

# ODISHA POWER TRANSMISSION CORPORATION LIMITED

OFFICE OF THE SR. GENERAL MANAGER,  
CENTRAL PROCUREMENT CELL,  
JANAPATH, BHUBANESWAR – 751022.

## TECHNICAL SPECIFICATION FOR ISOLATORS

400KV SINGLE ISOLATOR WITH 1 EARTH SWITCH

400KV SINGLE ISOLATOR WITH 2 EARTH SWITCH

220KV SINGLE ISOLATOR WITHOUT EARTH SWITCH

220KV SINGLE ISOLATOR WITH EARTH SWITCH

220 KV TANDEM ISOLATOR

132 KV DOUBLE ISOLATOR WITH EARTH SWITCH

132 KV SINGLE ISOLATOR WITH EARTH SWITCH

132 KV SINGLE ISOLATOR WITHOUT EARTH SWITCH

132 KV TANDEM ISOLATOR

33 KV DOUBLE ISOLATOR WITH EARTH SWITCH

33 KV SINGLE ISOLATOR WITHOUT EARTH SWITCH

### 1. TECHNICAL PARTICULARS OF 400 kV, 220 kV, 132 kV & 33 kV ISOLATOR

	Type:	400 kV	220 kV	132 kV	33 kV
1	Main switch	Double end break centre post rotating, gang operated			
2	Service	Outdoor			
3	Applicable standard	IS : 9921 / IEC-62271-102			
4	No. of Phases	3 phase			

5	Design Ambient temperature	50°C			
6	Type of operation	Electrically Ganged	Mechanically Ganged		
7	Rated voltage (kV)	In KV	In KV	In KV	In KV
	a) Nominal	400	220	132	33
	b) Maximum	420	245	145	36
8	Rated current (Amps)	<b>3150</b>	<b>2000</b>	<b>1250</b>	<b>1250</b>
9	Short time current for 3 sec. (kA)	<b>63</b>	40	31.5	25
10	Rated requency	50 HZ $\pm$ 5%			
11	System earthing	Effectively earthed			
12	Temperature rise	As per relevant IS/IEC standards			
13	Lightening Impulse withstand voltage (kVp)				
	(a) Across Isolating distance	1425(+240)	1200	750	195
	(b) To earth	1425	1050	650	170
14	1 minute power frequency withstand voltage				
	a) Across Isolating distance	610	530	315	80
	b) To earth	520	460	275	70
15	Switching Impulse withstand voltage (kVp)				
	a) Across Isolating distance	900(+345)	-	-	-
	b) To earth	1050	-	-	-
16	Max. RIV for frequency between 0.5 MHz and 2 MHz (micro-volt)	1000 at 267kV	1000 at 156kV	500 at 92kV	-
17	Corona Extinction Voltage (kV)	320	-	-	-

	Type	400 kV	220 kV	132 kV	33 kV
18	Operating mechanism				
	a) Isolator	Motor	Motor	Motor	Motor
	b) Earth switch	Motor	Motor	Motor	Manual
19	Auxiliary voltage				
	a) Control & Inter lock	220V DC 80% to 110%			
	b) Motor voltage	3 Phase 415V AC 50Hz			
	c) Heater, lamp & socket	Single phase 240 V 50HZ			

20	Safe duration of overload				
	150% of rated current	5 minute			
	120% of rated current	30 minute			
21	Minimum creepage distance of insulator (mm)				
22	Mounting structure	Tubular	Tubular / Lattice	Lattice	Lattice
23	Operating time	Less than 12 secs			
24	Insulator Data				
	a) Bending Strength (kgf)	800	800	800	600
	b) Height (mm)	3650	2300	1500	508
	c) Bottom PCD (mm)	300	254	184	76
	d) No. of holes & hole dia	8x18	8x18	4x18	4xM12
	e) Top PCD	127	127	127	76
	f) No. of holes & hole dia	4xM16	4xM16	4xM16	4xM12
	g) Minimum creepage distance (mm) 25mm/kV	10500	6125	3625	900
25	Bus Bar height from Plinth level (mm)	8000	5900	4600	3700
26	Phase Spacing (mm)	7000	4500	3000	1500
27	Minimum clearances (mm)				
	a) Phase to Phase	4000	2100	1300	320
	b) Phase to earth	3500	2100	1300	320
	c) Sectional clearance	6500	5000	4000	3000

## 2. SCOPE

This specification provides for design, manufacturer, testing at manufacturer's Works and delivery, supervision of erection, commissioning (if required) of outdoor station type 400 kV/220kV /132kV /33kV, 3 phase triple pole double break electrically / mechanically gang operated center rotating type (Single / Double) Isolator with / without earth switches, with electrical interlock, insulators and complete in all respect with connectors, arcing horns, operating mechanism, auxiliary switches, indicating devices etc. as described hereinafter.

## 3. STANDARDS

Isolators covered by this specification shall conform to latest edition of IEC 62271-102 and IS: 9921 and unless specifically stated otherwise in this specification.

## 4. TYPE

- The Isolators shall be outdoor type with three phase suitable for electrical as well as manual operation and local/remote operation. They shall have crank and reduction gear mechanism.
- All Isolators offered shall be suitable for horizontal upright mounting on steel structures. Each pole unit of the Isolators and earth switches shall be of identical construction and mechanically linked for gang operation for Isolators upto 220kV. 400kV Isolators shall be individual pole electrical gang operated
- Each pole of the Isolator shall be provided with two sets of contacts to be operated in series and the moving contact blades shall rotate in horizontal plane.
- It should be suitable for continuous service at the system voltages specified herein. The Isolators shall be suitable to carry the rated current continuously and full short circuit current at site condition without any appreciable rise in temperature. These shall also be suitable for operation at 110% rated (normal) voltage.
- The Isolators shall be suitable for Isolating low capacitive / inductive currents of 0.7amp at 0.15 power factor. The isolators shall be so constructed that they don't open under the influence of short circuit conditions.
- The Isolators and earth switches are required to be used on electrically exposed installation and this should be taken into account while fixing the clearance between phases and between phase and earth.

## 5. MAIN CONTACTS

Isolator shall have heavy duty, self-aligning and high pressure line type contacts made of high conductivity, corrosion resistant, hard-drawn electrolytic copper. All copper contact points shall be silver plated to 25 micron thickness or more. Fixed contact should be of reverse loop type with adequate number of copper strips which shall be backed by powerful phosphor bronze/stainless steel springs.

The Isolator moving arm/blade shall be made out of high conductivity, corrosion resistant, hard-drawn electrolytic copper of proper length, thickness and contact/surface area for Isolators upto 220kV.

For 400kV Isolator, the moving arm shall be made out of High conductivity *aluminium* tube of outer diameter not less than 120 mm.

The dimensions of the contacts should conform to the drawing approved during type test. However the current density of the current carrying parts shall not be more than the values specified below.

Current Density in Amps/sq. mm

	<u>Tubes</u>	<u>Flats</u>
Copper	2.5	2.0
Aluminium	1.25	1.0

These fixed and moving contacts shall be able to carry the rated current continuously and the maximum fault current without any appreciable rise in temperature. The Isolator blades shall retain their form and straightness under all conditions of operation including all mechanical stress arising out of operation as well as under rated short circuit condition.

The Isolator shall be self-cleaning type so that when Isolator remains closed for long periods in a heavily polluted atmosphere, binding does not occur. No undue wear or scuffing shall be evident during the mechanical endurance tests.

Contacts and springs shall be designed so that adjustment of contact pressure shall not be necessary throughout the life of the isolator. Contact springs shall not carry any current and shall not lose their characteristics due to heating effects. Each contact or part of contacts shall be independently sprung so that full pressure is maintained on all contact at all times.

The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces, where this is impracticable adequate corona rings made out of aluminium tubes shall be provided. Corona shields are not acceptable.

6. Base :

Each single pole of the isolator shall be provided with a complete galvanized steel base provided with holes and designed for mounting on a supporting structure. The base for 400/220/132 kV shall be made out of two channels of size 200x100 / 150x75 / 150x75 or more having thickness not less than 5mm. Base channel shall be rigid in construction and capable of taking all the loads like short circuit force, terminal load, wind load and vibration caused due to seismic / operation of Isolator. Leveling screws of adequate size shall be provided on either side of the base channel under the Insulator for the alignment of Isolator. For 33kV Isolator single base channel of size 100x50 can be provided.

The rotating insulator shall be mounted on a rotating post which shall have two ball bearings of suitable size and housed inside a bearing housing made out of aluminium alloy and greased for life. The distance between the bearings shall not be less than 200/150/125/70 mm for 400/220/132/33 kV respectively.

7. ARCING HORN AND GRADING HORN

Suitable arcing horn made of GI shall be provided on the fixed and moving contacts of Isolators if required. The contacts shall be of 'make before and break after' type.

8. ELECTRICAL INTERLOCK / MECHANICAL INTERLOCK

The Isolators shall be equipped with electrical interlock for interlocking with the associated circuit breakers and earth switch. The interlocking scheme shall be approved by OPTCL.

Suitable mechanical / constructional interlock shall be provided between Isolator and earth switch which should be rigid in construction and properly mounted to ensure reliable operation.

## 9. AUXILIARY SWITCHES

All isolators and earth switches shall be provided with 220V DC auxiliary switches for remote position indication on the control panel and for electrical interlocking with other equipment.

The auxiliary switch shall be provided with a minimum of auxiliary contacts-12 normally open and 12 normally closed and 10 normally open and 10 normally closed for earth switch.

The auxiliary switches and auxiliary circuits shall have a continuous current carrying capacity of at least 10 Amps. Auxiliary switches shall not be used as limit switches.

Details of make, rating and type of auxiliary switch along with the type test report shall be furnished in the offer.

## 10. EARTH SWITCH

a) Where earth switches are specified these shall include the complete operating mechanism and auxiliary contacts. The earth switch shall be operated by a separate mechanism.

b) The earth switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator.

c) Earth switches shall be only locally operated.

d) The earth switches shall be constructionally interlocked with the isolator so that the earth switches can be operated only when the isolator is open and vice versa. The constructional interlocks shall be built in construction of isolator and shall be in addition to the electrical interlocks. Suitable mechanical arrangement shall be provided for delinking electrical drive for manual operation.

e) Each earth switch shall be provided with flexible copper braids or any other improved design for connection to earth terminal. These braids shall have the same short time current carrying capacity as the earth blade.

f) The plane of movement and final position of the earth blades shall be such that adequate electrical clearances are obtained from adjacent live parts in the course of its movement between ON and OFF position.

g) Isolator design shall be such as to permit addition of earth switches at a future date. It should be possible to interchange position of earth switch to either side.

h) The earth switch should be able to carry the same fault current as the main blades of the Isolators and shall withstand dynamic stresses.

i) 400 kV earth switches shall be of double movement type (telescopic) i.e. it has to rotate 90 degree in first movement and then lift upwards to make a contact which ensures a reliable and jerk free operation of the earth switch. Proper locking arrangement shall be provided such that the earth switch shall be locked after lifting upwards to avoid opening during short circuit.

## 11. OPERATING MACHANISM

- a) The bidder shall offer motor operated Isolators and earth switches except for the earth switches of 33 kV Isolator which shall be manual operated with crank and reduction gear mechanism.
- b) *Control cabinet/operating mechanism box shall be made of cast aluminium / aluminum sheet of adequate thickness (minimum 3 mm) for 33 KV,132KV and stainless steel (grade-316) of minimum thickness 1.6 mm for 400 KV and 220 KV.*
- c) The enclosure shall be painted / powder coated to the Shade no 631 of IS:5(for aluminium enclosure)
- d) The enclosures of the operating mechanism Box shall conform to the degree of protection IP- 55
- e) A "Local/Remote" selector switch and a set of open/ close push buttons shall be provided on the control cabinet of the isolator to permit its operation through local or remote push buttons.
- f) For 400kV Isolators, Gang / Individual switch shall be provided.
- g) Provision shall be made in the control cabinet to disconnect power supply through suitable MCBs to prevent local/remote power operation.
- h) All control switches shall be of MCB/rotary switch type and Toggle/piano switches shall not be accepted.
- i) Motor shall be an AC motor as per IS:325. Motors rated 373 watt and above shall be used. The motor shall withstand without damage stalled torque for atleast 3 times the time lag of tripping device.
- j) Suitable reduction gearing shall be provided between the motor and the drive shaft of the isolator. The mechanism shall stop immediately when motor supply is switched off.
- k) Manual operation facility (with handle) should be provided with necessary interlock to disconnect motor.
- l) Gear should be of forged material suitably chosen to avoid bending/jamming on operation after a prolonged period of non operation. Also all gear and connected material should be so chosen/surface treated to avoid rusting. The Gears shall be lubricated for life with graphite or better quality non-drawing and non-hardening type grease.
- m)The test report for blocked rotor test of motor shall be submitted
- n) Only stranded copper conductor shall be used for wiring. Minimum size of the conductor for control circuit wiring shall be 2.5 sq.mm Copper.
- o) The operating mechanism shall be located such that it can be directly mounted on the support structure.
- p) Suitable anti condensation heaters with the provision of thermostat shall be provided.
- q) Each operating mechanism shall be provided with 1100V grade stud type terminal block of Polyamide material. (OAT-6 for non-disconnecting type and OAT 6T for disconnecting type of Elmex) / Connectwell (Equivalent). At least 20% spare terminals shall be provided.

r) A light fixture suitable for a 240 V CFL tube light shall be provided in each of the motor operated mechanism & shall be door operated type.

s) A 240V, single phase, 50 Hz, 15 amp AC plug and socket shall be provided in the cabinet with ON-OFF switch for connection of hand lamps.

t) A position indicator to show the isolator is in ON or OFF position to be provided at a suitable location.

## 12. OPERATION

The main Isolator and earth switches shall be individual pole electrically ganged motor operated for 400 kV and mechanically gang operated in case of 220/132/33 kV. The operating mechanism of the three poles shall be well synchronized and interlocked.

The Isolator blades shall be in positive continuous control throughout the entire cycles of operation. The operating rods and pipes shall be rigid enough to maintain positive control under most adverse conditions and to withstand all torsional and bending stresses arising from operation. Operation of the switches at any speed should not result in improper functioning, in displacement of parts / machines after final adjustment has been made. All holes in cranks, linkages etc. having moving pins shall be drilled and fitted accurately so as to prevent slackness and lost motion.

The isolator and earth switches shall be provided with "dead center mechanism" to prevent accidental opening by wind, vibration, short circuit forces or movement of the support structures.

## 13. DESIGN, MATERIALS AND WORKMANSHIP

- The live parts shall be designed to eliminate sharp points, edges and similar corona producing surfaces, where this is impracticable, adequate rings made out of aluminium tubes shall be provided. Corona shields are not acceptable.
- All ferrous metal parts shall be hot dip galvanized, as per IS 2629. All metal parts shall be of such materials or treated in such a way so as to avoid rust, corrosion and deterioration due to continued exposure to atmosphere and rain.
- Bolts, screws and pins shall be provided with standard locking device viz. Locknuts, spring washers, keys etc. and when used with current carrying parts, they shall be made of copper silicon or other high conductivity and wear resistant alloys.
- The switches should not need lubrication of any parts except at very long interval of five year minimum.

## 14. PROTECTIVE COATINGS

All ferrous parts including bolts, nuts and washers of the switches assembly shall be galvanised to withstand at least six one minute dips in copper sulphate solution of requisite strength (Preece dip tests) except the threaded portions which should withstand four dips.

## 15. INSULATORS

- Support insulators for all type of isolators shall be of solid core type.

- The insulator shall be made of homogeneous and vitreous porcelain of high mechanical and dielectric strength. It shall have sufficient mechanical strength to sustain electrical and mechanical loading on account of wind load, short circuit forces etc. Glazing of the porcelains shall be of uniform dark brown colour with a smooth surface arranged to shed away rain water.
- The porcelain shall be free from laminations and other flaws or imperfections that might affect the mechanical or dielectric quality. It shall be thoroughly vitrified, tough and impervious to moisture.
- The porcelain and metal parts shall be assembled in such a manner and with such material that any thermal differential expansion between the metal and porcelain parts throughout the range of temperature specified in this specification shall not loosen the parts or create under internal stresses which may affect the mechanical or electrical strength or rigidity. The assembly shall not have excessive concentration of electrical stresses in any section or across leakage surfaces. The cement used shall not give rise to chemical reaction with metal fittings.
- The insulator shall be suitable for water washing by rain or artificial means in service condition.
- Profile of the insulator shall also conform to IEC-815.
- Caps to be provided on top of the insulator shall be of high grade cast iron or malleable steel casting. It shall be machine faced and hot dip galvanized. The holes shall be suitable for bolts with threads having anti corrosive protection. The effective depth of threads shall not be less than the nominal diameter of the bolt. The cap shall be so designed that it shall be free from visible corona and shall have radio interference level within 500 micro volts.
- Casting shall be free from blow holes cracks and such other defects.

16. Name plate :

Isolator, earth switches and their operating devices shall be provided with name plate. The name plate shall be weather proof and corrosion proof. It shall be mounted in such a position that it shall be visible in the position of normal service and installation. It shall carry the following information's duly engraved or punched on it. Name plate shall be bilingual i.e. in English & Oriya

A. Isolator Base

Name : OPTCL  
 Name of manufacturer –  
 Type Designation –  
 Manufacturers serial No. –  
 Rated voltage –  
 Rated normal current –  
 Rated short time current (rms) and duration –  
 Rated short time peak current (KAP)  
 Weight

B. Earthing Switch

Name : OPTCL  
 Name of manufacturer –  
 Type Designation –  
 Manufacturers serial No. –  
 Rated voltage –

Rated normal current –  
Rated short time current (rms) and duration  
Rated short time peak current (KAP)  
Weight

### C. Operating Device

Name – OPTCL  
Name of manufacturer –  
Type Designation –  
Reduction gear ratio –  
AC motor

- i) Rated auxiliary voltage
- ii) Starting current
- iii) Designation of AC motor as per I.S 4722/325
- iv) Starting torque at 80% of supply voltage
- v) Over travel in degrees after cutting off supply  
Total operating time in seconds
- i) Close operation – Electrical
- ii) Open operation – electrical  
Open operation – manual

All components shall be given adequate treatment of climate proofing as per IS:3202 so as to withstand corrosive and severe service conditions.

All metal parts not suitable for painting such as structural steel, pipes, rods ,levers, linkages, nuts and bolts used in other than current path etc. shall be hot dip galvanized as per IS -2629

Complete details of painting, galvanizing and climate proofing of the equipment shall be furnished in the offer.

## 17. TESTS

### Type Tests

Isolators offered, shall be fully type tested as per the relevant standards. The Bidder shall furnish one set of the following valid type test reports for their different type of offered Isolators along with the offer. The Purchaser reserves the right to demand repetition of some or all the type tests in the presence of purchaser's representative. For this purpose the Bidder may quote unit rates for carrying out each type test and this will be taken during bid price evaluation, if required.

The following type test reports shall be submitted for evaluation purpose. In the absence of any one of the following, the bid is liable to reject.

- a) Short time withstand & peak withstand current test for Isolator & Earth Switch.
- b) Power frequency (Dry & Wet), Lightning Impulse dry withstand Test
- c) Radio interference voltage (RIV) test
- d) Mechanical endurance Test & Terminal load test
- e) Degree of Protection test (IP-55)
- f) Corona Test (For 400kV Only)
- g) Temperature rise test
- h) Blocked rotor test

During type tests the isolator shall be mounted on its own support structure or equivalent support structure and installed with its own operating mechanism to make the type tests representative. Drawing of equivalent support structure and mounting

arrangements shall be furnished for Purchaser's approval before conducting the type tests.

The type tests shall be conducted on the isolator along with approved insulators and terminal connectors.

Mechanical endurance test shall be conducted on the main switch as well as earth switch of one isolator of each voltage class for M0 class (1000 operations) for Isolators upto 220kV. 400kV Isolators shall be tested for extended mechanical endurance test, M2 class (10000 operations) as per IEC 62271-102 which shall be tested at any NABL accredited independent laboratory like CPRI/ERDA.

#### Acceptance and Routine Test :

All acceptance and routine test as stipulated in the relevant standards shall be carried out by the supplier in presence of Purchaser's representative.

Mechanical operation test (routine test) shall be conducted on isolator (main switch and earth switch) at the supplier's works as well as purchaser's substation site.

Immediately after completion of the routine test, the supplier shall give 20 days' advance intimation along with routine test certificates, valid calibration reports from Govt. approved test laboratories for the equipments, instruments to be used during testing for scrutiny by the purchaser to enable him to depute his representative for witnessing the tests.

If there will be any discrepancies in the routine test certificates and calibration reports furnished by the manufacturer, then after settlement of the discrepancies only, purchaser's representative will be deputed for witnessing the tests.

Special tests proposed to be conducted (if decided to conduct) as type test on isolators, are given at Annexure. These special type test charges shall be quoted along with all other type tests as per relevant IEC standard and these charges shall be included in the total bid price.

Test certificates of various raw materials and bought out items including but not limited to the following shall be furnished at the time of routine tests.

- a) Chemical analysis of copper alongwith a copy of excise certificate indicating genuine source of procurement of electrolytic grade copper.
- b) Aluminium extrusions
- c) Aluminium ingots & castings
- d) Fasteners
- e) Insulators
- f) Motor
- g) Gears
- h) Auxiliary switch
- i) Limit switch
- j) Overload / single phase preventer
- k) Interlocking devices
- l) Terminal block

#### 18. INSPECTION

- i) The Purchaser shall have access at all times to the works and all other places of manufacture, where the Isolators, earth switches and associated equipment are being manufactured and the supplier shall provide all facilities for unrestricted inspection of the

works of raw materials manufacture of all the accessories and for conducting necessary tests as detailed herein.

ii) The supplier shall keep the purchaser informed in advance of the time of starting of the progress of manufacture of equipment in its various stages so that arrangements could be made for inspection.

iii) No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

iv) The acceptance of any quantity of the equipment shall in no way relieve the supplier of his responsibility for meeting all the requirements of this specification and shall not prevent subsequent rejection if such equipment are later found to be defective.

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#### 19. QUALITY ASSURANCE PLAN

The Bidder shall invariably furnish following information along with his offer, failing which his offer shall be liable for rejection.

(i) Names of sub suppliers for raw materials, list of standards according to which the raw materials are tested, list of tests normally carried out on raw materials in presence of Supplier's representative, copies of test certificate

(ii) Information and copies of test certificates as in (I) and (ii) above in respect of bought out accessories.

(iii) List of manufacturing facilities available

(iv) Level of automation achieved and list of areas where manual processing still exists.

(v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

(vi) List of testing equipments with calibration certificates from Govt. approved test house available with supplier for final testing equipment and test plant limitation if any, vis-à-vis the type, special acceptance and routine test specified in the relevant standards. These limitations shall be very clearly brought out in the specified test requirements.

The supplier shall within 30 days of placement of order, submit following information to the purchaser.

i) List of raw material as well as bought out accessories and the names of sub-suppliers selected from the lists furnished along with offer.

ii) Type test certificates of the raw material and both bought out accessories.

iii) Quality Assurance Plan (QAP) with hold points for purchaser's inspection.

#### 20. DOCUMENTATION

All drawings shall conform to relevant international standards organisation (ISO). All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I. Units.

List of Drawings and Documents

The Bidder shall furnish four sets of following drawings / documents along with his offer.

a) General outline and assembly drawings of the dis-connector operating mechanism, structure, insulator and terminal connector.

b) Sectional views and descriptive details of items such as moving blades, contacts, arms contact pressure, contact support bearing housing of bearings, balancing of heights, phase coupling pipes, base plate, operating shaft, guides, swivel joint operating mechanism and its components etc.

c) Loading diagram

d) Drawings with structure for the purpose of type tests.

- e) Name plate.
- f) Schematic drawing.
- g) Type test reports.
- h) Test reports, literature, pamphlets of the bought out items and raw material.

The supplier shall within 2 weeks of placement of order submit four sets of final versions of all the above said drawings for Purchaser's approval. The purchaser shall communicate his comments / approval on the drawings to the supplier. The supplier shall, if necessary, modify the drawings and resubmit four copies of the modified drawings for Purchaser's approval within two weeks from the date of comments. After receipt of approval the supplier shall within three weeks submit 5 prints and soft copies in two CD of the approved drawings for purchaser's use.

Six sets of the type test reports, duly approved by the Purchaser shall be submitted by the supplier for distribution, before commencement of supply Adequate copies of acceptance and routine test certificates, duly approved by the Purchaser shall accompany the despatched consignment.

The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the purchaser. All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the supplier risk.

