all RTU functions, both individually and collectively.

Test operation and accuracy of all RTU analog inputs over entire range.

Test operation of all RTU digital input points.

Test operation of all RTU control outputs.

Test SOE and RTU time synchronization and accuracy.

Test RTU power failure and recovery.

Test of communications including all communication ports .modems and local interfaces.

For any variations in the configuration, hardware components used or variations from the type accepted equipment, owner has the right to perform any of the type testing before successful completion of the Routine testing.

Field Performance Tests

The supplier shall be responsible for providing field installation and testing. All hard wares will be installed, configured, interfaces to all field inputs and outputs established. Upon completion, a field performance test shall be performed to exercise all functions of the RTU . The SCADA database and displays information shall be provided by the bidder. This testing will include , but not be limited to the following tests.

RTU initialization

Proper functioning of hardware and software by exercising of selected RTU functions using the master station.

Test operation of all diagnostic software and confirm issuance of mindful messages for all types of error conditions.

Test time synchronization and accuracy of the RTU from the master station.

Development and integration of database at RTU and LDMS end in line with regional SCADA master database design will be the responsibility of the bidder.

- ✓ RTU database verification including point-to-point operation and scaling accuracy using the master station.
- ✓ Integration of RTU and regional SCADA master.

RTU should have provision for adopting **multifunction power line transducers** for measurement of various electrical parameters of 3 phase 3 wire or 4 wire electric power system. . The DC output of multi function transducer should be available through galvanized isolated analog outputs and RS 485,half duplex serial communication port over MODBUS RTU protocol/DNP 3.0

Modular 3 Phase Ct & PT circuit boards monitor the secondaries of sub-station voltage current transformers. These boards send the waveforms to the RTU for digital signal analysis. This is called transducer less technology. It should allow the master station to display any electrical parameters (single phase or 3 phase composite) from any measurement point. These parameters should include :

- Voltage
- MW
- MVAR
- Frequency

Technical Specification of multi function transducer:

Connection	:	3 phase 4 wire
Input value:		
I in	:	1A,5A(User selectable)
V in	:	110V
DC Output	:	4 nos of galvalised isolated 4-20mA DC, 500 or 750 Ohm
Communication port	:	RS 485 Modbus RTU
Type	:	Multi drop capability
Response Time	:	Less than 500 mSec.

Temperature : 0- 55⁰ C

Humidity : 95% RH non-condensing

Accuracy : ±0.5 % of Span

Standards and Regulations:

IEC 60688 : Electrical measuring transducers for converting AC
electrical quantities to analog or digital signals

IEC 60687 : Alternating current static watt-Hour Meters for Active
energy