## 21. INSTRUCTION MANUALS :

Five copies of the erection, operation and maintenance manuals in English be supplied for each type of Isolator one month prior to despatch of the equipment. The manual shall be bound volumes and shall contain all drawings and information required for erection, operation and maintenance of the Isolator including but not limited to the following particulars.

- (a) Marked erection prints identifying the component parts of the Isolator as shipped with assembly drawings.
- (b) Detailed dimensions and description of all auxiliaries.
- (c) Detailed views of the insulator stacks, metallics, operating mechanism, structure, interlocks, spare parts etc.

## 22. PACKING AND FORWARDING.

The equipment shall be packed in crates suitable for vertical / horizontal transport, as the case may be and suitable to withstand handling during transport and outdoor storage during transit. The supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting, such as lifting hooks etc. shall be provided. Any material found short inside the packing cases shall be supplied by supplier without any extra cost.

Each consignment shall be accompanied by a detailed packing list containing the following information:

- (a) Name of the consignee.
- (b) Details of consignment.
- (c) Destination.
- (d) Total weight of consignment.
- (e) Handling and unpacking instructions.
- (f) Bill of material indicating contents of each package.

The supplier shall ensure that the bill of material is approved by the purchaser before dispatch.

## 23. SUPERVISION OF ERECTION TESTING & COMMISSIONING (ET&C)

Purchaser proposes to utilize the services of the supplier for supervision of testing and commissioning of the equipment being supplied by him, if it is required. For this purpose, the supplier should make available the services of trained personnel (Engineers) who shall correct in the field, any errors or omissions in order to make the equipment and material properly perform in accordance with the intent of this specification.

The Engineer shall also instruct the plant operators in the operation and maintenance of the commissioned equipment. The supplier shall be responsible for any damage to the equipment on commissioning the same, if such damage results for the faulty or improper ET&C.

Purchaser shall provide adequate number of skilled / semi skilled workers as well as general tools and equipment and cranes required for equipment erection, at his own expenses. Apart from the above, the Purchaser shall not be responsible for providing any other facilities to the supplier. Special tools if required for erection and commissioning shall be arranged by the supplier at his cost and on commissioning these shall be supplied to the purchaser free of cost for future use.

## 24. QUATITITY AND DELIVERY REQUIREMENTS :

The scope of supply shall include a supply of 2.5% extra quantity of galvanised bolts, nuts, washers, split pins, cotter pins and such other small loose items free of cost.

ANNEXURE  
(Isolators)

LIST OF SPECIAL TESTS TO BE CARRIED OUT  
(IF DECIDED BY THE PURCHASER)

Sl. No.	Name of the Test	Standard to which it conforms.
1.	Test for visible Corona and Radio interference voltage (RIV) on Isolators and terminal connector	NEMA Pub No. 107-1964 ISRI Pub No. 1-1972
2.	Tests on insulators	IS-2544 IEC. 168
3.	Tests on terminal connectors	IS:5561
4.	Tests on galvanised components	IS:2633
5.	Stalled torque test on motor operating mechanism	At 110% of supply voltage

LIST OF MANDATORY SPARES

Sl. No	Item	Quantity
1.	Copper contact fingers for male and female contact per Isolator	2sets each for each Type of Isolators (400/220/132/33KV)
2.	Relay, power contactors, MCBs, Rotary switches for electrical control circuit per Isolator (Indicate the nos of relay, power contactors, MCBs, Rotary switches used in the electrical circuit of each type of isolators)	2sets for each Type of Isolators
3.	Support insulator stack for one pole of the isolator	2 stacks for each type of Isolators
4.	Terminal pad	2 Nos. for each type of isolators
5.	Limit switch and Auxiliary switch per Isolator (Indicate the nos of each switch used in each type of isolators)	2sets for each type of Isolators
6.	Terminal connectors per Isolator	2 sets for each type of isolators.



# **ODISHA POWER TRANSMISSION CORPORATION LIMITED**

## **TECHNICAL SPECIFICATION**

### **FOR 315 KVA & 1 MVA, 33/0.433 KV STATION TRANSFORMER**

#### **TECHNICAL SPECIFICATION FOR OUTDOOR TYPE 315KVA, 33/.433KV STATION TRANSFORMERS**

##### **1. SCOPE:**

1.1 This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply and delivery at site of oil immersed, naturally cooled 3 phase **315 KVA & 1000 KVA, 33kV/ 0.433KV** station transformers for outdoor use.

1.2 It is not the intent to specify completely herein all the details of the design and construction of equipment. However the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation, in a manner acceptable to the purchaser, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of bidder's supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

1.3 The transformer and accessories shall be designed to facilitate operation, inspection, maintenance and repairs. The design shall incorporate every precaution and provision for the safety of equipment as well as staff engaged in operation and maintenance of equipment.

1.4 All outdoor apparatus, including bushing insulators with their mountings, shall be designed so as to avoid any accumulation of water.

**2. STANDARD RATINGS:**

2.1 **315 KVA & 1000 KVA ,33/0.433 kV** Station Transformers.

**3. STANDARDS:**

3.1 The materials shall conform in all respects to the relevant Indian / International Standards, with latest amendments thereof unless otherwise specified herein. Some of them are listed below:

<b>Indian Standard</b>	<b>Title</b>	<b>International and Internationally recognized standards</b>
IS - 2026	Specification for Power Transformers	IEC 76
IS - 12444	Specification for Copper wire rod	ASTM B - 49
IS - 335	Specification for Transformer Oil	BS 148, D - 1473, D - 1533-1934 IEC Pub 296
IS - 5	Specification for colors for ready mixed paints	
IS - 104	Ready mixed paint, brushing zinc chromate, priming	
IS - 2099	Specification for high voltage porcelain bushing	
IS - 649	Testing for steel sheets and strips and magnetic circuits	
IS - 4257	Dimensions for clamping arrangement for bushings	
IS - 7421	Specification for Low Voltage bushings	
IS - 3347	Specification for Outdoor Bushings	DIN 42531 to 33
IS - 5484	Specification for Al Wire rods	ASTM B - 233
IS - 9335	Specification for Insulating Kraft Paper	IEC 554
IS - 1576	Specification for Insulating Press Board	IEC 641
IS - 6600	Guide for loading of oil Immersed Transformers	IEC 76

IS . 2362	Determination of water content in oil for porcelain bushing of transformer	
IS . 6160	Rectangular Electrical conductor for electrical machines	
IS - 5561	Electrical power connector	
IS . 6103	Testing of specific resistance of electrical insulating liquids	
IS . 6262	Method of test for power factor and dielectric constant of electrical insulating liquids	
IS . 6792	Determination of electrical strength of insulating oil	
IS - 10028	Installation and maintenance of transformers	

3.2 Material conforming to other internationally accepted standards, which ensure equal or better quality than the standards mentioned above, would also be acceptable. In case the bidders who wish to offer material conforming to other standards, the bidders shall clearly bring out the salient points of difference between the standards adopted and the specific standards in relevant schedule. Four copies of such standards with authentic English translations shall be furnished along with the offer.

#### 4. SERVICE CONDITIONS:

4.1 The Station Transformers to be supplied against this Specification shall be suitable for satisfactory continuous operation under the following climatic conditions as per IS 2026 (Part . I)

i) Location : At various locations in the state

ii) Maximum ambient air Temperature (°C) : 50

iii) Minimum ambient air Temperature (°C) : 0

iv) Maximum average daily ambient air temperature (°C) : 40

v) Maximum yearly weighted average Ambient temperature (°C) : 32

#### Note:-

1. The equipment shall generally be for use in moderately hot and humid tropical climate, conducive to rust and fungus growth .

#### 5. PRICIPAL PARAMETERS:

5.1 The transformers shall be suitable for outdoor installation with three phase, 50 Hz, 33 kV system in which the neutral is effectively earthed and they should be suitable for service with **fluctuations in supply voltage up to plus 12.5% to minus 12.5%**

5.2 The transformers shall conform to the following specific parameters:

Sl. No.	Item	33 kV Station Transformers
1	System voltage (max)	36 kV
2	Rated voltage HV	33 kV
3	Rated voltage LV	0.433KV
4	Frequency	50Hz +/-5%

5	No. of Phases	Three
6	Connection HV	Delta
7	Connection LV	Star (Neutral Brought out)
8	Vector group	Dyn . 11
9	Type of cooling	ONAN

Audible sound levels (decibels) at rated voltage and frequency for liquid immersed transformers shall be as below (NEMA Standards):

kVA rating	Audible sound levels (decibels)
315 KVA & 1000 KVA	56

## 6. TECHNICAL REQUIREMENTS:

### 6.1.1 CORE MATERIAL – CRGO

#### 6.1.2 CRGO Material

6.1.2.1 The core shall be stack / wound type of high grade cold rolled grain oriented annealed steel lamination having low loss and good grain properties, coated with hot oil proof insulation, bolted together and to the frames firmly to prevent vibration or noise. The core shall be stress relieved by annealing under inert atmosphere if required. The complete design of core must ensure permanency of the core loss with continuous working of the transformers. The values of the maximum flux density allowed in the design and grade of lamination used shall be clearly stated in the offer

6.1.2.2 The bidder should offer the core for inspection and approval by the purchaser during manufacturing stage.

6.1.2.3 The transformers core shall be suitable for over fluxing (due to combined effect of voltage and frequency) up to 12.5% without injurious heating at full load conditions and shall not get saturated. The bidder shall **furnish necessary design data** in support of this situation.

6.1.2.4 **No-load current shall not exceed 3% of full load current and will be measured by energizing the transformer at 433 volts, 50 Hz on the secondary. In crease of voltage of 433 volts by 12.5% shall not increase the no-load current by 6% (maximum) of full load current.**

6.1.2.5 **Flux density within the core should not exceed 1.6 web/sq meter at rated voltage & rated frequency.**

## 7. WINDINGS:

### 7.1 Material:

7.1.1 HV and LV windings shall be wound from Supper Enamel covered / Double Paper covered copper conductor .

7.1.2 LV winding shall be such that neutral formation will be at top.

7.1.3 The winding construction of single HV coil wound over LV coil is preferable.

7.1.4 Inter layer insulation shall be Nomex / Epoxy dotted Kraft Paper.

7.1.5 Proper bounding of inter layer insulation with the conductor shall be ensured. Test for bounding strength shall be conducted.

7.1.6 Dimensions of winding coils are very critical. Dimensional tolerances for winding coils shall be within limits as specified in Guaranteed technical Particulars (GTP Schedule- I).

7.1.7 Current density for HV and LV winding should not be more than 2.8 Ampere per sq mm at rated current & normal tap.

7.1.8 The core / coil assembly shall be securely held in position to avoid any movement under short circuit conditions.

7.1.9 Joints in the winding shall be avoided. However, if jointing is necessary the joints shall be properly brazed and the resistance of the joints shall be less than that of parent conductor. In case of foil windings, welding of leads to foil can be done within the winding.

## 8. TAPS:

8.1.1 Tappings shall be provided, on the higher voltage winding for variation of HV voltage within range of (-) 5.0 % to (+) 7.5% in steps of 2.5%.

8.1.2 Tap changing shall be carried out by means of an **externally operated self position switch and when the transformer is in de-energised condition**. Switch position No. 1 shall correspond to the maximum plus tapping. Each tap change shall result in variation of 2.5% in voltage. Provision shall be made for locking the tapping switch handle in position. Suitable aluminium anodized plate shall be fixed for tap changing switch to know the position number of tap.

## 9. OIL:

9.1 The insulating oil shall comply with the requirements of IS335 or BS 148. **Use of recycled oil is not acceptable**. The specific resistance of the oil shall not be less than  $2.5 \times 10^{12}$  ohm-cm at 27°C when tested as per IS 6103.

9.2 Oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling.

9.3 The oil shall be filled under vacuum.

9.4 The design and all materials and processes used in the manufacture of the transformer, shall be such as to reduce to a minimum the risk of the development of acidity in the oil.

## 10. INSULATION LEVELS:

Sl. No.	Voltage (kV)	Impulse Voltage (kV Peak)	Power Frequency Voltage (kV)
1	0.433	-	3
2	33	170	70

## 11. LOSSES:

11.1 The bidder shall guarantee individually the **no-load loss and load loss without any positive tolerance**. The bidder shall also guarantee the total losses at 50% and 100% load condition (at rated voltage and frequency and at 75°C).

11.2 The following maximum allowable losses at rated voltage and frequency and at 75°C shall be taken:

Voltage Rating	Rating (kVA)	Max. Losses at 50% loading (Watts)	Max. Losses at 100% loading (Watts)
33000/433 - 250 V	315	1300	4300
33000/433 - 250 V	1000	3450	11350

**11.3 Bids with higher losses than the above specified values would be treated as non-responsive. However, the manufacturer can offer losses less than above. The utility can evaluate offers with losses lower than the maximum allowable losses on total owning cost as per formula given in Annexure – I.**

**12. TOLERANCES:**

**12.1 No positive tolerance** shall be allowed on the maximum losses displayed on the label for both 50% and 100% loading values.

**13. PERCENTAGE IMPEDANCE:**

13.1 The value of percentage impedance of transformer at 75 °C at normal tap shall be **5.0% (Minimum). No negative tolerances is allowed.**

**14. Temperature rise:** The temperature rise over ambient shall not exceed the limits given below:

14.1 Top oil temperature rise measured by thermometer : 35 °C

14.2 Winding temperature rise measured by resistance method : 40 °C

Bids not meeting the above limits of temperature rise will be treated as non-responsive

14.3 The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise. Bidder shall submit the calculation sheet in this regard.

**15. PENALTY FOR NON PERFORMANCE:**

**15.1** During testing at supplier's works if it is found that the actual measured losses are more than the values quoted by the bidder, the purchaser shall reject the transformer and he shall also have the right to reject the complete lot.

15.2 Purchaser shall **reject the entire lot during the test at supplier's works, if the temperature rise exceeds the specified values.**

**15.3** Purchaser shall reject any transformer during the test at supplier's works, if the impedance values differ from the guaranteed values including tolerance.

## **16. INSULATION MATERIAL:**

16.1 Electrical grade insulation epoxy dotted Kraft Paper / Nomex and pressboard of standard make or any other superior material subject to approval of the purchaser shall be used.

16.2 All spacers, axial wedges / runners used in windings shall be made of pre-compressed Pressboard-solid, conforming to type B 3.1 of IEC 641-3-2. In case of cross-over coil winding of HV all spacers shall be properly sheared and dovetail punched to ensure proper locking. All axial wedges / runners shall be properly milled to dovetail shape so that they pass through the designed spacers freely. Insulation shearing, cutting, milling and punching operations shall be carried out in such a way, that there should not be any burr and dimensional variations

## **17 .TANK**

17.1.1 The internal clearance of tank shall be such, that it shall facilitate easy lifting of core with coils from the tank without dismantling LV bushings.

17.1.2 All joints of tank and fittings shall be oil tight and no bulging should occur during service.

17.1.3 Inside of tank shall be painted with varnish / hot oil resistant paint.

17.1.4 The top cover of the tank shall be slightly sloping to drain rain water.

17.1.5 The tank plate and the lifting lugs shall be of such strength that the complete transformer filled with oil may be lifted by means of lifting shackle.

**17.1.6** Manufacturer should carry out all welding operations as per the relevant ASME standards and submit a copy of the welding procedure and welder performance qualification certificates to the customer.

## **17.2 PLAIN TANK:**

17.2.1 The transformer tank shall be of robust construction rectangular / octagonal / round / elliptical in shape and shall be built up of electrically tested welded mild steel plates of thickness of 6 mm for the bottom & top ;& not less than 4 mm for the sides . Tolerances as per IS 1852 shall be applicable.

17.2.2 In case of rectangular tanks the corners shall be fully welded at the corners from inside and outside of the tank to withstand a pressure of 0.8 kg/cm<sup>2</sup> for 30 minutes.

17.2.3 Under operating conditions the pressure generated inside the tank should not exceed 0.4 kg/sq.cm positive or negative.

17.2.4 The tank shall be reinforced by welded flats on all the outside walls on the edge of the tank.

17.2.5 Permanent deflection: The permanent deflection, when the tank without oil is subjected to a vacuum of 525 mm of mercury for rectangular tank and 760 mm of mercury for round tank, shall not be more than the values as given below:

<b>Horizontal length of flat plate</b>	<b>Permanent deflection</b>
Upto and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.0
2501 to 3000	16.0
Above 3000	19.0

**17.2.6 The tank shall further be capable of withstanding a pressure of 0.8 kg/sq.cm (g) and a vacuum of 0.7 kg/sq.cm (g) without any deformation.**

17.2.7 The radiators can be tube or fin type or pressed steel type to achieve the desired cooling to limit specified temperature rise.

## **18. CONSERVATOR:**

18.1 The conservator shall be provided on transformers for plain tank .

18.2 When a conservator is provided, oil gauge and the plain or dehydrating breathing device shall be fitted to the conservator which shall also be provided with a drain plug and a filling hole [32 mm (1¼+)] normal size thread with cover.

18.3 The dehydrating agent shall be silica gel. The moisture absorption shall be indicated by a change in the colour of the silica gel crystals which should be easily visible from a distance. Volume of breather shall be suitable for 1Kg of silica gel conforming to IS 3410 .

18.4 The capacity of a conservator tank shall be designed keeping in view the total quantity of oil and its contraction and expansion due to temperature variation. The total volume of conservator shall be such as to contain 10% quantity of the oil. Normally 3% quantity the oil shall be contained in the conservator.

18.5 The cover of main tank shall be provided with an air release plug to enable air trapped within to be released, unless the conservator is so located as to eliminate the possibility of air being trapped within the main tank.

18.6 The inside diameter of the pipe connecting the conservator to the main tank should be within 20 to 50 mm and it should be projected into the conservator so that its end is approximately 20 mm above the bottom of the conservator so as to create a sump for collection of impurities. The minimum oil level (corresponding to 0°C) should be above the sump level.

## **19 SURFACE PREPARATION AND PAINTING:**

### **19.1 GENERAL**

19.1.1 All paints, when applied in a normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.

19.1.2 All primers shall be well marked into the surface, particularly in areas where painting is evident and the first priming coat shall be applied as soon as possible after

cleaning. The paint shall be applied by airless spray according to manufacturer's recommendations. However, where ever airless spray is not possible, conventional spray be used with prior approval of purchaser.

## **19.2 CLEANING AND SURFACE PREPARATION:**

19.2.1 After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.

19.2.2 Steel surfaces shall be prepared by shot blast cleaning (IS9954) to grade Sq. 2.5 of ISO 8501-1 or chemical cleaning including phosphating of the appropriate quality (IS 3618).

19.2.3 Chipping scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale. These methods shall only be used where blast cleaning is impractical. Manufacturer to clearly explain such areas in his technical offer.

## **19.3 PROTECTIVE COATING:**

19.3.1 As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

## **19.4 PAINT MATERIAL:**

19.4.1 Following are the types of paint which may be suitably used for the items to be painted at shop and supply of matching paint to site :  
Heat resistant paint (Hot oil proof) for inside surface.

19.4.2 For external surfaces one coat of thermo setting powder paint or one coat of epoxy primer followed by two coats of synthetic enamel / polyurethane base paint. These paints can be either air drying or stoving.

19.4.3 Also paint as above with one coat of high build Micaceous iron oxide (MIO) as an intermediate coat may be used.

## **19.5 PAINTING PROCEDURE:**

19.5.1 All prepared steel surfaces should be primed before visible re-rusting occurs or within 4 hours, whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is still warm.

19.5.2 Where the quality of film is impaired by excess film thickness (wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coating and apply another coating. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25%

## **19.6 DAMAGED PAINTWORK:**

19.6.1. Any damage occurring to any part of a painting scheme shall be made good to the same standard of corrosion protection and appearance as that was originally applied.

19.6.2. Any damaged paint work shall be made good as follows:

19.6.2.1 The damaged area, together with an area extending 25 mm around its boundary, shall be cleaned down to bare metal.

19.6.2.2 A priming coat shall be immediately applied, followed by a full paint finish equal to that originally applied and extending 50 mm around the perimeter of the original damage.

19.6.2.3 The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before and after priming .

**19.7 DRY FILM THICKNESS:**

19.7.1 To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Over spray, skips, runs, sags and drips should be avoided. The different coats may or may not be of the same colour

19.7.2 Each coat of paint shall be allowed to harden before the next is applied as per manufacturer's recommendation.

19.7.3 Particular attention must be paid to full film thickness at the edges.

19.7.4 The requirements for the dry film thickness (DFT) of paint and the materials to be used shall be as given below:

Sl.No.	Paint type	Area to be painted	No. of coats	Total dry film thickness (min.) (microns)
1.	Thermo setting powder paint	Inside outside	01 01	30 60
2.	Liquid paint a) Epoxy (primer) b) P.U. Paint (Finish coat) c) Hot oil paint / Varnish	outside outside inside	01 02 01	30 25 each 35/10

**19.8 TESTS FOR PAINTED SURFACE:**

19.8.1 The painted surface shall be tested for paint thickness.

19.8.2 The painted surface shall pass the cross hatch adhesion test and impact test as acceptance tests and Salt spray test and Hardness test as type test as per the relevant ASTM standards.

Note: Supplier shall guarantee the painting performance requirement for a period of not less than 5 years.

**20 BUSHINGS:**

20.1 The bushings shall conform to the relevant standards specified and shall be of outdoor type. The bushing rods and nuts shall be made of brass material 12 mm diameter for both HT and LT bushings. The tests as per latest IS 2099 and IS 7421 shall be conducted on the transformer bushings.

20.2 For 33 kV, 33 kV class bushings; for 0.433 kV, 1.1 kV class bushings shall be used.

20.3 Bushing can be of porcelain /epoxy material. Polymer insulator bushings conforming with relevant IEC can also be used.

20.4 Bushing of plain shades as per IS 3347 shall be mounted on the side of the tank and not on top cover.

20.5 Dimensions of the bushings of the voltage class shall conform to the Standards specified and dimension of clamping arrangement shall be as per IS 4257.

20.6 Minimum external phase to phase and phase to earth clearances of bushing terminals shall be as follows:

Voltage	Clearance	
	Phase to Phase	Phase to earth
33 kV	350 mm	320 mm
LV	75 mm	40 mm

The clearances in case of cable box shall be as below:

Voltage	Clearance	
	Phase to Phase	Phase to earth
33 kV	351 mm	222 mm
LV	45 mm	20 mm

20.7 Arcing horns shall be provided on HV bushings.

20.8 Brazing of all inter connections, jumpers from winding to bushing shall have cross section larger than the winding conductor. All the Brazes shall be qualified as per ASME, section . IX.

20.9 The bushings shall be of reputed make supplied by those manufacturers who are having manufacturing and testing facilities for insulators.

20.10 The terminal arrangement shall not require a separate oil chamber not connected to oil in the main tank.

## 21 TERMINAL CONNECTORS:

21.1 The HV bushing stems shall be provided with suitable terminal connectors suitable as per IS 5082 so as to connect the jumper without disturbing the bushing stem. Connectors shall be with eye bolts so as to receive conductor for HV. Terminal connectors shall be type tested as per IS 5561. The terminal arrangement for 433volts side shall be such as to suit 3 ½ X300 mm<sup>2</sup> armoured PVC cable .

## 22 TERMINAL MARKINGS:

22.1 High voltage phase windings shall be marked both in the terminal boards inside the tank and one the outside with capital letter 1U, 1V, 1W and low voltage winding for the same phase marked by corresponding small letter 2u, 2v, 2w. The neutral point terminal

shall be indicated by the letter 2n. Neutral is to be brought out and connected to local grounding terminal by an earthing strip.

## **23 FITTINGS:**

23.1 The following standard fittings shall be provided:

- i) Rating and terminal marking plates, non-detachable.
- ii) Earthing terminals with lugs . 2 Nos.
- iii) Lifting lugs for main tank and top cover.
- iv) Terminal connectors on the HV / LV bushings (For bare terminations only)
- v) Thermometer pocket with cap . 1 No.
- vi) Air release device
- vii) HV bushings . 3 Nos.,
- viii) LV bushings . 4 Nos.
- ix) Pulling lugs.
- x) Stiffener
- xi) Radiators . No. and length may be mentioned (as per heat dissipation calculations) / corrugations.
- xii) Arcing horns on HT side 3 nos.
- xiii) Prismatic oil level gauge.
- xiv) Drain cum sampling valve.
- xv) Top filter valve.
- xvi) Oil filling hole having p. 1- ¼+thread with plug and drain plug on the conservator.
- xvii) Silica gel breather.
- xviii) Base channel 100 mm x 50 mm, 460 mm long with holes to make them suitable for fixing on a platform or plinth.
- xix) 4 Nos. rollers
- xx) Pressure relief device or explosion vent.

## **24 FASTENERS:**

24.1 All bolts, studs screw threads, pipe threads, bolt heads and nuts shall comply with the appropriate Indian Standards for metric threads, or the technical equivalent.

24.2 Bolts or studs shall not be less than 6 mm in diameter except when used for small wiring terminals.

24.3 All nuts and pins shall be adequately locked.

24.4 Wherever possible bolts shall be fitted in such a manner that in the event of failure of locking resulting in the nuts working loose and falling off, the bolt will remain in position.

24.5 All ferrous bolts, nuts and washers placed in outdoor positions shall be treated to prevent corrosion, by hot dip galvanizing, except high tensile steel bolts and spring washers which shall be electro-galvanized / plated. Appropriate precautions shall be taken to prevent electrolytic action between dissimilar metals.

24.6 Each bolt or stud shall project at least one thread but not more than three threads through the nut, except when otherwise approved for terminal board studs or relay stems. If bolts and nuts are placed so that they are in accessible by means of ordinary spanners, special spanners shall be provided.

24.7 The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear plane between members.

24.8 Taper washers shall be provided where necessary.

24.9 Protective washers of suitable material shall be provided front and back of the securing screws.

## **25 OVERLOAD CAPACITY:**

25.1 The transformers shall be suitable for loading as per IS 6600.

## **26 TESTS:**

26.1 a) The type tests as indicated at clause-28 below should have been conducted on a transformer of **same design** during the **last five years on the date of opening of techno-commercial bids**. The bidder shall furnish type test reports along with the offer.

b) If the bidder has only conducted type tests for the tests stipulated at clause no. **28.1, 28.2, 28.3** as indicated below for the same design transformer during the last five years on the date of opening of techno-commercial bids he can furnish the same & in addition to that he will undertake that they will conduct balance type tests as indicated at **clause 28** of this technical specification at CPRI/ any Govt. approved laboratory (NABL Accredited) , within the stipulated delivery period without affecting the stipulated delivery period of the transformers (i.e Delivery to be completed within 4(four) months from the date of issue of the Purchase order) & at free of cost to OPTCL in presence of OPTCL's Inspecting officer, then their cases may be considered at the discretion of OPTCL.

c) However if the bidder have conducted the above type tests on a **same or higher rating** & voltage class (33/0.433KV) transformer of other design during the last five years as on the date of opening of techno-commercial bids & will furnish above type test reports along with the offer & will undertake that they will conduct type tests as indicated at **clause 28** of this technical specification at CPRI/ any Govt. approved laboratory (NABL Accredited) , **within the stipulated delivery period without affecting the stipulated delivery period of the transformers (i.e Delivery to be completed within 4(four) months from the date of issue of the Purchase order) & at free of cost to OPTCL in presence of OPTCL's Inspecting officer**, then their cases may be considered at the discretion of OPTCL.

d) If the facility for any of the type test(s) as indicated at **clause no.28** of this specification is not available at the Govt. approved laboratory, the bidder will propose any other laboratory or at their laboratory for conducting the said test(s) for which approval will be accorded by the OPTCL.

26.2 Special tests other than type and routine tests, as agreed between purchaser and bidder shall also be carried out as per the relevant standards.

26.3 The requirements of site tests are also given in this clause.

**26.4 The test certificates for all routine and type tests for the transformers and also for the bushings and transformer oil shall be submitted with the bid.**

26.5 The procedure for testing shall be in accordance with IS 1180/2026 as the case may be except for temperature rise test.

26.6 Before dispatch each of the completely assembled transformers shall be subjected to the routine tests at the manufacturer's works.

## **27 ROUTINE TESTS:**

27.1 Ratio, polarity, phase sequence , vector group & magnetic balance test.

27.2 No Load current and losses at service voltage and normal frequency.

27.3 Load losses at rated current and normal frequency.

27.4 Impedance voltage test.

27.5 Resistance of windings at each tap, cold (at or near the test bed temperature).

27.6 Insulation resistance at 60second,600 second & Polarisation Index (P.I i.e ratio of Insulation Resistance taken at 600seconds & at 60 seconds shall not be less than 1.5)

27.7 Induced over voltage withstand test.

27.8 Separate source voltage withstand test.

27.9 Neutral current measurement . The value of zero sequence current in the neutral of the star winding shall not be more than 2% of the full load current.

27.10 Oil samples (one sample per lot) to comply with IS 1866.

27.11 Measurement of no load losses and magnetizing current at rated frequency and 90%, 100% and 110% rated voltage.

27.12 Pressure & vacuum test for checking the deflection & oil leakage test.

## **28 TYPE TESTS TO BE CONDUCTED ON ONE UNIT:**

In addition to the tests mentioned in **clause 26 and 27** following tests shall be conducted:

28.1 Temperature rise test for determining the maximum temperature rise after continuous full load run. The ambient temperature and time of test should be stated in the test certificate.

28.2 Impulse voltage test: with chopped wave of IS 2026 part . III .

28.3 Short circuit withstand test: Thermal and dynamic ability.

28.4 Air Pressure Test: As per IS . 1180.

28.5 Un-balanced current test: The value of unbalanced current indicated by the ammeter shall not be more than 2% of the full load current.

28.6 Noise-level measurement.

28.7 Measurement of zero-phase sequence impedance.

28.8 Measurement of Harmonics of no-load current.

28.9 Transformer tank shall be subjected to specified vacuum. The tank designed for vacuum shall be tested at an internal pressure of 0.35 kg per sq cm absolute (250 mm of Hg) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the values specified below:

Horizontal length of flat plate (in mm)	Permanent deflection (in mm)
Upto and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.0
2501 to 3000	16.0
Above 3000	19.0

28.10 Transformer tank together with its radiator and other fittings shall be subjected to pressure corresponding to twice the normal pressure or 0.35 kg / sq.cm whichever is lower, measured at the base of the tank and maintained for an hour. The permanent deflection of the flat plates after the excess pressure has been released, shall not exceed the figures for vacuum test.

28.11 Pressure relief device test: The pressure relief device shall be subject to increasing fluid pressure. It shall operate before reaching the test pressure as specified in the above class. The operating pressure shall be recorded. The device shall seal-off after the excess pressure has been released.

**28.12 Short Circuit Test and Impulse Voltage Withstand Tests:** The purchaser intends to procure transformers designed and successfully tested for short circuit and impulse test. In case the transformers proposed for supply against the order are not exactly as per the tested design, the supplier shall be required to carry out the short circuit test and impulse voltage withstand test **at their own cost in the presence of the representative of the purchaser.**

28.12.1 The supply shall be accepted only after such test is done successfully, as it confirms on successful withstand of short circuit and healthiness of the active parts thereafter on un-tanking after a short circuit test.

28.12.2 Apart from dynamic ability test, the transformers shall also be required to withstand thermal ability test or thermal withstand ability will have to be established by way of calculations.

28.12.3 It may also be noted that the purchaser reserves the right to conduct short circuit test and impulse voltage withstand test in accordance with the IS, afresh on each ordered rating at purchaser cost, even if the transformers of the same rating and similar design are already tested. This test shall be carried out on a transformer to be selected by the purchaser either at the manufacturer's works when they are offered in a lot for supply or randomly from the supplies already made to purchaser's stores. The findings and conclusions of these tests shall be binding on the supplier.

28.12.4 Type test certificates for the tests carried out on prototype of same specifications shall be **submitted along with the bid**. The purchaser may select the transformer for type tests randomly.

**Note:- If Impulse & short circuit withstand test as indicated above for the same design transformer would have been conducted in a govt. approved test laboratory or at CPRI within last five years then the said tests shall not be repeated further. But other balance type tests including temperature rise test as indicated at cluse-28 above will be carried out on one unit.**

### **29 ACCEPTANCE TEST:**

29.1 **All transformers** shall be subjected to the stage inspection, routine / acceptance test as indicated above in presence of purchaser's representative at the place of manufacture before dispatch without any extra charges. The testing shall be carried out in accordance with IS:1180 and IS:2026.

29.2 Checking of weights, dimensions, fitting and accessories, tank sheet thickness, oil quality, material, finish and workmanship as per GTP and contract drawings.

29.3 Physical verification of core coil assembly and measurement of flux density of one unit of each rating, in every inspection with reference to short circuit test report.

29.4 **Temperature rise test on one unit of the total ordered quantity.-** This test shall be carried out as per IS.

### **30 TESTS AT SITE:**

The purchaser reserves the right to conduct all tests on transformer after arrival at site and the manufacturer shall guarantee test certificate figures under actual service conditions.

### **31 INSPECTION:**

31.1 In respect of raw material such as core stampings, winding conductors, insulating paper and oil, supplier shall use materials manufactured / supplied by standard manufacturers and furnish the manufacturer's test certificate as well as the proof of purchase from these manufacturers (excise gate pass) for information of the purchaser. The bidder shall furnish following documents along with their offer in respect of the raw materials:

- i) Invoice of supplier.
- ii) Mill's certificate.
- iii) Packing list.
- iv) Bill of landing.
- v) Bill of entry certificate by custom.

## **32 INSPECTION AND TESTING OF TRANSFORMER OIL:**

32.1 To ascertain the quality of the transformer oil, the original manufacturer's tests report should be submitted at the time of inspection. Arrangements should also be made for testing of transformer oil, after taking out the sample from the manufactured transformers and tested in the presence of purchaser's representative.

32.2 To ensure about the quality of transformers, the inspection shall be carried out by the purchaser's representative at following two stages:-

32.2.1 On line anytime during receipt of raw material and manufacture / assembly whenever the purchaser desires.

32.2.2 At finished stage i.e. transformers are fully assembled and are ready for dispatch.

**32.3** The **stage inspection** shall be carried out in accordance with **Annexure –II**.

32.4 After the main raw-material i.e core and coil material and tanks are arranged and transformers are taken for production on shop floor and a few assembly have been completed, the firm shall intimate the purchaser in this regard, so that an officer for carrying out such inspection could be deputed, **as far as possible within twenty days from the date of intimation**,. **During the stage** inspection a few assembled core shall be dismantled to ensure that the CRGO laminations used are of good quality. Further, as and when the transformers are ready for dispatch, an offer intimating about the readiness of transformers, **for final inspection for carrying out tests as per relevant IS shall be sent by the firm along with Routine Test Certificates**. The inspection shall normally be arranged by the purchaser at the earliest after receipt of offer for pre-delivery inspection. The proforma for pre delivery inspection of **Station** transformers is placed at **Annex – III**.

**32.5 In case of any defect/ defective workmanship observed at any stage by the purchaser's Inspecting Officer, the same shall be pointed out to the firm in writing for taking remedial measures**. Further processing should only be done after clearance from the Inspecting Officer / Purchaser.

32.6 All tests and inspection shall be carried out at the place of manufacture unless otherwise specifically agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall offer the Inspector representing the Purchaser all reasonable facilities, without charges, to satisfy him that the material is being supplied in accordance with this specification. this will include Stage Inspection during manufacturing stage as well as Active Part Inspection during Acceptance Tests.

32.7 The manufacturer shall provide all services to establish and maintain quality of workmanship in his works and that of his sub-contractors to ensure the mechanical / electrical performance of components, compliance with drawings, identification and acceptability of all materials, parts and equipment as per latest quality standards of ISO 9000.

32.8 Purchaser shall have every right to appoint a third party inspection to carry out the inspection process.

**32.9** The purchaser has the right to have the test carried out at his own cost by an independent agency wherever there is a dispute regarding the quality supplied. Purchaser has right to test 1% of the supply selected either from the stores or field to check the

quality of the product. In case of any deviation purchaser **have every right to reject the entire lot or penalize the manufacturer, which may lead to blacklisting, among other things.**

### **33 QUALITY ASSURANCE PLAN:**

33.1 The bidder shall invariably furnish following information along with his bid, failing which his bid shall be liable for rejection. Information shall be separately given for individual type of equipment offered.

33.2 Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of tests normally carried out on raw materials in the presence of bidder's representative, copies of test certificates.

33.3 Information and copies of test certificates as above in respect of bought out accessories.

33.4 List of manufacturing facilities available.

33.5 Level of automation achieved and list of areas where manual processing exists.

33.6 List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspection.

**33.7** List of testing equipment available with the bidder for final testing of equipment along with valid calibration reports. These shall be furnished with the bid. **Manufacturer shall possess 0.1 accuracy class instruments for measurement of losses.**

33.8 Quality Assurance Plan (QAP) with hold points for purchaser's inspection.

33.9 The successful bidder shall within 30 days of placement of order, submit following information the purchaser:

33.9.1 List of raw materials as well as bought out accessories and the names of sub-suppliers selected from those furnished along with offer.

33.9.2 Type test certificates of the raw materials and bought out accessories.

33.9.3 The successful bidder shall submit the routine test certificates of bought out accessories and central excise passed for raw material at the time of routine testing.

### **34 DOCUMENTATION:**

34.1 The bidder shall furnish along with the bid the dimensional drawings of the items offered indicating all the fittings.

34.2 Dimensional tolerances.

34.3 Weight of individual components and total weight.

34.4 An outline drawing front (both primary and secondary sides) and end-elevation and plan of the tank and terminal gear, wherein the principal dimensions shall be given.

34.5 Typical general arrangement drawings of the windings with the details of the insulation at each point and core construction of transformer.

34.6 Typical general arrangement drawing showing both primary and secondary sides and end-elevation and plan of the transformer.

### **35 PACKING AND FORWARDING:**

35.1 The packing shall be done as per the manufacturer's standard practice. However, it should be ensured that the packing is such that, the material would not get damaged during transit by Rail / Road / Sea.

35.2 The marking on each package shall be as per the relevant IS.

### **36 GUARANTEE**

36.1 The manufacturers of the transformer shall **provide a guarantee of 24 months from the date of receipt at the stores of the Utility or 18 months from the date of commissioning, whichever is earlier.** In case the Station transformer fail within the guarantee period the purchaser will immediately inform the supplier who shall take back the failed Transformer within 15 days from the date of the intimation at his own cost and replace / repair the transformer within forty five days of date of intimation with a roll over guarantee.

36.2 The outage period i.e. period from the date of failure till unit is repaired / replaced shall not be counted for arriving at the guarantee period.

36.3 In the event of the supplier's inability to adhere to the aforesaid provision, suitable penal action will be taken against the supplier which may inter alia include blacklisting of the firm for future business with purchaser for a certain period.

### **37 SCHEDULE:**

**37.1** The bidder shall fill in the following schedule which will be part of the offer. If the schedule are not submitted duly filled in with the offer, **the offer shall be liable for rejection.**

Schedule . A : Guaranteed Technical Particulars.

Schedule . B : Schedule of Deviations.

### **38 DEVIATION:**

38.1 The bidders are not allowed to deviate from the principal requirements of the Specifications. However, the bidder is required to submit with his bid in the relevant schedule a detailed list of all deviations without any ambiguity. In the absence of a deviation list in the deviation schedules, it is understood that such bid conforms to the bid specification and no post-bid negotiations shall take place in this regard.

38.2 The discrepancies, if any, between the specification and the catalogues and / or literatures submitted as part of the offer by the bidders, shall not be considered and representations in this regard shall not be entertained.

38.3 If it is observed that there are deviations in the offer in guaranteed technical particulars other than those specified in the deviation schedules then such deviations shall be treated as deviations.

38.4 All the schedules shall be prepared by vendor and are to be enclosed with the bid.

**Annex – I**

**METHODOLOGY FOR COMPUTING TOTAL OWNING COST**

<b>TOC = IC + (A x Wi) + (B x Wc)</b>	
Where,	
TOC	= Total Owing Cost
IC	= Initial cost (including taxes ) of transformer as quoted by the manufacturer
A factor	= Cost of no load losses in Rs/ watt
B factor	= Cost of load losses in Rs/ watt
Wi	= No load losses quoted by the manufacturer in watt
Wc	= Load losses quoted by the manufacturer in watt

The **A** and **B** factors capture the net present value of energy losses based on hours of operation, cost of energy (electrical tariff) equipment life (years of expected service) and cost of money (rate of return).

i) Capitalised cost of no load losses Rs / watt = **A factor= 116.013**

$$A \text{ factor} = H \times \frac{E_c}{1000} \times \frac{(1+r)^n \cdot 1}{r(1+r)^n}$$

$$= 8400 \times \frac{1.70}{1000} \times \frac{(1+0.115)^{25} \cdot 1}{0.115(1+0.115)^{25}}$$

ii) Capitalised cost of load losses Rs/watt = **B factor = A factor x LLF= 64.155**  
 =116.013X(0.3X0.7+0.7X(0.7)<sup>2</sup> )

iii) Capitalised cost of transformer = IC + (A x Wi) + ( B x Wc)

where

i) H = No. of service hours per year of the **Station** transformer = 8400 hr.

ii) r = Rate of interest = prime lending rate (in per unit)= 11.5%

iii) Ec = Average Energy cost (Rs/kWH).= Rs 1.70 / kwh

iv) n = Life of the transformer in years = 25 years

v) LLF = Loss Load factor = 0.3 LF + 0.7 LF<sup>2</sup>, where LF is the load factor

LF = 0.7

**N:B:- On testing ,if it is found that actual losses are more than the values quoted in the Bid, undisputed liquidated damages shall be recovered from the supplier at the following rates:-**

**i)For each Watt of excess in ‘No load Losses--- Rs232.026/Watt**

**ii)For each Watt of excess in ‘Load Losses’ -- Rs 128.310/ Watt**

For fraction of losses ,penalties shall be applied on prorata basis. No bonus shall be payable for losses which are less than those stated in the bid.

The purchaser reserves the right to reject the transformer if on testing ,the losses exceeds the guaranteed losses or the temperature rise in oil,winding exceed the value,impedance value differs the guaranteed value.

Annexure –II

**PROFORMA FOR STAGE INSPECTION OF STATION TRANSFORMERS**

**(A) GENERAL INFORMATION:**

1. Name of firm :M/s.
2. Order No. and Date :
3. quantity offered :
4. Details of offer :
  - a) Rating
  - b) Quantity
  - c) Serial Numbers
5. Details of last stage inspected lot :
  - a) Total quantity inspected
  - b) Serial Numbers
  - c) Date of stage inspection
  - d) Quantity offered for final inspection of (a) above with date

**(B) Availability of material for offered quantity :**

Details to be filled in

**(C) Position of manufacturing stage of the offered quantity :**

- a) Complete tanked assembly
- b) Core and coil assembly ready
- c) Core assembled
- d) Coils ready for assembly
  - (i) HV Coils
  - (ii) LV Coils

**Note:**

(i)Quantity offered for stage inspection should be offered for final Inspection within 15 days from the date of Issuance of clearance for stage inspection, otherwise stage inspection already cleared shall be liable for cancellation.

Sl. No.	Particulars	As offered	As observed	Deviation and
---------	-------------	------------	-------------	---------------

													Remarks.
(D)	<b>Inspection of Core:</b>												
	(I) Core Material												
	(1) Manufacturer's Characteristic Certificate in respect to grade of lamination used. (Please furnish test certificate).												
	(2) Remakes regarding Rusting and smoothness of core.												
	(3) Whether laminations used for top and bottom yoke are in one piece.												
	(II) Core Construction :												
	(1) No. of Steps												
	(2) Dimension of Steps												
	Step No.												
	<b>As offered:</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>
	W mm												
	T mm												
	<b>As found:</b>												
	W mm												
	T mm												
	(3) Core Dia (mm)												
	(4) Total cross Section area of core												
	(5) Effective cross Sectional area of core.												
	(6) Clamping arrangement												
	(i) Channel Size												
	(ii) Bolt size and No.												
	(iii) Tie Rods size and No.												
	(iv) <b>Painting.</b>												
	(a) Channels												
	(b) Tie Rods.												
	(c) Bolts												
	(7) Whether top yoke is cut for LV connection.												
	(8) If yes, at 7 above, whether Reinforcement is done.												
	(9) Size of Support Channels Provided for Core base and Bottom yoke (Single piece of channels are only acceptable)												
	(10) Thickness of insulation Provided between core base and support channel.												
	(11) Core length (leg center To leg center)												
	(12) Window height												

	(13) Core height			
	(14) Core weight only (without channels etc.)			
(E)	<b>INSPECTION OF WINDING</b>			
	<b>(I) Winding material</b>			
	(1) Material used for			
	(a) HV winding			
	(b) LV winding.			
	(2) Grade of material for			
	(a) HV winding			
	(b) LV winding.			
	(3) Test certificate of manufacturer (enclose copy) for winding material of:			
	(a) HV			
	(b) LV			
	<b>(II) CONSTRUCTIONAL DETAILS</b>			
	(1) Size of Cross Sectional Area of conductor for:			
	(a) HV winding			
	(b) LV winding.			
	(2) Type of insulation for Conductor for:			
	(a) HV winding			
	(b) LV winding.			
	(3) Diameter of wire used for delta formation(mm)			
	(4) Diameter of coils in:			
	a) LV winding.			
	6) i) Internal dia (mm)			
	ii) Outer dia (mm)			
	b) HV winding.			
	i) Internal dia (mm)			
	ii) Outer dia (mm)			
	(5) Current Density of winding Material used for:			
	(a) HV			
	(b) LV			
	(6) Whether neutral formation on top			
	(7) HV Coils/ Phase			
	(a) Number			
	(b) Turns /coil			
	(c) Total turns.			
	(8) LV Coils/ Phase			
	a) Number			
	b) Turns/ Coil			
	c) Total turns.			
	(9) Method of HV Coil Joints.			
	(10) Total weight of coils of			
	a) LV winding (kg)			
	b) HV winding (kg)			

(F)	<b>INSULATION MATERIALS:</b>			
	<b>(I) MATERIAL :</b>			
	1) Craft paper			
	a) Make			
	b) Thickness (mm)			
	c) Test Certificate of manufacturer(enclose copy)			
	2) Press Board.			
	a) Make			
	b) Thickness (mm)			
	c) Test Certificate of manufacturer(enclose copy)			
	3) Material used for top and bottom Yoke and insulation.			
	(II) Type and thickness of material Used: (mm)			
	a) Between core and LV			
	b) Spacers			
	c) Inter layer			
	d) Between HV and LV winding.			
	e) Between phases			
	f) End insulation.			
(G)	<b>CLEARANCES: (mm)</b>			
	<b>(I) Related to core and windings.</b>			
	1) LV to Core (Radial)			
	2) Between HV and LV (Radial)			
	3) (i) Phase to Phase Between HV Conductor			
	(ii) Whether two Nos. Press Board each of minimum 1 mm thick provided to Cover the tie rods.			
	4) Thickness of locking spacers Between LV coils (mm)			
	5) Axial wedges between HV and LV coils/phase (Nos.)			
	6) No.of radial spacers for Phase between HV coils			
	7) Size of duct between LV and HV winding (mm)			
	<b>(II) Between core- coil assembly And tank (mm)</b>			
	1) Between winding and body:			
	a) Tank lengthwise			
	b) Tank Breadth wise.			
	2) Clearance between top cover and top Most live part of tap changing Switch			
H	<b>TANK:</b>			
	<b>(I) Constructional details.</b>			
	1) Rectangular shape			
	2) Thickness of side wall(mm)			

	3) Thickness of top and bottom Plate (mm)			
	4) Provision of slopping cover Towards HV bushing.			
	5) Tank internal dimensions (mm)			
	a) Length			
	b) Breadth			
	c) height			
	(i) On LV side			
	(ii) On HV side.			
	<b>(II) General details:</b>			
	1) Inside painted by varnish/Oil corrosion resistant paint (please specify which type Of coating done).			
	2) Gasket between top cover and tank.			
	i) Material			
	ii) Thickness (mm)			
	iii) Jointing over laps (mm)			
	3) Reinforcement of welded angle (specify size and No.of angle Provided) on side walls of tank.			
	4) Provision of lifting lugs:			
	a) Numbers			
	b) Whether lugs of 8mm thick MS Plate provided.			
	c) Whether reinforced by welded plates edge wise below the lug upto re-enforcing angle of the tank done.			
	5) Pulling lug of MS Plate			
	a) Nos.			
	b) Thickness (mm)			
	c) Whether provided on Breadth side or length side.			
	6) Provision of air release plug.			
	7) Provision of galvanized GI Nuts Bolts with 1 No. Plain and 1 No. Spring washer.			
	8) Deformation of length wise side Wall of tank when subject to:			
	a) Vacuum of (-)0.7 kg/sq. cm for 30 minutes.			
	b) Pressure of 0.8 kg/sq. cm for 30 minutes			
	<b>(I) RADIATORS:</b>			
	1. Fin Radiators of 1.25mm thick sheet.			
	a) Dimension of each fin (LxBxT)			
	b) Fins per radiator			
	c) Total No. of radiators.			

	2. Verification of manufacturer's Test certificate regarding Heat Dissipation (excluding Top and Bottom) in w/sq m			
	3. Verification of position of radiator with respect to bushing.			
<b>(J)</b>	<b>CONSERVATOR:</b>			
	1. Dimensions (L x D) (in mm)			
	2. Volume (m <sup>3</sup> )			
	3. Inside dia of conservator tank pipe (mm)			
	4. Whether conservator outlet pipe is projected approx. 20mm inside the conservator tank.			
	5. Whether arrangement made so that oil does not fall on the active parts.			
	6. Whether die cast metal oil level gauge indicator having three positions at (-5° C, 30° C and 98° C) is provided.			
	7. Whether drain plug and filling hole with cover is provided.			
	8. Inner side of the conservator tank painted with			
<b>(K)</b>	<b>BREATHER</b>			
	1. Whether Die cast Aluminium Body breather for silica gel Provided.			
	2. Make			
	3. Capacity.			
	4. Weight of silica gel provided			
<b>(L)</b>	<b>TERMINALS:</b>			
	1. Material whether of Brass Rods/ Tinned Copper.			
	a) HV			
	b) LV			
	2. Size (dia in mm)			
	a) HV			
	b) LV			
	3. Method of Star connection formed on LV side of 6mm thick (should use Cu. Flat bolted/brazed with crimped lugs on winding - Please state dimensions of Cu flat used.(mm)			
	4. Method of Connection of LV winding to LV Bushing (end of winding should be crimped with lugs (Cu) and bolted with bushing stud).			
	5. Method of Connection of HV winding to HV bushing (Copper joint			

	should be done by using silver brazing alloy).			
	6. Whether SRB Ptube/insulated paper used for formation of Delta HV.			
	7. Whether Empire sleeves used on the portion of HV winding joining to HV bushing.			
	8. Whether neutral formation is covered with cotton tape.			
<b>(M)</b>	<b>BUSHINGS:</b>			
	1. Whether HV bushings mounted on side walls or top cover.			
	2. Whether sheet metal pocket used for mounting bushing (pipe are not acceptable).			
	a) HV			
	b) LV			
	3. Whether arrangement for studs for fitting of HV Bushing are in diamond shape (so that Arcing Horns are placed vertically).			
	4. Position of mounting of LV bushings.			
	5. Bushing Clearance: (mm)			
	a) LV to Earth			
	b) HV to Earth			
	c) Between LV Bushing			
	d) Between HV Bushing			
<b>(N)</b>	<b>TANK BASE CHANNEL / ROLLERS:</b>			
	1. Size of channel (mm)			
	2. Whether channels welded across the length of the tank.			
	3. Size and type of roller (mm)			
<b>(O)</b>	<b>OIL:</b>			
	1. Name of supplier			
	2. Break down voltage of oil: (kV)			
	i) Filled in tanked transformer			
	ii) In storage tank (to be tested by Inspection Officer).			
	3. Supplier's test certificate (enclosed copy).			
<b>(P)</b>	<b>ENGRAVING:</b>			
	1. Engraving of Sl. No. and name of firm			
	i) On bottom of clamping channel of core-coil assembly.			
	ii) On side wall and top cover of tank along with date of dispatch.			
<b>(Q)</b>	<b>i) MS plate of size 125x125mm welded on width side of stiffner</b>			

	ii) Following details engraved (as per approved GTP).			
	(a) Serial Number			
	(b) Name of firm			
	(c) Order No. and Date			
	(d) Rating			
	(e) Name of Inspecting Officer.			
	(f) Designation.			
	(g) Date of dispatch.			
<b>(R)</b>	<b>NAME PLATE DETAILS:</b>			
	Whether Name Plate is as per approved drawing.			
<b>(S)</b>	<b>COLOUR OF TRANSFORMER</b>			
	1. Tank body with dark Green colour			
	2. Conservator with white colour			
<b>(T)</b>	<b>CHECKING OF TESTING FACILITIES:</b>			
	(Calibration certificate also to be checked for its validity).			
	TEST :			
	1. No Load Current.			
	2. No Load Loss			
	3. % Impedance.			
	4. Load Losses			
	5. Insulation Resistance Test			
	6. Vector Group test (phase relationship).			
	7. Ratio & Polarity test relationship.			
	8. Transformer Oil test (Break Down Voltage).			
	9. Magnetic Balance.			
	10. Measurement of winding resistance (HV and LV both).			
	11. Induced over voltage withstand test (Double voltage and Double frequency).			
	12. Separate source power frequency withstand test at 70 kV for HV & 3kV for LV (one minute).			
	13. Air pressure/Oil leakage Test.			
	14. Vacuum test.			
	15. Unbalanced current test.			
	16. Temperature rise (Heat Run) test.			
<b>(U)</b>	We have specifically checked the following and found the same as per G.T.P./deviations observed as mentioned against each:			
	i) Rustlessness of CRGO laminations used.			
	ii) Core steps			
	iii) Core area			

	iv) Core weight			
	v) Winding cross sectional area			
	a) LV			
	b) HV			
	vi) Weight of windings.			
	vi) Clearance between winding and			
	vii) wall of tank (mm)			
	a) Length-wise			
	b) Breadth-wise.			
	viii) Clearance between top of yoke/ top most live part of tap changer to tank cover.			
	ix) Details of Neutral formation.			
	x) Connections to bushings:			
	a) LV			
	b) HV			
	xi) Slope of tank top			
	xii) Position of mounting of bushings.			

### Annexure-III

#### PROFOREMA FOR PRE-DELIVERY INSPECTION OF STATION TRANSFORMERS

1.	Name of the firm.	
2.	Details of offer made	
	(i) Order No. and Date.	
	(ii) Rating.	
	(iii) Quantity.	
	(iv) Sl. No. of transformer.	
3.	Date of stage inspection clearance.	
4.	Reference of stage inspection clearance.	
5.	Quantity offered and inspected against the order prior to this lot.	

#### (A) ROUTINE/ ACCEPTANCE TESTS TO BE CARRIED OUT (Clause-27,29 above & ISS)

Sl. No	PARTICULARS	OBSERVATIONS.
.		

1.	(a) Ratio Test	AB/an
		BC/bn
		CA/Cn
	(b) Polarity Test, Vector Group, Phase Sequence	
	c) Magnetic Balance	
2.	No load loss measurement	
		W1
		W2
		W3
	TOTAL	
	Multiplied Factor	
	CT	
	Watt meter	
	Total x MF	
	NET LOSS	
3.	Load loss measurement	
		W1
		W2
		W3
	<b>Total</b>	
	<b>Multiplied Factors:</b>	
	<b>CT</b>	
	<b>Watt meter</b>	
	<b>PT</b>	
	Total x MF	
	Loss at ambient temperature (watt)	
	Loss at 75° C (with calculation sheet )(watt)	
4.	Winding Resistance:	
	<b>H.V.</b> (In Ohms)	
	(a) At ambient temperature of            ° C	A-B
		B-C
		C-A
	(b) Resistance at 75° C	A-B
		B-C
		C-A

Sl. No.	PARTICULARS	OBSERVATIONS.
	<b>L.V.</b> (In Ohms)	
	(a) At ambient temperature of            ° C	a-b
		b-c
		c-a
	(b) Per Phase Resistance at 75° C	a-n
		b-n
		c-n
5.	Insulation Resistance (M ohm)	HV-LV
	60sec,600sec , Polarisation Index(P.I)	HV-E
		LV-E
6.	Separate Source voltage withstand test voltage	
		<b>HV</b> 70 kV for 60 secs.
		<b>LV</b> 3 kV for 60 secs
7.	Induce over-voltage withstand test at double	100 Hz, 866 volts

	voltage and double frequency.	For 60 seconds.
8.	No load current at 90% volts 100% Volts 110% volts	
9.	Unbalance current	
10.	Vector group test	Diagram and readings be shown in separate sheets.
11.	Percentage Impedance at 75° C(Please furnish calculation sheet)	
12.	Transformer oil test (Break down voltage)	
13.	Oil leakage test	
14.	Heat run test	To be carried out once against the order.
15.	Bushing clearance (mm)	HV                      LV
	(a) Phase to Phase	
	(b) Phase to Earth	
16.	Comments on compliance by the firm on the modifications done as per stage inspection clearance letter issued.	
17.	Whether fittings of the order have been verified	
18.	Whether aluminium die cast silicagel breather with tin container is fitted on the transformers offered.	
19.	Whether engraving of Sl.No. and Name of firm on core clamping channel, side wall and top cover of tank has been verified.	
20.	Whether MS Plate of size 125 x125mm welded on with side of stiffner.	
21.	Whether engraving of name of firm, Sl.No. and Rating of transformer, Order No. and date and Date of Despatch on MS Plate.	
22.	Copy of calibration certificate of metering equipments be enclosed.	

**Note:- If the Purchaser's Inspecting officer wants to note & incorporate any other readings pertaining to the above tests then the same shall have to be incorporated in the test report by the supplier. Also if the inspecting officer decides to carry out any other low voltage tests to know the soundness of the transformer then the same shall have to be carried out by the supplier.**

**(B) POINTS TO BE SEEN / DIMENSIONS TO BE NOTED AT THE TIME OF DISMANTLING OF TRANSFORMERS:**

Sl. No.	PARTICULARS	OBSERVATIONS.
1.	Details of the transformer dismantled for physical verification.	
	(a) Rating (kVA)	
	(b) Sl. No.	
2.	Whether GI Nut Bolts with one spring one plain washer provided for tightening the tank cover.	
3.	Details of gasket used between top cover and tank material	

	(i) Thickness (mm)	
	(ii) Type of joints.	
4.	Whether core is earthed properly with copper strip (one end should be tightened in between the core laminations and other end bolted on core clamping channel).	
5.	Connections from winding to bushings (describe the manner in which it has been done)	
	(a) HV	
	(b) LV	
	(c) Formation of Star connection on LV side.	
6.	Winding wire dia and cross sectional area:	
	(a) HV	
	(i) Dia (mm)	
	(ii) Area (sq mm)	
	(b) LV	
	(i) L x W x Nos.of layer	
	(ii) Area (sq.mm)	
7.	Thickness of press board(s) provided between HV coils to cover the tie rods.	
8.	Whether painted with oil and corrosion resistant paint / varnish	
	(a) Inside of the tank	
	(b) Inside of the conservator tank.	
	(c) Core clamping and core base channels	
	(d) Tie rods.	
	(e) Core bolts.	
9.	Whether tie rods and core bolts insulated, if yes, material of insulation.	
10.	Whether flap on inner side of top cover provided to prevent direct falling of oil on core-coil assembly.	
11.	Method of joints.	
	(a) Between HV Coils.	
	(b) Between tap coils	
	(c) For tap changer	
12.	Whether engraving of Sl.No. and name of firm done on bottom channel of core coil assembly.	
13.	Diameter of copper wire used for formation of delta (should not be less than 1.5 times the dia of conductor). (mm)	
14.	Whether empire sleeves provided up to the end portion of HV winding joining to bushing.	
15.	<b>HV</b> Coils.	
	(a) Inner dia (mm)	
	(b) Outer dia (mm)	
16.	<b>LV</b> Coils.	
	(a) Inner dia (mm)	
	(b) Outer dia (mm)	
17.	Core dia	
18.	Core height including base channel and insulation in between (mm)	
19.	Leg Center of core	
20.	Clearance between	

	(a) Core and LV (mm)	
	(b) HV And LV (mm)	
	(c) Phase to Phase of HV coils (mm)	
	(d) Core coil assembly and tank body (mm)	
	(i) Length-wise	
	(ii) Width-wise	
	(e) top of yoke and top cover (mm)	
	(f) Top most live part of tap changer and top cover.	
21.	Weight of core only (kg)	
22.	Weight of windings (kg)	
	(a) LV	
	(b) HV	
23.	Whether core laminations are in one piece, used for	
	(a) Bottom yoke	
	(b) Top yoke	
24.	Specific remarks regarding smoothness and rusting core used.	
25.	Volume of oil filled (to be done once against the order)	
	(a) In conservator tank	
	(b) In tank of the transformer	
26.	Weight of transformer (inclusive of all fittings, accessories, oil etc. complete)	
27.	Inner dimensions of the tank	
	(a) Length	
	(b) Width	
	(c) Height	
	(i) LV side	
	(ii) HV side	
28.	Remarks, if any:	

**Note** : Please ensure that complete details have been filled in the proforma and no column has been left blank.

#### Annexure-IV

#### SOUERCE OF MATERIALS/PLACES OF MANUFACTUR, TESTING AND INSPECTION.

Sl. No	Item	Source of Material	Place of Manufacture	Place of testing and inspection.
1.	Laminations			
2.	Copper Conductor			
3.	Insulated winding wires			
4.	Oil			

5.	Press boards			
6.	Kraft paper			
7.	MS Plates/Angles/Channels			
8.	Gaskets			
9.	Bushing HV/LV			
10	Paints.			

**SCHEDULE IA  
GUARANTEED AND OTHER PARTICULARS FOR STATION  
TRANSFORMERS**

(To be furnished by the Manufacturer)

**Sl. No. Description.**

1. Make
2. name of Manufacturer
3. Place of Manufacture
4. Voltage Ratio
5. Rating in kVA
6. Core Material used and Grade:
  - a) Flux density
  - b) Over fluxing without saturation  
(Curve to be furnished by the  
Manufacturer in support of his claim)
7. Maximum temperature rise of:
  - a) windings by resistance method
  - b) Oil by thermometer
8. Magnetizing (no-load) current at:
  - a) 90% Voltage
  - b) 100% Voltage
  - c) 110% Voltage
9. Core loss in watts:

- a) Normal voltage
  - b) Maximum voltage
10. Resistance of windings at 20°C, 75°C  
(with 5% tolerance)
    - a. HV Winding (ohms)
    - b. LV Winding (ohms)
  11. Load losses (watts) at 75°C at normal tap (100% Load Condition)
  12. TOTAL Losses (Load loss + No Load Loss) at 100% load at 75°C at rated Voltage, frequency & at normal tap.
  13. Total Losses at 50% load at 75°C
  14. Current density used for: (Ampere/sq mm)
    - a) HV Winding.
    - b) LV Winding.
  15. Clearances: (mm)
    - a) Core and LV
    - b) LV and HV
    - c) HV Phase to phase
    - d) End insulation clearance to earth
    - e) Any point of winding to tank.
  16. Efficiency at 75°C
    - a) Unity P.F and
    - b) 0.8 P.F.
      - 1) 125°C load
      - 2) 100°C load
      - 3) 75°C load
      - 4) 50°C load
      - 5) 25°C load
  17. Regulation at:
    - a) Unit P.F.
    - b) 0.8 P.F. at 75°C
  18. % Impedance at 75°C
  19. Flash test:-
    - (i) HV 70 kV/ 50HZ for 1 minute
    - (ii) LV 3 kV /50 Hz for 1 minutes.
  20. Over potential test (Double voltage and Double frequency for 1 minute)
  21. Impulse test.

22. Mass of : (kg)
- a) Core lamination (minimum)
  - b) Windings (minimum)
  - c) Tank and fittings
  - d) Oil
  - e) Oil quantity (minimum) (litre)
  - f) Total weight
23. Oil Data:
- 1) Quantity for first filling (minimum) (litre)
  - 2) Grade of oil used.
  - 3) Maker's name
  - 4) BDV at the time of filling (kV)
24. Transformer:
- 1) Overall length x breadth x height (mm x mm x mm)
  - 2) Tank length x breadth x height
  - 3) Thickness of plates for
    - a) Side plate (min)
    - b) Top and bottom plate (min)
  - 4) Conservator Dimensions.
25. Radiation:
- 1) Heat dissipation by tank walls excluding top and bottom
  - 2) Heat dissipation by cooling tube
  - 3) Diameter and thickness of cooling tube.
  - 4) Whether calculation sheet for selecting cooling area to ensure that the transformer is capable of giving continuous rated output without exceeding temperature rise is enclosed.
26. Inter layer insulation provided in design for:
- 1) Top and bottom layer
  - 2) In between all layer
  - 3) Details of end insulation.
  - 4) Whether wedges are provided at 50°C turns of the HV coil.
27. Insulation materials provided.
- a) For Conductors
    - (1) HV
    - (2) LV
  - b) For Core.

28. Material and Size of the wire used.

1) **HV Dia (mm) (SWG)**

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- 2) **LV** a) Strip size.  
b) No. of Conductors in parallel  
c) Total area of cross section (sq mm).

29. Whether the name plate gives all particulars as required in tender

30. Particulars of bushings HV/LV

- 1) Maker's name
- 2) Type IS-3347/IS-2099/IS-7421
- 3) Rating as per IS
- 4) Dry power frequency voltage withstand test
- 5) Wet power frequency voltage withstand test.

**Note:**

The following shall be specifically confirmed:

- 1) Whether the offer conforms to the limits of impedance mentioned in the specification.
- 2) Whether the offer conforms to the limits of temperature rise mentioned in the specification.
- 3) Whether the losses of the transformers offered are within the limits specified.
- 4) Whether the transformer offered is already type tested for the design and test reports enclosed.

**SCHEDULE IB  
ADDITIONAL DETAILS**

Sl. No.	Description	
1.	Core Grade	
2.	Core diameter	mm
3.	Gross core area	Sq cm
4.	Net core area	Sq cm
5.	Flux density	Tesla
6.	Mass of core	Kg
7.	Loss per kg of core at the specified flux density	watt
8.	Core window height	mm
9.	Center to enter distance of the core	mm
10.	No.of LV Turns	
11.	No.of HV turns	

12.	Size of LV conductor bare/covered	mm
13.	Size o HV conductor bare/covered	mm
14.	No. of parallels	
15.	Current density of LV winding.	A/sq mm
16.	Current density of HV winding.	A/sq mm
17.	Wt. of the LV winding for Transformer	kg
18.	Wt. of the HV winding for Transformer	Kg
19.	No. of LV Coils/phase	
20.	No. of HV Coils/phase	
21.	Height of LV Winding.	mm
22.	Height of HV Winding.	mm
23.	ID/OD of HV winding	mm
24.	ID/OD of LV winding	mm
25.	Size of the duct in LV winding	mm
26.	Size of the duct in HV winding	mm
27.	Size of the duct between HV and LV	mm
28.	HV winding to LV winding clearance	mm
29.	HV winding to tank clearance	mm
30.	Calculated impedance	%
31.	HV to earth creepage distance	mm
32.	LV to earth creepage distance	mm

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

## **TECHNICAL SPECIFICATION**

**FOR**

**390KV,216KV, 120KV & 30KV SURGE  
ARRESTER**

**I- 390 KV**

**II- 216KV**

**III- 120KV**

**IV- 30KV**

**TECHNICAL SPECIFICATION FOR SURGE ARRESTERS  
FOR 400 KV,220 KV, 132KV & 33KV SYSTEMS.  
CONTENTS**

<b>CLAUSE NO</b>	<b>T I T L E</b>
1.0	SCOPE
2.0	STANDARDS
3.0	GENERAL TECHNICAL REQUIREMENTS
4.0	CONSTRUCTION

5.0	TESTS
6.0	INSPECTION
7.0	QUALITY ASSURANCE PLAN
8.0	DOCUMENTATION
9.00	PACKING & FORWARDING
10.0	QUANTITY & DELIVERY REQUIREMENT

<b>APPENDIX 6 I</b>	<b>TECHNICAL REQUIREMENTS</b>
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<b>ANNEXURES</b>	
A	GUARANTEED TECHNICAL PARTICULARS
B	CHECK 6 LIST
C	CALIBRATION STATUS OF TESTING EQUIPMENTS/METERS
D	CHECK-LIST TOWARDS TYPE TEST REPOR

<b>APPENDIX 6 II</b>	<b>QUANTITY AND DELIVERY SCHEDULE</b>
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**TECHNICAL SPECIFICATION FOR SURGE ARRESTERS FOR 400KV, 220KV,  
132KV & 33KV SYSTEMS**

**1.0 SCOPE :**

1.1 This Specification provides for the design, manufacture, inspection and testing before despatch, packing and delivery F.O.R. (destination) of metal oxide (gapless) Surge Arresters with discharge counters, insulating base, terminal connectors and other accessories as specified here in.

Following is the list of documents constituting this Specification. :

(i)	Technical Specification (TS)	
(ii)	Technical Requirements.	Appendix-I
(iii)	Quantity and delivery schedule.	Appendix-II
(iv)	Guaranteed Technical Particulars	Annexure-A

(v)	Check-List.	Annexure-B
(vi)	Calibration Status of testing equipments and meters/Instruments.	Annexure-C
(vii)	Check-list towards Type Test Reports.	Annexure-D
Note : Annexure-A,B,C,& D are to be filled up by the Bidder.		

1.1 All the above along with amendments thereof shall be read and interpreted together. However, in case of a contradiction between the Technical Specification and any other volume, the provisions of this volume will prevail.

1.2 The Surge Arrester shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and purchaser shall have the power to reject any work or materials, which in his judgement is not in full accordance therewith.

## 2.0 STANDARDS:-

2.1 Except to the extent modified in the Specification, the Surge Arrester shall conform to the latest editions and amendments of the standards listed hereunder.

Sl. No.	Standard Ref. No.	Title.
1	IEC-99-4	Specification for Surge Arresters without gap for AC System.
2	IS:2147	Degree of protection, provided by enclosures for low voltage switchgear and control.
3	IS:2629	Recommended practice for hot dip galvanization of iron and steel.
4	IS:2633	Method for testing uniformity of coating on zinc coated articles.
5	IS:3070	Specification for surge arresters for alternating current system.
6	IS:5621 & IEC-621155	Specification for large hollow porcelain for use in electrical installation.
7	IEC-60-1	High-Voltage Test technique.

8	IEC-270	Partial discharge measurements.
9	IEC-99-1	Non-linear resistor type gapped arresters for a.c. systems.
10		Indian Electricity Rules, 1956.
11.	IEC-60815	Shed profile of hollow porcelain Insulator.

2.2 Surge Arresters with the requirement of other authoritative standards, which ensure equal or better quality than the standards, mentioned above shall also be acceptable. Where the equipment offered by the supplier conforms to other standards, salient points of difference between the standards adopted and the specified standards shall be clearly brought out in the offer. 4 (Four) copies of the reference standards in English language shall be furnished along with the offer.

**3.0 GENERAL TECHNICAL REQUIREMENTS :**

3.1 The Surge Arrester shall confirm the technical requirements as per Appendix-I and this TS.

3.2 The energy handling capability of each rating of Arrester offered, supported by calculations, shall be furnished with the offer.

3.3 The Surge Arresters shall be fitted with pressure relief devices and arc diverting paths and shall be tested as per the requirements of IEC for minimum prospective symmetrical fault current as specified in Appendix-I.

3.4 A grading ring shall be provided if required, (for attaining all the relevant technical parameters) on each complete Surge Arrester.

**3.5 PROTECTIVE LEVELS :**

**Surge Arresters shall be capable of providing protection to sub-station equipments, designed for the withstand levels, given in the following table.**

Sl. No.	Equipment to be protected	Insulation level of 420KV Systems	Insulation level of 245KV Systems.	Insulation Level of 145KV Systems	Insulation Level of 36KV System
		L.I. Level (KVP)	L.I. Level (KVP)	L.I. Level (KVP)	L.I. Level (KVP)
1	Auto Transformers/Power Transformers.	± 1300	± 950	± 650	± 170
2	Instrument Transformers.	± 1425	± 1050	± 650	± 170
3	Reactors	± 1300	± 950	± 650	± 170
4	Circuit Breakers/Isolators.				
(i)	Phase to ground.	± 1425	± 1050	± 650	± 170
(ii)	Across open contacts.	± 1425(+240)= 1650	± 1200		



Surge arrester shall be suitable for the following duty cycles of circuit breaker at the following system voltages:

1.	420 KV Circuit Breaker.	0-0.3 sec-co-3 min-co
2.	245 KV Circuit Breaker.	0-0.3 sec-co-3 min-co
3.	145 KV Circuit Breaker	0-0.3 sec-co-3 min-co
4.	36 KV Circuit Breaker	0-0.3 sec-co-3 min-co

**3.6 DUTY REQUIREMENT :**

**3.6.1 Surge Arresters shall be of heavy-duty station class and gapless type without any series or shunt gaps.**

**3.6.2 Surge Arresters shall be capable of discharging over voltages occurring during switching of un-loaded transformers, lines, capacitors and reactors.**

**3.6.3 The Surge Arresters shall be capable of discharging lightning and switching surges and temporary power frequency over-voltages.**

**3.6.4 The Surge Arresters shall be capable of discharging the energy equivalent to class 3 of IEC-99-4.**

**3.7 The reference current of the arrester shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage. The supplier shall submit values and the supporting evidence along with calculations on above.**

**3.8 Surge Arresters shall be fully stabilized thermally to give a life expectancy of 100 years under site conditions.**

**3.9 Surge Arresters shall be able to withstand maximum wind load of 260 Kg./sq.m.**

**3.10 Surge Arresters shall be capable of withstanding effects of direct solar radiation**

**3.11 Surge arresters shall be capable of spark over on severe switching Surges and multiple strokes.**

**3.12 The Surge Arrester should be adequately designed to operate satisfactorily under temporary power frequency over-voltage as given in specific technical requirements, after discharging two shots of respective long duration surges.**

**3.13 Unless otherwise brought out separately by the Bidder in the schedule of deviations, the Surge Arresters, offered shall conform to the specification scrupulously. All deviations from the specification shall be brought out in the schedule of deviations. The discrepancies between the specification and the catalogues or literature, submitted as part of the offer shall not be considered as valid deviations unless specifically brought out in the schedule of deviations.**

**4.0 CONSTRUCTION :**

4.1 Non linear blocks shall be sintered metal oxide material. These shall be provided in such a way as to obtain robust construction with excellent electrical and mechanical properties even after repeated operations.

4.1.1 All the units of arresters of same rating shall be inter-changeable without adversely affecting the performance.

4.2 The Surge Arresters shall be suitable for pedestal type mounting.

4.3 All the necessary flanges, bolts, nuts, clamps etc. required for assembly of complete arrester with accessories and mounting on support structure to be supplied by the purchaser, shall be included in supplier's scope of supply.

4.4 The drilling details for mounting the Arrester on owner's support shall be supplied by the supplier.

4.5 The minimum permissible separation between the Surge Arrester and any earthed object shall be indicated by the Bidder in his offer.

4.6 Surge Arresters shall be designed to incorporate pressure relief devices and arc diverting paths to prevent shattering of the blocks or the porcelain housing, following prolonged current flow or internal flash over and providing path for flow of rated fault currents in the event of arrester failure.

4.7 Surge Arresters shall incorporate anti-contamination feature to prevent arrester failure, caused by uneven voltage gradient across the stack, resulting from contamination of the arrester porcelain.

4.8 Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.

4.9 The heat treatment cycle details alongwith necessary quality checks used for individual blocks alongwith insulation layer, formed across each block are to be furnished. Metalised coating thickness for reduced resistance between adjacent discs is to be furnished alongwith the procedure for checking the same. Details of thermal stability test for current distribution of current on individual disc is to be furnished.

4.10 Each individual unit of Surge Arresters shall be hermetically sealed and fully protected against ingress of moisture. The hermetic seal shall be effective for the entire lifetime of the arrester and under the service conditions as specified. The supplier shall furnish sectional view of the arrester showing details of sealing employed.

4.11 The Surge Arresters shall be suitable for hot line washing.

**4.12 PORCELAIN HOUSING :**

4.13.1 All porcelain Housings shall be free from lamination cavities or other flaws, affecting the maximum level of mechanical and electrical strengths.

4.13.2 The porcelain shall be well vitrified and non-porous.

4.13.3 The minimum creepage distance of the arrester housing shall be as per Appendix-I.

4.13.4 The porcelain petticoat shall be preferably of self-cleaning type (Aerofoil design). The details of the porcelain housing such as height, angle of inclination, shape of petticoats, gap between the petticoats, diameter (ID and OD) etc. shall be indicated by the Bidder in his offer in the form of detailed drawing.

4.13.5 Porcelain housings shall be so co-ordinated that external flash over will not occur due to application of impulse or switching Surge voltages up to the maximum design value for arrester.

#### **4.14 GALVANISATION, NICKEL PLATING ETC. :**

4.14.1 All ferrous parts exposed to atmosphere shall be hot dip galvanised as per IS: 2629, as amended from time to time. Tinned copper/brass lugs shall be used for internal wiring of discharge counter. Screws used for electrical connections shall be either made of brass or shall be nickel-plated.

4.14.2 Ground terminal pads and nameplate brackets shall be hot dip galvanised.

4.14.3 The material shall be galvanised only after completing all shop operations

#### **4.15 ACCESSORIES AND FITTINGS :**

##### **4.15.1 Surge Counters;**

4.15.1.1 A self- contained Surge counter, suitably enclosed for outdoor use and requiring no auxiliary of battery supply for operation shall be provided for each unit. The surge counter shall be operated by the discharge current, passed by the surge arrester and shall be suitable for mounting on the support structure of the Arrester.

4.15.1.2 Surge counters shall be of the Electro-mechanical type and designed for continuous service.

4.15.1.3 The cyclometer counter shall be visible through an inspection window from ground level. The counter terminals shall be robust and adequate size and shall be so located that the incoming and outgoing connections are made with minimum possible bends.

4.15.1.4 Internal parts shall be unaffected by atmospheric conditions at site. Alternatively, a weather proof housing to IP 55 shall be provided and this shall be designed to allow the recording device to be read from ground level without exposing the internal parts to the atmosphere.

**4.15.1.5 The Surge Counter shall be connected in the main earth lead from the arrester in such a manner that the direction of the earth lead is not changed or its surge impedance materially altered. A bolted link shall be provided so that the surge counter may be short circuited and removed without taking the arrester out of service.**

4.15.1.6 All necessary accessories and earthing connection leads between the bottom of the Arrester and discharge counter shall be in the supplier's scope of supply.

4.15.2 **LEAKAGE CURRENT METERS :**

4.15.2.1. Leakage current meters (suitable milli-ammeter) shall be connected in the earthing path of the surge arresters to measure the resistor grading leakage current. Meters shall be designed for continuous service.

4.15.2.2. The ammeter shall be suitable for mounting on the support structure of the arrester. The push buttons shall be mounted such that it can be operated from the ground level.

4.15.2.3. The internal parts shall be fully weather - proof to IP 55 or better with a transparent cover to provide an unobstructed view of the ammeter..

4.15.3. Arresters shall be complete with insulating base having provision for bolting to flat surface of the structure.

4.15.4. Grading /corona rings shall be provided on each complete Arrester unit, as required, for proper voltage stress distribution.

4.15.5. The grounding terminals shall be suitable for accommodating purchaser's grounding connection to steel earth mat.

4.15.6. The Bidder has to quote unit rates of the insulating base and the surge counter separately. The purchaser reserves its option to procure insulating base and surge counter.

4.15.7. Clamp type terminal connector, suitable for 400 KV-ACSR MOOSE/AL TUBE, 220KV-ACSR MOOSE Conductor 132KV & 33KV-ACSR MOOSE Conductor shall be provided having both horizontal and vertical take-off.

4.15.8. Two clamp type ground terminal connectors, suitable for G. I. Strip (50 x 6) or (50 x 8) should be provided.

4.15.9. All interconnecting hardware such as nuts, bolts, spring washers etc. with 5% spares shall be supplied for different units

4.15.10. Pollution Shunt (Copper braid) shall be supplied along with each surge Arrester for by-passing the surface current..

4.15.11. Other standard accessories, which are specifically not mentioned, but are usually, provided with Surge Arrester of such type and rating for efficient and trouble free operation should be supplied.

4.16 **NAME PLATE :**

Each single pole Arrester shall be provided with non-corrosive legible name plate, at the base bearing thereon, voltage rating of the complete pole and the number of demountable sections with the following data, indelibly marked

- (a) ORISSA POWER TRANSMISSION CORPORATION LIMITED.
- (b) Purchase order No. & Date.
- (c) Name of device.
- (d) Manufacturer's name and trademark and identification no. Of the arrester being supplied.
- (e) Year of manufacture
- (f) Rated voltage
- (g) Rated Frequency
- (h) Maximum continuous operating voltage.
- (i) Type
- (j) Nominal discharge current.
- (k) Long duration discharge class.
- (l) Pressure relief current in KA(rms)
- (m) Energy discharge capability ( KJ/KV rating).

## 5.0 **TEST :**

### 5.1 **Type Tests:**

The surge Arrester offered should have been subjected to the following type tests in an independent Government approved test laboratory. The bidder shall furnish four sets of type test reports alongwith the offer. These tests must not have been conducted earlier than five years from the date of opening of technical bid. For any change in the design, type already type tested and the design type offered against this specification, the purchaser reserves the right to demand repetition of some or all type tests without any extra cost to OPTCL in the presence of Purchaser's representative at the cost of the supplier.

- 1 Insulation withstands tests :
  - (a) Lightning Impulse Voltage Test.
  - (b) Wet switching impulse test. (For 390KV/216KV only).
- 2 Residual voltage tests.
- 3 Long duration current impulse withstand tests.
- 4 Operating duty tests.
- 5 Pressure relief tests.
  - (a) High current test.
  - (b) Low current test.
- 6 Power frequency voltage vs. time curve.  
(Temporary over voltage test)
- 7 Contamination test. (artificial pollution test).
- 8 Seismic withstand test.
- 9 IP-55 test on surge counter.
- 10 Minimum current operation tests of the surge counter.
- 11 Maximum current withstand test of the surge counter.
- 12 Mechanical terminal load test on bushing.
- 13 Partial discharge test.

N.B. :- Even if the condition i.e.  $\div$  the dry arcing distance or the sum of the partial dry arcing distances is larger than the test voltage divided by 500 KV/m $\phi$  the lightning impulse voltage test must have been conducted or is to be conducted without any financial liability to OPTCL.

Even if the type test reports are found to be valid as per this specification, the purchaser reserves the right to demand the repetition of some or all the type tests in the presence of purchaser's representative. For this purpose, the bidder shall quote unit rates for carrying out each type test. These prices, if necessary, will be taken into consideration for bid evaluation.

## 5.2 **ROUTINE TESTS** :

The following routine tests shall be conducted at the supplier's cost on each surge arrester and shall be submitted along with or before offering for inspection for purchaser's approval.

- (a) Measurement of reference voltage.
- (b) Residual voltage tests.
- (c) Measurement for partial discharge and contact noise.
- (d) Sealing test for units with sealed housings.

## 5.3 **ACCEPTANCE TESTS** :

The following tests, considered as acceptance tests, shall be conducted in the presence of purchaser's representative for which no charges will be payable by OPTCL. The acceptance tests, whenever possible shall be conducted on the complete arrester unit. The number of samples to be subjected to acceptance test shall be decided by the purchaser at the time of actual testing.

- I Temperature Cycle Test on Housing.
- II Measurement of Power Frequency Voltage at the reference current.
- III Measurement of leakage current and capacitive current at M.C.O.V.
- IV Lightning Impulse Residual Voltage Test at N.D.C., 50% of N.D.C. & 200% of N.D.C.
- V Partial Discharge Tests on complete arresters/units at 1.05 times M.C.O.V.
- VI Special Thermal stability test.
- VII Porosity test on porcelain components.
- VIII Galvanisation test on metal parts.
  
- IX The functional (operational) test on the Surge Counter by way of checking its operation at following nominal discharge currents :
  - (i) 100 Amps with 8/20 micro second wave shape.
  - (ii) 10 KA with 8/20 micro second wave shape.
  
- X Check of calibration of leakage current meters.

## 6 **INSPECTION** :

- I The purchaser shall have access at all time to the works and all other places of manufacture, where the Surge Arresters are being manufactured and the supplier shall provide all facilities for unrestricted inspection of the supplier's works, raw materials, manufacture of all the accessories and for conducting the necessary tests.
  
- II The supplier shall keep the purchaser informed in advance of the time of starting and the progress of manufacture of equipment in its various stages so that arrangements could be made for inspection.

- III No material shall be despatched from its point of manufacture unless the material has been satisfactorily inspected, tested and despatch schedule attached to this specification.
- IV The acceptance of any quantity of equipment shall in no way relieve the supplier of his responsibility for meeting all the requirements of this specification and shall not prevent subsequent rejection, if such equipments are later found to be defective.

## 7 **QUALITY ASSURANCE PLAN :**

7.1 The Bidder shall invariably furnish following informations alongwith his offer, failing which the offer shall be liable for rejection.

- (i) Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of tests, normally carried out on raw materials in presence of Bidder's representative, copies of test certificates.
- (ii) Information and copies of test certificates as in (I) above in respect of bought-out items.
- (iii) List of manufacturing facilities available.
- (iv) Level of automation, achieved and list of areas where manual processing exists.
- (v) List of areas in manufacturing process where stage inspections are normally carried out for quality control and details of such tests and inspections.
- (vi) Special features provided in the equipment to make it maintenance free
- (vii) List of testing equipments, meters available with Bidder for final testing of equipment, specified and test plant limitation, if any, vis-à-vis the type, acceptance and routine tests, specified in the relevant standards and this specification. These limitations shall be very clearly brought out in the offer.
- (viii) All the testing equipments, meters etc. should have been calibrated in a Government approved laboratory. The Bidder must submit the list of testing equipments and meters test-wise as per Annexure-C of this Technical Specification.

7.2 The suppliers, within 30 days of placement of order submit the following informations to the purchaser.

- (i) List of raw materials as well as bought out accessories and the names of the materials as well as bought-out accessories and the names of sub-suppliers, selected from those, furnished alongwith the offer.
- (ii) Type test certificates of the raw material and bought out accessories.
- (iii) Quality Assurance Plan (QAP) with hold points for the purchaser's inspection. The QAP and hold points shall be discussed between the purchaser and the supplier before the QAP is finalised.

7.3 The supplier shall submit the routine test certificates of bought out item and raw material at the time of acceptance testing of the fully assembled equipment.

## 8.0 **DOCUMENTATION :**

8.1 All drawings shall conform to relevant Indian Standard as per relevant IS. All drawings shall be in ink and suitable for microfilming. All dimensions and data shall be in S.I. Units.

- 8.2 The supplier shall furnish four sets of following drawings/documents along with his offer.
- (i) General outline drawings of the complete Arrester with technical parameters.

- (ii) Drawings showing clearance from grounded and other line objects and between adjacent poles of Surge Arresters, required at various heights of Surge Arresters.
- (iii) Drawings showing details of pressure relief devices.
- (iv) Detailed drawing of discharge counters along with the wiring and schematic drawing of discharge counter and meter.
- (v) Outline drawing of insulating base.
- (vi) Details of grading rings, if used.
- (vii) Mounting details of Surge Arresters.
- (viii) Details of line terminal and ground terminals.
- (ix) Volt-time characteristics of Surge Arresters.
- (x) Details of galvanization being provided on different ferrous parts.
- (xi) The detailed dimensional drawing of porcelain Housing such as ID, OD, thickness and insulator details such as height, profile of petticoats, angle of inclination and gap between successive petticoats, total creepage distance etc.
- (xii) Cross-sectional view of the Surge Arrester Units showing all components.

### 8.3 **TEST REPORTS :**

- (i) Four copies of type test reports shall be furnished to the purchaser with the tender specification. Copies of acceptance test reports and routine test reports shall be furnished to the purchaser. One copy will be returned duly certified by the purchaser and only thereafter shall the materials be despatched.
- (ii) All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser.
- (iii) All test reports of tests, conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when requested for by the purchaser.

### 9.0 **PACKING AND FORWARDING :**

9.1 The equipment shall be packed in suitable crates so as to withstand handling during transport and outdoor storage during transit. The supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement of lifting such as lifting hooks etc. shall be provided. Any material found short inside the packing cases shall be supplied by the supplier without any extra cost.

9.2 Each consignment shall be accompanied by a detailed packing list containing the following informations :

- (a) Name of the consignee :
- (b) Details of consignment :
- (c) Destination :
- (d) Total weight of consignment :
- (e) Sign showing upper/lower side of the crate :
- (f) Handling and unpacking instructions :
- (g) Bill of materials indicating contents of each package :

9.3 The supplier shall ensure that the bill of materials is approved by the purchaser before despatch.

### 10.0 **QUANTITY AND DELIVERY REQUIREMENT :**

- (i) The scope of supply shall include a supply of 2.5% extra quantity of bolts, nuts, washers, split pins, cotter pins and such other small loose items free of cost.



**APPENDIX – I.**

**(TECHNICAL REQUIREMENTS)**

**TECHNICAL REQUIREMENTS FOR METAL OXIDE (GAPLESS) SURGE ARRESTERS**

The Surge Arrester under this Specification shall conform to the parameters given below :-

		390KV	216KV	120KV	30KV
Sl. No.	Particulars.	Technical Parameters	Technical Parameters.	Technical Parameters	Technical Parameters
1	Nominal system voltage (phase to phase) (KV rms).	400	220	132	33
2	Highest system voltage (phase to phase) (KV rms).	420	245	145	36
3	System Frequency (HZ).	50 ± 5 %	50 ± 5 %	50 ±5%	50 ±5%
4	System Neutral earthing.	Effectively earthed.	Effectively earthed.	Effectively earthed	Effectively earthed
5	Installation.	Outdoor.	Outdoor.	Outdoor	Outdoor
6	Class.	Station class, 10 KA, heavy duty type.	Station class, 10 KA, heavy duty type.	Station class, 10 KA, heavy duty type.	Station class, 10 KA, heavy duty type.
7	Type of construction for 10 KA rated arrester.	Single column, single phase.	Single column, single phase.	Single column, single phase.	Single column, single phase
8	No. of phases.	Three	Three	Three	Three
9	Maximum duration of earth fault (Sec.)	3	3	3	3
10	Maximum prospective symmetrical fault current at arrester location (KA rms.)	40	40	40	40
11	Rated arrester voltage (KV rms)	390	216	120	30
12	Nominal discharge current (KAP)  Disscharge current at which insulation coordination will be done	10 KA of 8/20 micro-second Wave. And 20 KA of 8/20 microsec wave	10 KA of 8/20 micro-second Wave.	10 KA of 8/20 micro-second Wave.	10 KA of 8/20 micro-second Wave.
13	Minimum energy discharge capability (KJ/KV)	As per relevant ISS/IEC	As per relevant ISS/IEC	As per relevant ISS/IEC	As per relevant ISS/IEC

14	Maximum continuous operating voltage at 50° C(KV rms)	303	175	102	25
15	Maximum switching surge residual voltage (KVP)	780 at 1KA	496 at 1KA	272 at 1KA	72 at 500A
16	Maximum residual voltage at 8/20 micro second(KVP)				
	(i) 5 KA.		567	320	85
	(ii) 10 KA Nominal discharge current.	900 KVP	600	340	90
	(iii) 20 KA.	975 KVP	668	380	100
17	Long duration discharge class	3	3	3	2
18	High current short duration test value (KAP)(4/10 Micro-second wave).	100	100	100	100
19	Current for pressure relief test (KA-rms)	40	40	40	40
20	Minimum total creepage distance (mm).	10500	6125	3625	900
21	One minute dry and wet power frequency withstand voltage of Arrester housing (KV-rms).	630	460	275	70
22(a)	Impulse withstand voltage of arrester housing with 1.2/50 micro-second wave (KVP).	<b>+1425</b>	+ 1050	+650	+170
22(b)	Switching Impulse Voltage (Wet) (KVP)	<b>+1050</b>	700	-	-
23	Pressure relief class.	A	A	A	A
24	Corona extinction voltage (KV-rms).	320 min	216	-	-
25	RIV at 92 KV rms.	Less than 500 micro volts	Less than 500 micro volts.	Less than 500 micro volts.	Less than 500 micro volts
26	Partial discharge at 1.05 times continuous over-voltage.	Nor more than 50 PC.	Nor more than 50 PC.	Nor more than 50 PC	Nor more than 50 PC
27	Seismic acceleration.	0.3g horizontal 0.15g vertical	0.3g horizontal 0.15g vertical.	0.3g horizontal 0.15g vertical.	0.3g horizontal 0.15g vertical
28	Reference ambient temperature.	50°C	50°C	50°C	50°C
29	(a) IR at MCOV.	Less than 500 micro amperes.	Less than 500 micro amperes.	Less than 500 micro amperes.	Less than 400 micro amperes

	(b) IC at MCOV.	Less than 1500 micro amperes.	Less than 1500 micro amperes.	Less than 1500 micro amperes.	Less than 1200 micro amperes
30	a) Reference Current (mA)	1 to 5 mA	1 to 5 mA	1 to 5 mA	1 to 5 mA
	b) Reference voltage at reference current.	Greater than rated voltage.	Greater than rated voltage.	Greater than rated voltage.	Greater than rated voltage.
31	Maximum steep current Impulse RDV (KVP). at 10 KAP	1050	654	372	100
32	Maximum cantilever strength of the arresters (KGM).	1000	1000	1000	325
33	TOV(KVP).				
	(i) 0.1 sec.	580	382	170	53
	(ii) 1.0 sec.	565	366	163	51
	(iii) 10.0 sec.	550	351	156	49
	(iv) 100.0 sec.		336	149	47

## ANNEXURE – B

### CHECK 6 LIST

- 1 Whether calculation towards energy handling capability of the Surge Arrester furnished as per Clause No.3.2 of TS ?
- 2 Whether there is provision of Corona Grading Ring in the SA as per Clause No.3.4 and 4.15.4 of TS ? If not, whether justification for non-provision of the same furnished ?
- 3 Whether calculations and supporting evidence furnished to satisfy Clause No.3.7 of TS ?
- 4 Whether the heat treatment cycle details alongwith necessary quality checks used for individual blocks furnished as per Clause 4.10 of TS ?
- 5 Whether sectional view of arrester showing details of sealing provided as per Clause No.4.11 of TS furnished ?
- 6 Whether S.A. is suitable for hot line washing as per Clause No.4.12 of TS ?
- 7 Whether porcelain petticoat is of Aero foil design ? Whether drawing of porcelain Housing as per Clause No.4.13.4 of TS furnished ?
- 8 Whether information as per Clause No.7.1 (i) to (viii) of TS

furnished ?

9 Whether drawings and documents as per Clause No.8.2 (i) to (xii) of TS furnished ?

10 Whether special measures in the manufacture of Surge Arrester for operating at ambient temperature of 50°C (against 40°C as per IEC-99-4, Clause No.4.4.1) are to be taken ?  
í í í í í í í .. State the special measures in details í í í í í í í .

Signature of the Tenderer With Seal & Date

**ANNEXURE-D**  
**CHECK LIST TOWARDS TYPE TEST REPORTS.**

Name of the Type Test.	Date of Test.	Name of the Laboratory where the Test has been conducted.	Whether the Laboratory is Government Approved.	Whether the Test reports are valid as per Clause No.5.1 of T.S.	Whether the copy of Test Report in complete shape alongwith drawings etc. furnished or not ?	Whether the Type Tested Surge Arrester fulfills the technical requirements as per TS.	<b>If the type tested Surge Arrester does not fulfill the technical requirements as per this specification, whether the bidder agrees to conduct the particular type test again at their own cost without any financial liability to OPTCL in the presence of OPTCL's representative within the specified delivery period.</b>	Remarks.
1	2	3	4	5	6	7	8	9

Signature of the Tenderer with seal and date.

ANNEXURE 6C.

**CALIBRATION STATUS OF TESTING EQUIPMENTS AND INSTRUMENTS/METERS.**

Na	Meters	Date	Due	Name	Whether	Whether	Whether	Whether the	Whether	Inspite of	Rema
----	--------	------	-----	------	---------	---------	---------	-------------	---------	------------	------

me of the test.	and equipment s required for the corresponding test with range accuracy make and Sl. No.	of Calibr ation.	date of Calibr ation.	of the Calibra ting Agency	Calibrat- ing Agency is Govt. Approv- ed.	documents relating to Govt. Approval of the cali- brating Agency furnished ?	the meters/eq- uipment fulfill the accuracy class as per calibration report	calibrat- ing agency has put any limitation towards the use of the particular meter/equipm ent. If yes, state the limitations.	green sticker or blue sticker or yellow sticker has been affixed on the body of the particular equipmet/met er. State the colour of the affixed sticker.	imposed limitations , whether the particular meter/equi pment can still be used? Justify its use for correspond ing test(s).	rks
1	2	3	4	5	6	7	8	9	10	11	12

Signature of the tenderer with seal and date.

**ODISHA POWER TRANSMISSION CORPORATION LIMITED**

**OFFICE OF THE SR. GENERAL MANAGER,  
CENTRAL PROCUREMENT CELL,  
JANAPATH, BHUBANESWAR – 751022.**

**TECHNICAL SPECIFICATION**

**FOR**

**220,132 & 33 KV IVT**

**&**

**400,220 & 132 KV CVT**

**220 KV, 132KV, 33KV INDUCTIVE VOLTAGE  
& 400 KV,220KV,132KV CAPACITIVE VOLTAGE  
TRANSFORMERS WITH METERING WINDING OF**

## **ACCURACY CLASS (0.2)**

**I- 220KV IVT**

**II-132KV IVT**

**III-33KV IVT**

**IV-400 KV CVT**

**V-220KV CVT**

**VI-132KV CVT**

## **TECHNICAL SPECIFICATION FOR 220 KV, 132KV, 33KV INDUCTIVE & 400 KV,220KV,132KV CAPACITIVE VOLTAGE TRANSFORMER**

### **1.0 SCOPE :**

Voltage transformers shall be supplied with common marshalling box in a batch of 3 CVT $\phi$ / IVT $\phi$  along with terminal connectors and other fittings for providing necessary inter phase and control room interconnections.

The design of capacitor/Inductive voltage transformers shall be such that its accuracy shall not be affected by the presence of pollution on the external surface of its insulators.

The voltage transformer shall operate satisfactorily in system with high **X/R** ratio.(Tp=100ms)

Voltage transformer tanks along with top metallics shall be galvanised and painted to required shade stipulated under relevant sections of the specification.

1.1 This specification provides for the design, manufacture, assembly inspection and testing at the manufacturer $\phi$  works, packing and delivery FOR [Destination] of outdoor mounted type, single phase, single unit type Inductive voltage transformers for 220 KV, 132KV & 33KV systems, & Capacitive Voltage Transformers for 400 kv,220kv, 132KV system to be used for voltage indication, supply of potential to tariff meters, relays for feeder protection in Grid Sub-stations of OPTCL, Orissa.. In addition to the above functions the 400 kv,220kv, 132KV CVT shall be suitable for carrier coupling.

1.2 The IVTs shall be complete in all respects with insulators, bimetallic connectors, fixing details etc. as described herein.

1.3 Bidders are required to quote for 0.2 accuracy class [metering winding] for 33KV, 132KV, 220KV IVTs & 220kv, 132KV CVTs in the following manner.

- (a) Guaranteed Technical Particulars.
- (b) Technical literatures, brochures and drawings as per this specification.
- (c) Type Test reports.
- (d) List of orders, executed and Usersø certificates with offer, failing submission of the above particulars with the offer, the tender may not be considered for evaluation.

2.0 Following is the list of documents constituting this Specification.

- (i) Technical Specification (TS).
- (ii) Technical requirements. - [Appendix-I]
- (iii) Guaranteed Technical Particulars. - [Vol-III]
- (iv) Calibration status of testing equipment and meters/Instruments. - [Annexure-B]
- (vi) Check list towards Type Test Reports.- [Annexure-C]

N.B.:- Annexure-A,B & ,C are to be filled up by the Bidder.

### 3.0 **STANDARDS:-**

3.1 The IVTs & CVTs shall conform in all respects to high standards of Engineering, design, workmanship and latest revisions of relevant standards at the time of offer and the Purchaser shall have the power to reject any work or material which in his judgement is not in full accordance therewith.

3.2 Except to the extent modified in the specifications, the IVTS & CVTs shall conform to the latest editions and the amendments of the standards listed hereunder:

Sl. No.	Standard Ref. No.	Title.
01	IEC-44(4)	Instrument Transformer ó measurement of PDS.
02	IEC-60	High voltage testing techniques.
03	IEC-171	Insulation co-ordination.
04	IEC-186	Voltage Transformers.
05	IEC-186(A)	Voltage Transformers (first supp. to IEC-186)
06	IEC-270	Partial discharge measurement.
07	IS-335	Insulating oil for transformers and switch gears.
08	IEC-8263	Method for RIV Test on high voltage insulators.
09	IS-2071	Method of high voltage testing.
10	IS-2099	High Voltage porcelain bushings.

11	IS-2147	Degree of protection provided by enclosures for low voltage switch-gear and control.
12	IS-2165	Insulation co-ordination for equipments of 100KV and above.
13	IS-3156 (Part-I to IV).	Voltage transformers.
14	IS-3347	Dimensions of porcelain transformer bushings.
15	IS-4146	Application guide for voltage transformers.
16.	IS-5547	Application guide for Capacitor Voltage Transformers.
17.	IS-9348	Coupling Capacitor & Capacitor Devices.

3.3 All the above alongwith the amendments thereof shall be read and interpreted together. However, in case of a contradiction between the Technical Specification and any other volume, the provisions of this Technical Specification will prevail.

3.4 The voltage transformers with the requirements of other authoritative standards, which ensure equal or better quality than the standards, mentioned above shall also be acceptable. Where the equipments, offered by the supplier conforms to other standards, salient points of difference between the standards shall be brought out in the offer. 4 (four) copies of the reference standards in English language shall be furnished alongwith the offer.

3.5 The supplier is to furnish the standards as mentioned above from Sl. 1 to 17 at their own cost, if required by the purchaser.

#### 4.0 **CLIMATIC AND SERVICE CONDITIONS** :

4.1 The VTS are required to operate satisfactorily under the following conditions.

- (a) Maximum ambient temperature - 50°C.
- (b) Maximum daily average ambient air temperature - 45°C.
- (c) Maximum relative humidity ó 100%.
- (d) Average number of rainy days in a year ó 120 days.
- (e) Average annual rainfall ó 150 cms.
- (f) Altitude not exceeding ó 1000 M.
- (g) Maximum wind pressure ó 260kg/sq.m.

#### **EARTHQUAKE INCIDENCE:-**

The VTS are to be designed to withstand earthquake of an intensity, equivalent to 0.3g in the horizontal and 0.15g in the vertical direction where,  $g$  stands for acceleration due to gravity.

#### **5.0 PURCHASER'S AUXILIARY POWER SUPPLY:-**

5.1 Following power supplies shall be made available at site:

- (a) AC-3 phase, 415V, 50HZ earthed.

- (b) AC single phase, 240V, 50HZ earthed.
  - (c) 220V DC, Ungrounded.
- 5.2 All equipments and devices shall be capable of continuous satisfactory operation on AC and DC supplies of nominal voltage, mentioned above with variations as given below.
- (a) AC voltage variation. ± 10%
  - (b) Frequency variation. ± 5%.
  - (c) Combined voltage & frequency variation. ± 10%
  - (d) DC voltage variation. 190V to 240V DC.
- 5.3 The supplier shall make his own arrangements for the power supplies other than those specified under Clause-5.1 above.

**6.0 INSTALLATION:-**

The VTS covered under this specification shall be suitable for outdoor installation without any protection from rain, dust, mist and direct rays of the sun.

**7.0. GENERAL TECHNICAL REQUIREMENTS FOR IVT :-**

- 7.1 Each IVT shall be supplied, filled with insulating oil and shall be hermetically sealed to prevent atmosphere coming in contact with oil, avoiding filtration and change of oil. In case the tenderer intends to use Nitrogen or any other inert gas above the oil level, the gas must not leak out and the same shall be stated in the tender.
- 7.2 However, the IVT shall have a provision for draining and filling insulating oil after drying or preferably must have arrangement for drying the oil by continuous process with oil filters.
- 7.3 The IVT shall be suitable for transport in horizontal position if the transport limitations so demand.

**SECONDARY TERMINAL BOX:-**

- 1.2.1 The secondary terminals shall be brought out in a weather proof terminal box with a rating not less than IP-55.
- 1.2.2 All secondary terminals shall be brought out in a compartment on one side of each IVT for easy access. The exterior of this terminal box shall be Aluminum extruded sheets.
- 1.2.3 The terminal box shall be provided with removable gland plate and glands suitable for 1100 volts grade. PVC insulated, PVC sheathed multi core 4 sq.mm to 6 sq.mm stranded copper conductor cable.
- 1.2.4 The terminal box shall be provided with a door in front so as to have easy access of secondary terminals. The door shall have a sealing/locking arrangement and shall be suitable to prevent penetration of moisture and rain water.

1.2.5 The dimensions of the terminal box and its openings shall be adequate to enable easy access and sufficient working space for use of normal tools.

1.2.6 The terminal blocks shall be standard type and provided with ferrules indelibly marked or numbered and their identifications shall correspond to the designation on the relevant wiring diagram.

1.2.7 Secondary wiring terminal studs shall be provided with at least three nuts, plain and spring washers. The studs, nuts and washers shall be of brass, duly nickel plated. The minimum diameter of the studs shall be 6 mm. The length of at least 15 mm shall be available on the studs for inserting the leads.

Polarity shall be indelibly marked on each primary and secondary terminals.

1.3 The IVT shall be filled with oil under vacuum after processing and thereafter hermetically sealed to eliminate breathing and to prevent air and moisture from entering the tanks. Oil filling and/or oil sampling cocks, if provided to facilitate factory processing should be properly sealed before despatching the IVT. The method, adopted for hermetic sealing shall be described in the offer.

1.4 The castings of base, collar etc. shall be diecast and tested before assembly to detect cracks and voids, if any.

1.5 The characteristics of the IVTS shall be such as to provide satisfactory performance such as voltage error and phase displacement at rated frequency shall not exceed the values as per relevant standards at any voltage between 80% and 120% of rated voltage and with burdens of between 25% and 100% of rated burden at a power factor of 0.8 lagging. The error shall be determined at the terminals of the IVT and shall include the effects of any fuses or resistors as an integral part of the IVT.

1.6 Inductive voltage transformers shall be designed so as to achieve the minimum risk of explosion in service. The bidder shall bring out in his offer, measures taken to achieve this.

1.7 **PRIMARY WINDING:-**

Primary winding of the IVT will be connected phase to neutral with the neutral point solidly earthed. The arrangement for this shall be included in the scope of supply. The primary conductor shall be of adequate cross-section so that the maximum permissible current density shall not be exceeded even during short-circuit conditions.

7.11 **SECONDARY WINDING.**

Suitably insulated copper wire of electrolytic grade shall be used for secondary windings. The secondary conductor shall be of adequate cross section so that the maximum permissible current density shall not be exceeded even during short- circuit conditions. Each 220KV IVT & 132KV IVT will have two secondary windings, protection-150VA; 6Metering-150VA 6

burden at 0.8 lagging power factor and rated voltage of 110V/1.732V for protection and 110/1.732V for metering winding. Secondary windings shall be used for metering, relaying and synchronizing. Each winding shall comply requirements of both Part-II and III of up-to-date editions of IS-3156/IEC-186. 33KV IVT will have two secondary winding of 75 VA burden at 0.8 lagging power factor and rated voltage 110/1.732 volts( one metering and one protection winding).

7.12 **CORE:-** Core laminations shall be of cold rolled grain oriented silicon steel or other equivalent alloys of low hysteresis and eddy current losses, high permeability to ensure accuracy i.e. 0.2 accuracy class at both normal and high over voltage. The core material , thickness of lamination, the relevant graphs showing the characteristics of the core materials shall be submitted along with the offer.

7.13 **TANK.**

7.13.1 Both expansion chambers and tanks of the IVT shall be made of high quality steel and shall be able to withstand full vacuum and pressure, occurring during transit and thermal and mechanical stresses resulting from maximum short circuit current during operation. The tanks along with all ferrous parts shall be hot- dip galvanized as per relevant standard.

7.13.2 The metal tanks shall have bare minimum number of welded joints so as to minimize possible locations of oil leakage. Welding in horizontal plane is to be avoided as welding at this location may give way due to vibrations during transport resulting in oil leakage. Supplier has to obtain specific approval from the purchaser for any horizontal welding, used in the bottom tank

7.13.3 Paint inside the metallic housing shall be of anti-condensation type.

7.14 **PORCELAIN HOUSING.**

7.14.1. The housing shall be made up of homogeneous, vitreous porcelain of high mechanical and dielectric strength, Glazing of porcelain shall be of uniform brown or dark brown colour with a smooth surface, arranged to shed away rain water or condensed water particles( fog).The details of location and type of joint, if provided on the porcelain, shall be furnished by the Bidder along with the offer.

7.14.2.The bushings of the IVTS shall conform to latest edition of IS-2099.The hollow porcelain insulators shall conform to the latest edition of IS-5621

7.14.3 The insulators shall be cemented with Portland cement to the flanges resulting in high mechanical, tensile and breaking strength

7.14.4. The bushings shall have ample insulation, mechanical strength and rigidity for the condition under which they shall be used and shall be used and shall be designed to prevent

accumulation of explosive gases and provide adequate oil circulation to remove the internal heat.

7.14.5 Cast metal and caps for the bushings shall be of high strength hot dip galvanized malleable iron. They shall have smooth surface to prevent discharge taking place between the metal parts and porcelain as a result of ionisation.

7.14.6 The insulation of bushings shall be co-ordinated with that of the IVT such that the flashover, if any, shall occur only external to the IVT.

7.14.7 Oil level gauge and convenient means of filling, sampling and draining of oil shall be provided.

7.14.8 End shields should be provided for distribution of stresses.

7.14.9 Corona shields for bushings, if required, should be provided.

7.15 INSULATING OIL.

The quantity of insulating oil for the filling and the complete specification of the insulating oil shall comply in all respects with the provisions of the latest edition of IS-335. The IVTS shall be supplied completely filled with purified oil.

7.16. PREVENTION OF OIL LEAKAGE AND ENTRY OF MOISTURE:-

The supplier shall ensure that the sealing of the IVT is properly achieved. In this connection, the arrangement provided by the supplier at various locations including the following ones shall be described, supported by sectional drawings

- (a) Locations of emergence of primary & secondary terminals..
- (b) Interface between porcelain housing and metal tank(s).
- (d) Cover of the secondary terminal box.

7.16.1 Nuts and bolts or screws used for fixation of the interfacing porcelain bushings for taking out terminals shall be provided on flanges, cemented to the bushings and not on the porcelain.

7.16.2 For gasketed joints, wherever used, nitrile butyl rubber gaskets shall be used. The gasket shall be fitted in properly machined groove with adequate space for accommodating the gasket under compression.

7.17 FITTINGS AND ACCESSORIES:- Fittings and accessories, listed below shall be supplied with each IVT. Any fitting, required essential other than those listed below shall also be supplied along with each IVT.

- (a) Oil level gauge.

- (b) Oil filling hole and cap.
- (c) Pressure relieving device.
- (d) Lifting lugs for core and windings, bushings & complete transformers.
- (e) Phase terminal connectors.
- (f) Tank earthing pads/terminals with necessary nuts and bolts and washers for connecting to Purchaser's strip.
- (g) Name/Rating plate.
- (h) MCB & H.R.C. fuse.

7.18.1 OIL LEVEL GAUGE:- An oil level gauge shall be provided to indicate the oil level in the IVT. This gauge shall be mounted in such a way that the oil level can be seen from the ground level.

7.18.2 PRESSURE RELIEVING DEVICE:- Each IVT shall be provided with a pressure relieving device so as to protect bushing of the IVT even under unfavourable conditions.

7.18.3 OIL DRAIN COCK:- An oil drain cock alongwith a stop cock shall be provided in the bottom flange so as to permit taking of oil samples for testing, if required.

7.18.4 EARTHING:- Metal tank of each IVT shall be provided with two separate earthing terminals for bolted connection to 50mm x 6mm flat to be provided by the Purchaser for connection to station earth-mat.

7.18.5 LIFTING ARRANGEMENT:- The IVT shall be provided with suitable lifting arrangement to lift the entire unit. The lifting arrangement shall be clearly shown in the general arrangement drawing. Lifting arrangement [Lifting eye] shall be positioned in such a way so as to avoid any damage to the porcelain housing or the tanks during lifting for installation/transport. Necessary string guides shall be offered which shall be of removable type.

7.18.6 NAME PLATE:- The IVT shall be provided with non-corrosive legible name plate with the information specified in relevant standards, duly engraved/punched on it.

7.18.7 GASKET JOINT:- The manufacturer shall furnish the type of gasket used or setting methods.

7.18.8 TERMINAL CONNECTORS:- All the IVTS shall be provided with bimetallic solderless clamp type, rigid type terminal connectors, suitable for ACSR Moose Conductor for 220KV IVT & CVT ACSR .MOOSE /MOOSE Conductor for 132KV, 33KV IVT & 132KV CVT..Each terminal connector shall be of universal type, suitable for both horizontal and vertical connections to the transmission line conductors/station bus bar.

7.18.8.1 TERMINAL CONNECTORS shall be manufactured and tested as per IS:5561.

7.18.8.2 All castings shall be free from blow holes, surface blisters, cracks and cavities.

All sharp edges and corners shall be blurred and rounded off.

7.18.8.3 No part of a clamp shall be less than 10mm thick.

7.18.8.4 All ferrous parts shall be hot dip galvanized conforming to IS-2633.

For bimetallic connectors, copper alloy linear of minimum thickness of 2 mm shall be cast integral with aluminium body.

7.18.8.5 All current carrying parts shall be designed and manufactured to have minimum contact resistance.

7.18.8.6 Connectors shall be designed to be corona free in accordance with the requirements, stipulated in IS-5561.

7.18.9 SECONDARY WIRING:-

The Secondary wiring shall be enclosed in conduits and shall be brought to a terminal block ready for external connections. The wiring shall be of adequate cross-section and not less than 4.00 sq.mm copper wire.

7.18.10 The supplier shall supply necessary hardwares, required for connection of phase side conductor to the line terminal and the grounding strip to the grounding terminal.

7.18.11 Necessary nuts and bolts for fixing the IVTS on the supporting structures shall be in tenderer's scope of supply.

**B.7.0 GENERAL TECHNICAL REQUIREMENTS FOR 400 kv,220KV & 132KV CAPACITIVE VOLTAGE TRANSFORMER:-**

7.1 The design of capacitor voltage transformers shall such that its accuracy shall not be affected by the presence of pollution on the external surface of its insulators.

7.2 The CVT shall operate satisfactorily in system with high X/R ratio. ( $T_p=100$  ms).

7.3 The CVT transformer tanks along with top metallic shall be galvanized and painted to required shade.

7.4 Impregnation details along with tests and checks to ensure successful completion of impregnation cycle shall be furnished for purchaser's approval.

7.5 Bellows, if used to cater for expansion of insulating oil, shall be tested in accordance with relevant standards. The details shall be subject to the approval of the purchaser.

7.6 The CVT shall be capacitor voltage type with electromagnetic units and shall be suitable for carrier coupling..

7.7 All windings of voltage transformer secondaries shall be protected by MCB and HRC cartridge type fuses. In addition, fuses shall be provided for the protection and metering windings for fuse monitoring scheme. The secondary terminals of the CVTs shall be terminated to stud type non-disconnecting terminal blocks in the individual phase secondary boxes via the fuse

- 7.8 CVTs shall be suitable for high frequency (HF).coupling, required for power line carrier communication. The carrier signal must be prevented from flowing into potential transformer (EMU) circuit by meant of a RF choke/reactor, suitable for effectively blocking the carrier signal over the entire carrier frequency range i.e. 40 to 500 KHZ. Details of the arrangement shall be furnished along with the bid. HF terminal of the CVT shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling devices of the carrier communication equipment, when utilized. The bushing shall be fully protected against rain and vermin so as to avoid the possibility of short circuits to earth. An earthing link with fastener shall be provided for HF terminal.
- 7.9 The electromagnetic unit, comprising compensating reactor, intermediate transformer and protective and damping devices should have a separate terminal box with all secondary terminals, brought out.
- 7.10 Voltage transformers should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens.
- 7.11 The accuracy of the windings (3P/3P/0.2) shall be maintained through out the entire burden range preferably in the frequency range of 48 HZ to 51.5 HZ on all the three windings without any adjustment during operation. Preference will be given to such bidders who can offer for maintaining the above accuracy class in the frequency range i.e. 48 HZ to 51.5 HZ up to the above specified burden values.
- 7.12 CONSTRUCTIONAL FEATURES:-
- 7.12.1 The 400kv, 220KV & 132KV CVT shall be suitable for mounting on support structure of tubular GI pipe of nominal bore of 300/200 mm. or lattice type structures.
- 7.12.2 Access to secondary terminals shall be possible without any danger of access to high voltage circuit.
- 7.12.3 CVTs shall be hermetically sealed units.
- 7.12.4 A protective surge Arrester/spark gap shall be provided to prevent break down of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor/primary winding, turning reactor/RF choke etc. due to short circuit in transformer secondaries. In case of an alternative arrangement, the Bidder shall bring out the details in the Bid.
- 7.12.5 The CVT secondary terminals shall brought out in to a weather proof terminal box for ease of access. The terminal box shall have an IP rating of not less than IP 55. The terminal box shall be provided with a removable gland plate at the bottom and shall be suitable for accepting the required number of PVC insulated PVC sheathed, 10 core 2.5 mm<sup>2</sup> standard copper conductor cable.

- 7.12.6 All terminals shall be clearly marked to facilitate connection of secondary wiring.
- 7.12.7 Secondary fuses or MCBs shall be provided on or adjacent to each CVT, located such that they are accessible while the primary is live and shall be provided with labels indicating their function and their phase colours CVT secondary circuits shall be complete in themselves and shall be earthed at one point only. A separate earth link shall be provided for each secondary winding and shall be situated at the CVT.
- 7.12.8 Where CVTs are supplied which are, or may be connected to different sections of the bus bar, it shall not be possible for the CVT secondary circuits, to be connected in parallel.
- 7.12.9 An auxiliary switch or relay shall be provided in each phase of the secondary circuit of the synchronizing and metering voltage supply connections to break the circuits automatically as soon as the circuit breaker is opened.
- 7.12.10 To prevent ferro resonance, suitable damping devices shall provided for connection to the transformer secondaries.
- 7.12.11 CVTs shall meet the requirements, given in this section of the specification.
- 7.12.12 The creepage and flashover distances of the high voltage insulator shall be suitable for the out door service conditions, specified in the schedules.
- 7.12.13 The bidder in the offer is to state the suitable precautions/methods, adopted during design stage of the CVT to avoid the un-desirable effects due to ferro resonance phenomena. The precautions/methods include lower level of working flux density in EMU, greater utilization of the linear portion of the magnetization curve, providing an air gap in the magnetic circuit, connecting a suitable damping resistance permanently across the secondary etc.
- 7.12.14 It should be stated in the bid offer regarding the steps taken in the design stage for elimination/minimization of the influence of the transient response on the behavior of high speed relays.
- 7.12.15 It shall be ensured by the bidder in the offer that the connection of carrier, frequency coupling device across the CVT will not affect the designated accuracy class of the CVT windings.
- 7.12.16 The capacitor divider unit shall comply to IS: 9348/1979.
- 7.12.17 It shall also be complied in the offer through a calculation sheet, proving that the designated accuracy class of the CVT (both metering and protection) are not affected by extreme temperatures, to be encountered in service conditions (Max. ambient temperature 50° C and minimum -0° C).
- 7.12.18 The terminal contractors should be suitable for ACSR MOOSE, /÷ ZEBRA (as per requirement) Conductor, complying to Cl.No.A.7.18.8 of this specification.

8.. TESTS:-

8.1 Type Tests:- The offered 220KV, 132KV & 33KV Inductive voltage transformer & 400KV, 220kv, 132KV capacitive voltage transformer should have been subjected to the following type tests in a Government approved Test Laboratory. The bidder shall furnish four sets of type test reports along with the offer. These tests must not have been conducted earlier than five years from the date of opening of the bid. For any change in the design/type already type tested and to the design/type offered against this specification, the purchaser reserves the right to demand repetition of some or all type tests/special tests without any extra cost to OPTCL in the presence of purchaser's representative at the cost of the supplier.

For 220 KV, 132KV & 33KV IVT:

- (a) Temperature rise test.
- (b) Short circuit withstand capability test.
- (c) Lightning Impulse Test.
- (d) High Voltage power frequency wet withstand voltage tests.
- (e) Determination of errors.
- (f) IP-55 Test on secondary Terminal Box.

N.B.:- [I] The dielectric type tests should have been carried out on the same transformer.

(ii) After the IVT was subjected to the dielectric tests, it should have been subjected to all routine tests as per relevant standards.

(iii) For Temperature Rise Test, the test must have been made with the appropriate rated burden, connected to each secondary winding.

For 400 kv, 220KV & 132KV CVT.

TYPE TESTS/SPECIAL TESTS FOR 400 KV, 220KV, 132KV CVT:-

- a) Lightning Impulse voltage test on complete CVT unit.
- b) Power frequency over-voltage test on complete CVT unit.
- c) Partial discharge test.
- d) Radio interference voltage test.
- e) Corona extinction voltage test.
- f) Temperature rise test on complete CVT unit.
- g) Ferro resonance test on the complete C.V.T. unit.
- h) Transient response tests.
- i) Determination of Temperature Co-efficient test.

- j) High frequency capacitance and equivalent resistance measurement test (as per IEC-358)
- k) Stray capacitance and stray conductance test (as per IEC-358).
- l) Accuracy tests.
- m) Thermal stability test.
- n) Thermal Co-efficient test (as per IEC-358)
- o) Fast transient test.
- p) Seismic withstand test.
- q) IP-55 test on secondary Terminal Box.
- r) Magnetization and internal burden tests.
- s) Effectiveness of sealing tests.
- t) Mechanical Terminal load test on Bushing.
- u) Dielectric loss angle test (Tan Delta Test).

- N.B:-
1. The dielectric type tests should have been carried out on the same CVT.
  2. After the CVT was subjected to the dielectric tests, it should have been subjected to all routine tests as per relevant standards.
  3. The ratio errors, phase displacements before, during and after the temperature rise test on complete CVT unit should have been determined with stipulated burdens and the same should comply with the designated accuracy class for each winding of the CVT.

8.2 ROUTINE TESTS:- The following routine tests shall be conducted on each VT in the presence of Purchaser's representative for which no charges will be payable by OPTCL. No sampling is allowed.

- (a) Verification of terminal markings.
- (b) Power frequency withstand tests on primary windings/capacitor voltage divider for IVT/CVT
- (c) Partial discharge measurement for 400 KV, 220KV, 132KV IVT & 220KV & 132KV CVT.
- (d) Power frequency withstand tests on secondary windings/Low voltage terminal of the capacitor divider for 220KV & 132KV CVT.
- (e) Power frequency withstand tests between sections.
- (f) Determination of errors on complete IVT./CVT.
- (g) Measurement of Insulation resistance.
- (h) Oil leakage test.
- (i) Measurement of capacitance and dielectric dissipation factor before and after dielectric tests (as per IEC-358)
- (j) Power frequency tests on electromagnetic unit for 400 KV, 220KV & 132KV CVT.

(k) Any other test as per relevant national & international standards.

N.B.:- Determination of errors shall be performed after the other tests. The standard reference VT to be used during testing for determination of ratio error and phase angle error should be of 0.05 accuracy class or better as per standard practice, presently adopted by OPTCL.

9. INSPECTION:

9.1 The Purchaser shall have access at all times to the works and all other places of manufacture, where the IVTs/CVTs are being manufactured and the supplier shall provide all facilities for unrestricted inspection of the supplier's works, raw materials, manufacturer of all the accessories and for conducting the necessary tests.

9.2 The Supplier shall keep the Purchaser informed in advance of the time of starting and of the progress of manufacture of equipment in its various stages so that arrangement could be made for inspection at the discretion of the Purchaser.

9.3 No material shall be despatched from its manufacture unless the material has been satisfactorily inspected, tested and despatch clearance issued. However, the Purchaser reserves the right to alter the despatch schedule attached to this Specification.

9.4 The acceptance of any quantity of equipment shall in no way relieve the supplier of his responsibility for meeting all the requirements of this Specification and shall not prevent subsequent rejection, if such equipments are found to be defective.

9.5 Clear 15 (Fifteen) days notice shall be given to this office for deputing officer(s) for inspection. The Voltage Transformers shall be despatched only after the inspection is conducted by a representative of OPTCL and release order, issued from this office after approval of Routine Test Certificates. The shop routine test certificates in triplicate for all the Voltage Transformers along with the calibration certificates of all the meters and equipments to be used during testing (as per Annexure-B of the Specification) should be furnished along with the Inspection Offer. The Inspecting Officer will be authorised for inspection of the Voltage Transformers subject to the condition that the routine test certificates and calibration certificates of the testing equipments/meters will be found to be in order.

10. QUALITY ASSURANCE PLAN:-

10.1 The Bidder shall invariably furnish following informations along with his offer.

[i] Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards, according to which the raw materials are tested, list of tests, normally carried out on raw materials in presence of Bidder's representative, copies of test certificates.

[ii] Information and copies of test certificates as in [i] above in respect of bought out items.

- [iii] List of manufacturing facilities available.
- [iv] Level of automation achieved and list of areas where manual processing exists.
- [v] List of areas in manufacturing process where stage inspections are normally carried out for quality control and details of such tests and inspection.
- [vi] Special features provided in the equipment to make it maintenance free.
- [vii] List of testing equipments, meters and test plant limitation, if any, vis-à-vis the type, acceptance and routine tests, specified in the relevant standards. These limitations shall be very clearly brought out in the offer.
- [viii] All the testing equipments, meters etc. should have been calibrated in a Government approved laboratory. The Bidder must submit the list of testing equipments and meters test-wise as per ANNEXURE-B of the Technical Specification.

10.2 The Supplier shall within 30 days of placement of order submit the following information to the Purchaser.

- [i] List of raw materials as well as bought out accessories and the names of the materials as well as bought out accessories and the name of Sub-suppliers selected from those, furnished along with the offer.
- [ii] Type test certificates of the raw materials and bought out accessories.
- [iii] Quality Assurance Plan (QAP) with hold points for the Purchaser's possible inspection. The QAP and hold points shall be discussed between the Purchaser and the Supplier before the QAP is finalised.

10.3 The Supplier shall submit the routine test certificates of bought out items and raw materials at the time of acceptance testing of the fully assembled equipment.

11 DOCUMENT: The supplier shall furnish four sets of following drawings/documents along with his offer.

- [a] General outline and assembly drawings of the Inductive Voltage Transformers/ Capacitive Voltage Transformers.
- [b] Sectional views showing:-
  - [i] General constructional features.
  - (ii) Materials/gaskets/sealing used.
  - iii] The insulation of the winding arrangements, method of connection of primary/secondary winding to the primary/secondary terminals etc.
- [c] Schematic drawing.
- [d] Rating & diagram plate as per relevant IEC/ISS
- [e] Secondary Terminal Box.

- [f] Assembly Sectional view of Primary terminal./ capacitor voltage divider
- [g] Assembly drawing for secondary terminal
- [h] The detailed dimensional drawing of Porcelain Housing such as ID,OD, thickness and insulator details such as height, profile of petticoats, angle of inclination and gap between successive petticoats, total creepage distance etc.
- [i] Sectional view of pressure release device.
- [j] Drawing showing details of Oil level.
- [k] All type test reports relating to the tests as specified in Clause-8.1 of the above.
- [l] Ratio and phase angle error curves for IVTS/ CVTS
- [m] Magnetization characteristic curves such as B-H curves and Sp. Loss vs. Flux density curves for core material, used for IVT & EMU unit of CVT.
- [n] Sectional view of EMU unit of 400 KV,220KV&132KV CVT

12. TEST REPORTS:-

- [i] Four copies of type test/special test reports shall be furnished to the Purchaser with the tender offer.
  - [ii] Copies of acceptance test reports and routine test reports shall be furnished to the Purchaser. One copy will be returned, duly certified by the Purchaser and only thereafter shall the materials be despatched.
  - [iii] All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the Purchaser.
  - [iv] All test reports of tests, conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when required for by the purchaser.
13. The necessary galvanized flanges, bolts etc. for the base of the Inductive/Capcitive Voltage Transformers shall be supplied without any extra cost to the purchaser.

14. PACKING AND FORWARDING:-

14.1 The equipment shall be packed in suitable crates so as to withstand handling during transport and outdoor storage during transit. The supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting such as lifting hooks etc. shall be provided. Any material found short inside the packing cases shall be supplied by supplier without any extra cost.

14.2 Each consignment shall be accompanied by a detailed packing list containing the following informations:

- [a] Name of the consignee.

- [b] Details of consignment.
- [c] Designation.
- [d] Total weight of consignment.
- [e] Sign showing upper, lower side of the crate.
- [f] Handling and unpacking instructions.
- [g] Bill of materials indicating contents of each package.
- [h] Set of approved drawings.

14.3 The supplier shall ensure that the bill of materials is approved by the Purchaser before despatch.

15. Any tender without complete information as asked for in the above Specification is likely to be rejected.

CVTø shall be suitable for high frequency (HF) coupling required for power line carrier communication. The carrier signal must be prevented from flowing into potential transformer (EMU) circuit by means of a RF choke/reactor suitable for effectively blocking the carrier signals over the entire carrier frequency range i.e. 40 to 500 kHz. Details of the arrangement shall be furnished along with the bid. HF terminal of the CVT shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling devices of the carrier communication equipment, when utilised. The bushing shall be fully protected against rain and vermin so as to avoid the possibility of short circuits to earth. An earthing link with fastener shall be provided for HF terminal. The electromagnetic unit comprising compensating reactor, intermediate transformer and protective and damping devices should have a separate terminal box with all secondary terminals brought out. Voltage transformers should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens.

The accuracy of the metering winding (0.2) shall be maintained throughout the entire burden range up to 100 VA/100 VA/1100 VA for 420kV CVTø on all the three windings without any adjustments during operation.

## Constructional features

420 KV CVTø shall be suitable for mounting on support structure of made out of preferably lattice or tubular GI pipe of nominal bore of 300/200 mm.

Access to secondary terminals shall be possible without any danger of access to high voltage circuit. Voltage transformers shall be hermetically sealed units.

A protective surge arrester/spark gap shall be provided to prevent breakdown of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor/primary winding, tuning reactor/RF choke etc. due to short circuit in transformer secondaries. In case of an alternate arrangement, Bidder shall bring out the details in the Bid.

The wiring diagram for the interconnection of the three single phase CVTø shall be provided inside the marshalling box in such a manner that it does not deteriorate with time. The wiring diagrams shall be fixed

The primary and secondary windings of voltage transformers shall be constructed from high purity, annealed, high conductivity copper meeting the requirements of IEC 28.

The VT secondary terminals shall be brought out into a weather proof terminal box for ease of access. The terminal box shall have an IP rating of not less than IP 55. The terminal box shall be provided with a removable gland plate at the bottom and shall be suitable for accepting the required number of PVC insulated PVC sheathed 10 core 2.5 mm<sup>2</sup> stranded copper conductor cable.

All terminals shall be clearly marked to facilitate connection of secondary wiring.

Secondary fuses or MCBs shall be provided on or adjacent to each voltage transformer, located such that they are accessible while the primary is live and shall be provided with labels indicating their function and their phase colours. Voltage transformer secondary circuits shall be complete in themselves and shall be earthed at one point only. A separate earth link shall be provided for each secondary winding and shall be situated at the voltage transformer.

Where voltage transformers are supplied which are, or may be, connected to different sections of the busbar, it shall not be possible for the voltage transformer secondary circuits to be connected in parallel.

An auxiliary switch or relay shall be provided in each phase of the secondary circuit of the synchronising and metering voltage supply connections to break the circuits automatically as soon as the circuit breaker is opened.

To prevent ferro resonance, suitable damping devices shall be provided for connection to the transformer secondaries.

Voltage transformers shall meet the requirements given in this section of the Specification.

The creep age and flash over distances of the high voltage insulator shall be suitable for the outdoor service conditions specified in the Schedules.

## Oil Filled voltage transformers

The following facilities shall be provided for oil filled voltage transformers:

- Visual oil level indicator of prismatic or other or means of determining the position of the diaphragm or bellows seal visible from ground level.
- Oil drain cock and sampling valve where applicable.

### Requirement Of 420kv Capacitor Voltage Transformer

Particulars	Parameters		
Rated primary	420kV		
Type	Single phase capacitor voltage transformer		
No. of secondaries	3		
Rated voltage factor	1.2 continuous 1.5 for 30 seconds		
Phase angle errors	±20 minutes		
Capacitance(pF)	4400/8800+10% , -5%(as per applicable)		
Voltage Ratio $\frac{kV}{V}$	Secondary core Nos.		
	Core-1 $\frac{400/\sqrt{3}}{110/\sqrt{3}}$	Core-2 $\frac{400/\sqrt{3}}{110/\sqrt{3}}$	core-3 $\frac{400/\sqrt{3}}{110/\sqrt{3}}$
Application	Protection	Protection	Metering and instrumentation
Accuracy	3P	3P	0.2
Output burden(VA) minimum*	100	100	100

\*The bidder shall also estimate the requirement of burden and offer the same as an alternative for the Employers consideration.

**REMARKS :**

C.T., P.T. & CVT consoles. Marshalling box shall be of aluminium alloy of 3mm are to be supplied along with the C.T., P.T. & CVT equipments. One console box is required for 3 nos. equipment. Details of quantities required are to be engineered by the contractor. These consoles are suitable for outdoor mounting and shall have proper slope at the top for easy discharge of water.

## APPENDIX 6 I.

### **TECHNICAL REQUIREMENTS FOR 400 KV,220KV, 132KV & 33KV INDUCTIVE VOLTAGE TRANSFORMERS &400 KV,220KV, 132KV CAPACITIVE VOLTAGE TRANSFORMER.**

Sl. No	Particulars.	Description.				
		400 KV/220KV CVT	220KV IVT	132KV CVT	132KV IVT	33KV IVT
1	Type	Single phase, 50Hz, oil Filled, self cooled, Hermetically sealed, Outdoor porcelain type.	Single phase, 50Hz, oil filled, self cooled, Hermetically sealed, outdoor porcelain type	Single phase, 50Hz, oil Filled, self cooled, Hermetically sealed, Outdoor porcelain type.	Single phase, 50Hz, oil filled, self cooled, Hermetically sealed, outdoor porcelain type.	Single phase,50Hz, oil filled, self cooled, Hermetically sealed, outdoor porcelain type.
2	Nominal system voltage.	400 KV/220KV	220KV	132KV	132KV.	33KV.
3	Highest system voltage.	420 KV/245KV	245KV	145KV	145KV.	36KV
4	Frequency.	50Hz± 5%	50Hz± 5%	50Hz ± 5%	50Hz± 5%	50Hz± 5%
5	System earthing.	Effectively solidly earthed.	Effectively solidly earthed.	Effectively solidly earthed.	Effectively solidly earthed	Effectively solidly earthed
6	Number of phases.	3 [single phase]	3 [single phase]	3 [single phase]	3 [single phase]	3 [single phase]
7	(i)Number of secondary windings. (ii)Purpose of windings.	3 [three]  Protection & metering.	2 (two)  Protection & metering	3 [three]  Protection & metering.	2 [two]  Protection & metering.	2 (two) one protection and one Metering)
8	Rated primary voltage.	400/1.732 KV / 220/1.732 KV	220/1.732 KV	132/1.732 KV	132/1.732KV	33/1.732KV
9	Rated secondary voltage.	Winding-I-110/1.732V Winding-II-110/1.732V Winding-III-110/1.732V	Winding-I-110V /1.732V (Protection) Winding-II-110/1.732V (Metering)	Winding-I-110/1.732V Winding-II-110/1.732V Winding-III-110/1.732V	Winding-I-110V/ 1.732V (Protection) Winding-II-110/ 1.732V(Metering)	110/1.732V (Metering) 110/1.732V Protection
10	Ratio	400 KV/1.732/110V/1.732 & 220KV/1.732/110V/1.732	220KV/1.732/110V /1.732V	132KV/1.732/110V/1.732	132KV/1.732/110V/1.732V	33KV/1.732/110/1.732
11	Rated burden.	Winding-I (P)-100VA Winding-II (P)-100VA Winding-III(M)-100VA/0.2 class & simultaneous burden-100 VA with accu. cl-0.2	Winding-I(P)- 150VA /3P; Winding-II(M)-150VA/0.2 class & simultaneous burden-150VA with accu. cl-0.2	Winding-I (P)-100VA /3P; Winding-II (P)-100VA/3P; Winding-III (M)-75VA/0.2 class & simultaneous burden-100	Winding-I(P)-150VA /3P; Winding-II(M)- 150 VA /0.2 & Simultaneous Burden- 150 VA with accu. cl-0.2	Winding-I(P)-75VA /3P; Winding-II(M)- 75 VA /0.2 & Simultaneous Burden- 75 VA

				VA with accu. cl-0.2		
12	Accuracy class .	3P/3P/0.2	3P/ 0.2	3P/3P/0.2	3P/ 0.2	3P/0.2
13	Rated voltage factor at rated frequency.	1.2 continuous. 1.5 for 30 second.	1.2 continuous. 1.5 for30 seconds.	1.2 continuous. 1.5 for 30 second.	1.2 continuous. 1.5 for30 seconds.	1.2 continuous. 1.5 for 30 seconds
14	Temperature rise at 1.2 times the rated primary voltage, rated frequency & rated burdens.	As per IEC-186	As per IEC-186.	As per IEC-186	As per IEC-186.	As per IEC-186.
15	Temperature rise at 1.5 times the rated primary voltage for 30 seconds, rated frequency & rated burden.	As per IEC-186.	As per IEC-186.	As per IEC-186.	As per IEC-186.	As per IEC-186
16	One-minute power frequency dry withstands test voltage for primary winding.	630KV (rms)/ 460KV [rms]	460KV [rms]	275KV [rms]	275KV [rms]	70KV (rms)
17	1-minute power frequency wet withstands test voltage for primary winding.	630KV(rms)/460KV [rms]	460KV [rms]	275KV [rms]	275KV [rms]	70KV (rms)
18	1.2/50 micro second impulse withstand test voltage for primary winding	1425 KV(peak) /1050KV [peak]	1050KV [peak]	650KV [peak]	650KV [peak]	170KV (peak)
19 (i) (ii)	One-minute power frequency withstands test voltage for Secondary winding Between LV(HF) terminal & earth terminal	3KV [rms]  10KV [rms] for exposed terminals & 4KV [rms] for terminals, enclosed in a weatherproof box.	3KV [rms]	3KV [rms]  10KV [rms] for exposed terminals & 4KV [rms] for terminals, enclosed in a weatherproof box.	3KV [rms]  -	3 KV (rms)
20	Class of insulation.	±Aø or better for EMU.	±Aø	±Aø or better for EMU.	±Aø	±Aø
21	Material of the conductor of primary and secondary windings.	Copper for EMU	Copper	Copper for EMU	Copper.	Copper
22	Fault level of the bus to which PTs will be connected.	40KA [rms].for 1 second.	40KA [rms].for 1 second.	31.5KA [rms]	31.5KA [rms].for 1second.	25KA for 1 second.
23	Minimum creepage distance.	10500mm /	6125mm	3625 mm	3625mm	900mm

24	Quality of oil.	EHV Grade As per IS-335.	EHV Grade As per IS-335.	EHV Grade As per IS-335.	EHV Grade As per IS-335.	EHV Grade As per IS-335.
25	Radio interference voltage at 1.1 times maximum rated voltage at 1.0 MHZ.	500 micro volts.	500 micro volts.	500 micro volts.	500 micro volts.	-
26	Partial discharge level.	Less than 10 piccocoulombs.	Less than 10 piccocoulombs.	Less than 10 Piccocoulombs.	Less than 10 piccocoulombs.	
27	Seismic acceleration- Horizontal & Vertical.	0.3g. 0.15g.	0.3g. 0.15g.	0.3g. 0.15g.	0.3g. 0.15g.	0.3g. 0.15g.
28	Accuracy class of standard V.T. to be used during testing towards determination of ratio errors and phase angle errors for metering windings.	0.05 or better.	0.05 or better.	0.05 or better.	0.05 or better.	0.05 or better.
29.	Capacitance (Pf)	4400/8800 (as applicable) + 10%,-5%	-	4400 + 10%,-5%	-	-

Name of the test.	Meters and equipments required for the corresponding test	Date of Calibration.	Due date of Calibration.	Name of the Calibrating Agency.	Whether Calibrating Agency is Govt. Approved.	Whether documents relating to Govt. Approval of the calibrating Agency furnished ?	Whether the meters/equipment fulfill the accuracy class as per calibration	Whether the calibrating agency has put any limitation towards the use of the particular	Whether green sticker or blue sticker or yellow sticker has been affixed on the body of the	Inspite of imposed limitations,, whether the particular meter/equipment can still be	Remarks
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	with range, accuracy, make and Sl. No.						report	meter/equipment. If yes, state the limitations.	particular equipment/meter. State the colour of the affixed sticker.	used ? Justify its use for corresponding test(s).	
1	2	3	4	5	6	7	8	9	10	11	12

**Signature of the tenderer with seal and date.**

**ANNEXURE-C**

**CHECK LIST TOWARDS TYPE TEST REPORTS.**

Name of the Type Test.	Date of Test.	Name of the Laboratory where the Test has been conducted.	Whether the Laboratory is Government Approved.	Whether the Test reports are valid as per Clause No.8.1 of T.S.	Whether the copy of Test Report in complete shape alongwith drawings etc. furnished or not ?	Whether the Tested I.V.T/CVT fulfills the technical requirements as per TS.	<b>If the type tested I.V.T/CVT</b> does not fulfill the technical requirements as per this specification, whether the bidder agrees to conduct the particular test(s) again at their own cost without any financial liability to OPTCL in	Re mark

							the presence of OPTCL's representative within the specified delivery period.	
1	2	3	4	5	6	7	8	9

Signature of the Tenderer with seal and date.

**ODISHA POWER TRANSMISSION CORPORATION  
LIMITED**

**OFFICE OF THE SR. GENERAL MANAGER,  
CENTRAL PROCUREMENT CELL,  
JANPATH, BHUBANESWAR – 751022**

**TECHNICAL SPECIFICATION**

**FOR**

**220 & 48 V VOLTS LEAD ACID PLANTE & 48 V  
VRLA TYPE STORAGE BATTERY ALONGWITH**

**BATTERY CHARGER**

- I- a) 350AH/ 220 & 48 V BATTERY (FOR 132 and 220KV S/S)  
b) 645 AH for 220 & 48 V BATTERY(FOR 220 KV & 400 KV S/S).  
c) 48 V, 300 AH,Maintenance Free VRLA Type Battery.

- II- BATTERY CHARGER SUITABLE FOR 350 AH & 645 AH for  
220V & 48 V

**LEAD PLANTE ACID & 48 V,300AH VRLA Type STORAGE BATTERY**

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<b>A3.0.</b>		Installations
<b>A4.0.</b>		Particulars of the System

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A6.0.	Details of specifications of plante Batteries.
A7.0.	Design & construction details.
A8.0.	Installation of battery.
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### Part ó B [CHARGER]

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- II GTP for Battery Charger
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- IV-A Calibration status of meters & equipments for testing of battery.
- IV-B Calibration status of meters & equipments for testing of battery charger.
- V-A Check list towards Type Test reports for battery.
- V-B Check list towards Type Test reports for battery charger.
- VI Check list for delivery schedule

**PART – A**  
**TECHNICAL SPECIFICATION FOR 220 VOLTS LEAD ACID PLANTE STORAGE BATTERY**

**A.1. SCOPE :**

- A.1.1. These specifications cover the design, manufacturer, assembly, shop testing at manufacturer's works before despatch, supply and delivery at SITE and erection testing and commissioning of 220 volt lead Acid Plante Storage battery.
- A.1.2. The scope of supply shall include all parts and accessories etc. which are usual and necessary for erection, operation and maintenance of the battery banks and the chargers, as specified, above though not individually and specifically stated or enumerated.

**A.2.0. STANDARDS :**

2.1. The equipments shall comply in all respects with the latest edition of relevant Indian Standard Specifications except for the modifications specified herein. The equipments manufactured according to any other authoritative national / international standard which ensure an equal or better quality than the provisions of these specifications shall also be acceptable. Where the equipment offered conform to any other standard, salient points of differences between the proposed standard and the provisions of these specifications shall be clearly brought out in the tender. A Xerox copy of such standards [in English shall be enclosed with the offer].

**2.2. A LIST OF RELEVANT STANDARDS IS GIVEN BELOW :**

- [i] IS-1652-1991 - Specification for stationery cells and batteries, lead Acid type with Plante Positive Plates
- [ii] IS : 266-1993 - Specification for Suphuric Acid.
- [iii] IS-6071-1986 - Specification for synthetic separators for lead acid batteries.
- [iv] IS:1069-1993 - Specification for quality tolerances water for storage batteries.
- [v] IS:1146-1981 - Specification for rubber and plastic containers for lead acid storage batteries.
- [vi] IS:8320-2000 - General requirements and methods of tests for lead-acid storage batteries.
- [vii] IS:1885-Part-8/1996 Electro technical vocabulary-stationary cells & batteries.
- [viii] IEEE-485/1983 - IEEE recommended practice for sizing large lead storage batteries for generating stations and sub-stations.

**A3.0 INSTALLATIONS :**

A3.1. Equipments covered under these specifications shall be suitable for indoor installation.

**A4.0 PARTICULARS OF THE SYSTEM:**

A4.1. One set of 220 Volts, 350AH and 645 AH capacity battery alongwith equipments such as boost charger, trickle charger shall be sufficient to cater to the DC power requirements in the Sub-stations as proposed. The system offered should be suitable to OPTCL system.

**A.5.0 GENERAL REQUIREMENTS OF THE EQUIPMENTS :**

General requirement of the different components of the Battery system are given below.

A5.1 One set of 220V,350 & 645 AH lead acid type plante storage battery set is required for meeting the D.C. load requirements of indicating lamps, emergency lighting, relays, alarms, circuits breakers etc. The battery shall be kept in healthy conditions with the help of the existing float charging unit. The existing boost charger unit shall supply quick charging current to bring back the battery to fully charged conditions after it has discharged to a considerable extent while meeting the emergency load. The battery shall meet practically all the heavy current demands, as required for operation [closing and / or operating of circuit breakers, emergency lighting load and field flashing load etc). It should be noted that, the 220V batteries are to be accommodated in the Battery Room and should operate satisfactorily over the entire range of ambient temperature of 0<sup>0</sup> C to 50<sup>0</sup> C and relative humidity of 95%.

**A.6.0. DETAILS OF SPECIFICATIONS OF PLANTE BATTERIES Type Battery:**

6.1. The batteries shall be made of closed type lead acid cells with planteqtype plates manufactured to conform to IS: 1652-1991.

**6.2. CAPACITY :**

6.3. The capacity of the batteries shall be as follows :

- [i] Voltage. - 220V/48 V
- [ii] Output at 27<sup>0</sup> C - 350AH/550AH at 10 hrs. discharge rate.

The batteries shall normally remain under floatingq condition with the ickleq charger supplying the continuous load. However, the batteries shall be capable of supplying the following loads under emergency conditions without any assistance from the chargers and without their terminal voltage falling below 200 V [90% of rated voltage]

350AH/645AH

- [I] I stage [continuous] - 35A for 10 hours. ,65 A for 10 hours
- [ii] Stage emergency - 15A for 3 hours for lighting.

6.4. The number of cells for the 220 V/48V batteries shall be so chosen that for the nominal floating voltage of the cells, the battery voltage shall be 237.5V/51.85V and for the minimum [discharged condition] voltage of the cells, the voltage of the battery shall not be less than 198V/43.2V, while the assigned rating of the battery bank can not lowered below its rated voltage of 220/48V volts.

## **A7.0 DESIGN AND CONSTRUCTION DETAILS : (For Plante Type)**

**7.1 Containers** : The containers for the cells shall be of impervious, moulded transparent, plastic/glass material having heat-resisting, high strength, non-reacting and low inflammable properties conforming to IS-1146-1981. The containers shall be mounted on insulators blocks. The containers shall be of robust construction and free from flaws, bubbles or foreign matter. The surface of the containers shall have a finish substantially free from blisters, rough spots, scales, blow holes and other imperfections or deformations. The handle bars, if provided, shall be of such that sufficient sediment space shall be available and the batteries will not have to be cleared out during their normal life. Battery containers shall be subjected to type, Routine and Acceptance Tests as per the requirements of IS-1146-1981. The containers of the label attached firmly to the containers shall be marked with the information as per requirements of cl No. 2.2 of the above standard. The suppliers' manufacturers' test certificates shall be submitted by the tenderer for the scrutiny of the purchaser.

**7.2 Plates** : The positive plates shall be of pure lead lamelle type with plante formation. The negative plates shall be pasted antimonial-lead Grid type so designed as to hold the active material securely in place and in firm contact with the grid during service. The plates shall be designed for maximum durability and shall not buckle during all service conditions including high rate of discharge and the fluctuation of load.

**7.3 Separators** : The separators shall be of synthetic material conforming to the latest edition of IS-6071-1986. These shall permit free flow of electrolyte and would not be affected by the chemical reaction inside the cell and shall last for indefinite time. The internal resistance factor of the separators shall assure high discharge characteristics under all operating conditions. Proper arrangement to keep end plates in position shall be furnished by the bidder alongwith his offer.

**7.4 Electrolyte** : The electrolyte shall be prepared from the battery grade sulphuric acid conforming to IS-266-1993 and shall have a specific gravity of 1.2 at 27<sup>0</sup>C. The sulphuric acid of battery grade shall be colourless liquid. The concentrated sulphuric acid on dilution with an equal volume of distilled water shall be free from suspended matter and other visible impurities. The sulphuric acid shall meet the requirements of columns . 4 and 5 Table . 1 of IS-266-1993. The requisite quantity shall be despatched in non-returnable containers suitably packed and marked as per the requirements of the above Indian Standards. The container materials and packing shall be subject to approval of the purchaser.

Sufficient quantity of distilled water conforming to IS-1069-1993 shall be supplied in non-returnable containers to correct the level of electrolyte during initial testing and commissioning. The material of containers and packing shall be subject to the approval of the purchaser.

7.5. **Plate group bar with terminals** : The plate group bar with terminals shall conform to IS-1652-1991. The positive and negative terminals shall be clearly marked for easy identification. The legs of the plates of like polarity shall be connected to the load, turned to a horizontal group bar having an upstanding terminal post adopted for connection to the external circuit. The group bars shall be sufficiently strong to hold the plates in position.

7.6. **Buffers/spring**: Suitable buffers / springs shall be provided in the cells to keep the end plates in position. These shall have adequate length and strength.

7.7. **Cell lids** : Lids used with sealed or closed type cells shall be of glass, plastic or ebonite and shall be provided with vent plugs. Terminal post shall be suitably sealed at the lid to prevent escape of acid spray, by means of rubber grommets, sealing compound or other suitable device. The positive and negative terminal posts shall be clearly and indelibly marked for easy identification.

7.8. **Water** :- Water used for preparation of electrolyte and also to bring the level of electrolyte to approximately correct height during operation / testing shall conform to relevant standards.

7.9. **Venting device** : The venting device shall be anti splash type and shall allow gases to escape freely but shall effectively prevent acid particles or spray from coming out. There shall be two vent holes, one serving as a guide for acid level indicator for checking the electrolyte level and other to permit drawing of electrolyte samples, servicing, checking of specific gravity etc.

7.10. **Marking** : Acid level line shall be permanently and indelibly marked around on all the containers.

The following information shall be indelibly marked on the outside surface of each cell :

- [i] Manufacturer's name, type and trade mark.
- [ii] Nominal voltage.
- [iii] AH capacity at 10 hours rate with specified end cell voltage.
- [iv] Cell number.
- [v] Upper and lower electrolyte level in case of transparent containers.

[vi] Type of positive plate.

[vii] Type of container.

[viii] Date of manufacture [ month and year] or [week and year].

#### **A8.0. INSTALLATION OF BATTERY :**

8.1. The battery set shall be installed on wooden racks in a separate battery room non air . conditioned but ventilated. The tenderer shall offer racks and mounting insulators etc.

8.2. The cell shall be arranged on the racks in a two-tier arrangement with two rows of cells on each tier or with some other suitable arrangement depending upon the availability of space inside the battery room. The lay out shall be subject to the approval of the purchaser. The racks shall be constructed of best quality seasoned **teak wood** / with metallic stand with at least three [3] coats of anti-acid paint of approved shade and also flame proof coating. These racks shall be such that cells are located at convenient height to facilitate maintenance and they may be so constructed so as to promote free access to the floor directly beneath the rack to facilitate easy cleaning of the floor. These shall be designed and arranged in such a way that easy handling of the cells is possible while in operation. Numbering tags for each cell shall be attached on to the racks.

8.3. The tenderer shall indicate and include the proposed arrangement of the batteries and include arrangement for fixing and mounting of inter-bank, inter-row, inter-cell and tap-off connectors etc.

#### **A9.0. CONNECTORS:**

Bars tinned copper lead connectors shall be employed for Inter-cell and inter-row, inter-tier connections. However, the tee-off connection from the battery unit shall be made with acid resisting cables of suitable size. A suitable terminal box alongwith acid-resisting cable shall be provided by the tenderer for this purpose. The connectors shall preferably be of bolted type and the bolts and nuts shall be of similar material as that of connectors and shall be provided with corrosion resisting lead coating.

The connectors shall be of sufficient cross-section to withstand all the working conditions including one minute discharge rate as well as short circuit conditions.

#### **A.10. ACCESSORIES :-**

The equipments and accessories, listed below shall be furnished as part of each battery set and the price of the battery quoted shall be inclusive of these items.

[a] Teak wood racks with three coats of anti-acid paint and flame-proof coating.

- [b] Stand insulators +5% extra.
- [c] Cell insulators +5% extra.
- [d] All Cell interconnectors and end take-offs.
- [e] Lead coated connection hardware such as bolts, nuts etc.5% extra. Or any other connector suitable for VRLA type Battery.
- [f] Cell numbering tags with fixing arrangement.
- [g] Teakwood, cable clamps with hardware.
- [h] Diluted sulphuric acid of sufficient quantity and of specific gravity according to the relevant ISS and 10% extra shall be supplied in non-returnable acid proof containers, suitable packed.
- [i] Two numbers cell testing centre-zero voltmeters 3-0-3 volts range, Accuracy class shall be 0.5 or better and resistance not less than 1000 ohms.
- [j] One number syringe type hydrometer complete with accessories and suitable for measuring SP gravity between 1.1 to 1.320 with graduation of 0.005 Sp. Gravity together with temperature correction charts.
- [k] One number floating hydrometer.
- [l] Two numbers thermo-meters having range 0-100 deg. C whose one division of the graduated scale shall represent at the most 1 degree centigrade with separate gravity correction chart.  
[Accuracy of calibration shall not be less than 0.5<sup>0</sup>C]
- [m] One number wall mounting teak-wood for hydrometers and thermo-meters.
- [n] Two numbers acid-resisting plastic jugs [2 litre capacity]
- [o] Two numbers plastic funnels.
- [p] Two numbers rubber syphone.
- [q] Two numbers rubber aprons.
- [r] Two pairs of rubber gloves.
- [s] Two pairs of rubber boots-knee height.
- [t] Two sets special tools or tools required for connecting the terminals of the batteries.
- [u] The battery terminals shall be brought out in a junction box to be mounted on the battery stands.
- [v] Ampere-hour meter[10 hour discharge rate] of 600 . 1250 AH range-1 no.
- [w] Any other accessories, not specified but required for installation, satisfactory operation and maintenance of batteries for a period of 5 [five] years.

**A.11.0 MAXIMUM SHORT CIRCUIT CURRENT :**

The Bidder shall state the maximum short circuit current of each battery alongwith the safe duration in seconds which it can withstand. Methods, proposed to be adopted for protecting batteries from the short circuit conditions should also be stated to avoid damage to the battery and loss to the associated equipment.

**A.12. VENTILATION :**

The bidder shall indicate in his bid the requirements of ventilation in the battery room. The battery shall operate satisfactorily over the entire range of the temperature and humidity indicted in this specification without affecting its normal life. Bidder shall indicate the percentage reduction in battery capacity at the lowest temperature of 27 deg C. If any special ventilation requirements are necessary, the same shall be indicated.

**A.13. CAPACITY :**

The standard Ampere-hour capacity at ten hour rate shall be 350/550 AH with an end cell voltage of 1.85 volts/cell.

**A.14. CHARGING :**

The bidders shall state whether an equalising charge is recommended for the battery. If so, the equalising charge voltage, current, duration and the interval between the equalising charging shall be specified in the Data sheet. Bidder shall also indicate the requirements for boost charging.

**A.15. LIFE :**

The bidder shall quote in his offer the Guaranteed life of the battery when operating under the conditions specified.

**A.16. INSTRUCTION MANUALS :**

Eight sets of instruction manuals for installation, commissioning, charging and maintenance instruction shall have to be furnished.

**A.17. TRANSPORT :**

The batteries, accessories and racks etc. shall be suitably packed and transported to site.

**A.18. TESTS:**

**A.18.1 TYPE TESTS :** The bidder shall submit the test reports alongwith his offer for the following type tests, conducted on the offered samples as per relevant National Standard[s] within five years from the date of opening of the bid and test witnessed by any Government Department / Government undertaking, failing which the offer is liable for rejection.

[a] Verification of constructional requirements.

- [b] Verification of dimensions.
- [c] Test for capacity.
- [d] Test for retention of charge.
- [e] Endurance Test.
- [f] Ampere-hour and watt-hour efficiency test.
- [g] Test for voltage during discharge.

If the type test report [s] does/do not meet the requirements as per this specification, OPTCL at its discretion may ask the supplier to conduct the above type tests [s] at the supplier's cost in the presence of OPTCL's representative without any financial liability to OPTCL

**A.18.2 ACCEPTANCE TESTS** : Following shall constitute the acceptance tests which shall be test witnessed by the purchaser's representative at the works of the manufacturer at the cost of supplier.

- [i] Verification of marking.
- [ii] Verification of dimensions.
- [iii] Test for capacity for 10 hours discharge rate along with the Test for voltage during discharge.
- [iv] Ampere-hour and watt-hour efficiency test.

**A18.3.1** The Purchaser may at his discretion undertake test for capacity and voltage during discharge after installation of the battery at site without any extra cost.

**A.18.3.2.** The supplier shall arrange for all necessary equipments including the variable resistor, tools, tackles and instruments. If a battery fails to meet the guaranteed requirement, OPTCL shall have the option of asking the supplier to replace the same within 15 [fifteen] days from the date of declaring the same to be insufficient/failed / not as per the specification [s].

**A.19. DRAWINGS / DOCUMENTS :**

The tenderer shall submit the following drawings / documents along with his offer failing which the offer is liable for rejection.

- [a] General battery arrangement, proposed size of individual and over all dimensions along with sectional views showing all connections etc.
- [b] Pamphlets and technical literature giving detailed information of the batteries offered.

The manufacturer shall submit the following drawings / documents in 7 [seven] copies within 15[fifteen] days from the date of issue of the purchase order for purchaser's approval. :-

- [a] Lay out details of the batteries.
- [b] OGA and cross-sectional details for battery cells.
- [c] Instruction manuals for initial charging and subsequent charging.
- [d] Technical data, curves etc.

**A.20. GUARANTEED TECHNICAL PARTICULARS :**

The Guaranteed technical particulars, as called for in the Annexure . I & II shall be furnished alongwith the tender. Any tender lacking complete information in this respect is likely to be rejected.

**A.21. All deviations from the specification shall be separately listed, in the absence of which it will be presumed that the provisions of these specifications are complied with by the tenderer**

**PART – B**  
**CHARGER FOR PLANTE BATTERIES**

**B.1 BRIEF DESCRIPTION**

Charging equipment comprising of a **float charger and a Float cum boost & Float Cum Boost Charder suitable for 48 V Battery Type VRLA for Telecommunication Purpose**) charger, is required to meet the D.C. power requirements of the sub-station under normal conditions, i.e., when AC auxiliary power supply is available and also to keep all the cells in the state of full charge. The float charger shall supply the continuous DC load at the bus bars in addition to keeping, the plante batteries floated in a healthy condition. In case of failure of A.C. mains or sudden requirement of additional DC power, the battery shall meet the demand as the battery shall be connected in parallel with the charger. After the battery has discharged to a considerable extent, it shall be fully recharged by the boost charger unit in a short period so as to prepare it for the next emergency. Even during the boost charging of the battery, the continuous DC load at the bus shall be met by the trickle-charging unit. The boost charging unit shall however be provided with suitable control arrangement to function as a stand-by for float charging unit in case of necessity.

**B.2 ARRANGEMENTS :**

**B.2.1 Trickle (Float) Charger :**

The trickle charger shall have arrangement for regulation of D.C. output voltage by:-

- (i) automatic voltage regulation system.
- (ii) Shall be of thyristor control type with both auto/manual control arrangement.

**B.2.2. Quick (Boost) Charger :**

The quick charger shall be similar type as trickle charging equipment, but shall have the following features.

- (i) Shall be of higher capacity to deliver D.C. output, as stipulated in this specification for quick charging of the plante batteries.
- (ii) Shall be provided with control arrangement for auto/manual current regulation features, necessary for quick charging

(iii) Shall also have auto/manual voltage control arrangement for use when the charger will be utilised as a trickle charger.

B.3. The Trickle and Quick charger shall be self supporting cubicle type with front panels hinged and suitable for mounting instruments, incoming A.C., circuit breaker with thermal and instantaneous releases relays, contactors and control switches etc. The panels shall have access from the backside also. These cubicles shall also house transformers, rectifiers and other equipment, accessories, as stipulated in this specification.

#### **B.4 DESIGN AND CONSTRUCTION DETAILS:**

B.4.1 The trickle charger and quick charger shall be complete with silicon controlled rectifier units, dry type air-cooled transformers, control electronics, smoothing filters etc. suitable for operation from  $415V \pm 10\%$ ,  $50 \text{ HZ} \pm 5\%$ , 3 phase A.C. supply. The charger output shall be stabilized to  $\pm 1\%$  of set value for  $\pm 10\%$  input voltage variations and 0-100% load variation.

B.4.2 The battery charger shall have full-wave, Half-controlled thyristor controlled bridge rectifier circuit. The charger output voltage shall suit the battery offered. The float voltage shall be adjustable from 80% to 115% of nominal voltage. The boost voltage shall be adjustable from 80% to 135% of nominal voltage. Ripple voltage shall be less than 3% RMS voltage.

B.4.3 Each float charger shall be capable of floating each cell of the battery bank at the specified voltage and supplying specified float current continuously under normal system operation.

B.4.4 Under normal operation, the float charger shall be supplying the DC load current and at the same time trickle charge the station battery. When the battery voltage goes down considerably, automatic transfer arrangement shall be provided such that the battery is disconnected from the float charger and gets connected to the boost charger. However, when battery is on boost charge, DC load shall be fed from the float charger. In addition, means shall be provided to ensure interruption free availability of control power from the battery whenever there is a power failure irrespective of whether the battery is on boost charge or float charge.

B.4.5 The selection of electronic components shall be used on ambient temperature of 50 degree C. and shall be of worst-case design to ensure continuous and trouble

free service. The control electronics shall be built on plug in type glass epoxy printed circuit boards of modular design.

- B.4.6 The maximum temperature, attained by any part of trickle charger and quick charger, when in service at site under continuous full load conditions shall not exceed the permissible limits as fixed by relevant standards and as corrected to site condition.

**B.4.7 Charger Panel :**

- B.4.7.1 Charger panels shall be rigid, self supporting structures, completely assembled and totally enclosed cubicle type construction, made out of structural steel members with sheet steel-coverings.

- B.4.7.2 The enclosure of the charger shall be made of CRCA sheet steel of thickness not less than 2 mm for load bearing members, 1.6mm for door and non-load bearing members and 3 mm for gland plates. Panels shall be offered with base frame of 3.0 mm thick CRCA sheet, painted black all around, suitable for bolting/ welding/ grouting on to the foundation. Gaskets on doors and inter panel gaskets shall be of neoprene rubber.

- B.4.7.3 The panel shall have hinged front and back doors with concealed type hinged locks and latches.

- B.4.7.4 The panel shall have adequate cross . ventilation arrangement to avoid any undue rise in temperature.

- B.4.7.5 All equipmentø and wiring used in the panel shall be tropicalised dust proof and vermin-proof.

- B.4.7.6 Power wiring for the chargers shall be done with 1.1KV grade, heavy duty, single core, stranded copper conductor PVC insulated cables or suitable sized PVC sleeved copper bus bars. Control wiring for the charger shall be done with 1.1 KV grade PVC insulated copper wires of cross section 2.5 sq. mm for all control connection. Wire of 2.5 sq. mm cross section shall be used for control bus. All control wiring shall be ferruled.

- B. 4.7.7 Necessary terminals for grounding the panel with two separate earthings shall be arranged for bottom entry and suitable cable glands shall be provided for the cables.

- B.4.7.8 Each charger panel shall incorporate all the necessary controls, Indications, interlocks, protective devices and timing features to ensure any operation.

Provision shall be made with necessary contact / relays for annunciation in the event of alternating current power failures to the charger and automatic

shut down of the charger by over-voltage / current devices. Annunciation shall however be prevented when the charger is manually shutdown or when A.C. power supply is momentarily interrupted for adjustable period of 1 to 5 seconds.

- B.4.7.9. The float and equaliser charging rates shall both be adjustable from the front of the charger control panel. Each charger shall be protected against any damage from over voltage/ load currents and shall be so designed that it can continuously deliver at least rated current output without operation of the protective over-load device for abnormal conditions of low battery voltage down to 175V (80%) of the rated voltage). But the chargers shall be disconnected from A.C. input supply through an over-voltage relay, if the input voltage exceeds 10% of the rated voltage of the equipment. Necessary selector switches for Trickle Charging and Quick charging shall be provided. There shall be make before break type blocking Diodes and other equipments to be shown in the drawing or otherwise found necessary for charging or otherwise found necessary for charging the battery without increasing the voltage beyond safe value across the load shall also be supplied by the tenderer.
- B.4.8 The rectifier units of the chargers shall be capable of supplying an impulse load of 6/7 times its rated capacity. The trickle charger in conjunction with automatic voltage regulators shall have drooping characteristics, So as to transfer the load beyond its capacity to the battery.
- B.4.9 The incoming and outgoing circuits shall be provided with MCCBs with static releases for overload, short circuit and earth fault protections. The incoming power supply to the chargers will be from two sources with a facility of changeover switch. The change over facility shall be provided in the charger itself.
- B.4.10 The battery circuit shall be provided with HRC fuse protection over a suitably rated load break isolator switch and reverse protection circuits.
- B.4.11 Input volt meter and ammeter shall be of moving iron type and shall be 96 x 96 mm. Square. These meters shall be of accuracy class not less than 1.0 and shall be of flush mounting type with required PTs and CTs and selector switches. Output voltmeter and ammeter shall be moving iron type and shall be 96 x 96 mm square. The meter shall be of accuracy class not less than 1.0 and shall be flush mounting type. The ammeter shall be centre zero type for measurement of charging and discharging current from the battery.
- B.4.12 Cluster LED lamps for indicating Input on condition and Output on condition, float status on / off, boost status on / off etc. shall be provided. Annunciation with audiovisual alarms shall be provided for the following.
- Input mains failure.
  - Input phase failure.

- Input fuse failure.
- Rectifier fuse failure.
- Filter fuse failure
- DC over voltage
- DC under voltage
- Output fuse failure
- Charger over-load
- Earth leakage
- Alarm supply fuse failure
- Charger trip
- Output MCCB tripped
- AC under voltage
- Battery low condition

**ACCEPT, TEST AND RESET** push buttons shall be provided. 20% spare annunciation windows shall be provided.

B.4.13: Any other item(s), not stipulated in this specification, but required for installation, operation and maintenance of the battery charger is / are included in the scope of supply without any extra charge on OPTCL.

**B.5 TRANSPORT** : The chargers alongwith its accessories shall be suitably packed and transported to site in ready to use condition.

## **B.6 TESTS**

**B.6.1 Type Tests** : The bidder shall submit the test reports alongwith his offer for the following type tests conducted on the offered samples (both float charger and boost charger) as per relevant National Standard (s) within five years from the date of opening of the bid and test-witnessed by any Government Department /Government undertaking, failing which the offer is liable for rejection.

- (a) Measurement of voltage regulation / AVR regulation
- (b) Efficiency and power factor measurement test
- (c) Temperature rises test so as to determine the temperature rise of SCR, Transformer primary, Secondary and core, Diode, capacitor, choke and cabinet etc.
- (d) Measurement of insulation resistance.
  - i) AC input to earth.
  - ii) AC input to DC output.

- iii) DC output to earth
- (e) Test for rectifier transformer.
- (f) DC voltage current characteristic
- (g) High Voltage Tests.
- (h) Determination of regulation
- (i) Measurement of ripple
- (j) Reverse leakage test.

**B.6.2 Acceptance Tests :** Followings shall constitute the acceptance tests which shall be tested by the purchaser's representative at the works of the manufacturer at the cost of the supplier (both for FC & FCBC) for each charger. No sampling is allowed.

- (a) Measurement of voltage regulation / AVR Regulation
- (b) Efficiency and power factor measurement
- (c) Temperature rise test so as to determine the temperature rise of SCR, Transformer primary, secondary and core, diode, capacitor, choke and cabinet etc.
- (d) Measurement of insulation resistance.
- (1) AC input to earth
- (2) AC input to DC output
- (3) DC output to earth
- (e) Test for rectifier transformer (all relevant tests as per corresponding ISS)
- (f) DC voltage current characteristic
- (g) High voltage tests.
- (h) Determination of regulation.
- (i) Measurement of ripple
- (j) Tests for indications and alarms as per this specification
- (k) Tests for indicating instruments.
- (l) Determination of system set points.
- (m) Soft start test

N.B. : The supplier shall provide arrangements for monitoring the temperature across the elements, as stipulated above, continuously during the temperature rise test without disconnection of any of the temperature measuring devices across the hottest spot of each of the above elements.

All other tests, as may be necessary to ensure that all equipments are satisfactory shall also be carried out. In addition to the above tests, manufacturer's test certificates,

vendors test certificates for different equipments, accessories, instruments etc. shall be submitted, whenever required by the purchaser.

#### **B.7. DRAWINGS / DOCUMENTS**

The tenderer shall submit the following drawings / documents alongwith his offer failing which the offer is liable for rejection.

- (a) OGA of the battery chargers
- (b) General layout with overall dimensions
- (c) Electrical schematic diagram showing connections and controls.
- (d) Leaflets and technical literature giving detailed information of the panels offered.

The manufacturer shall submit the following drawings / documents in 7 (seven) copies within 15 (fifteen) days from the date of issue of the purchase order for purchaser's approval.

- (a) OGA of the battery chargers
- (b) General layout with overall dimensions marked alongwith sectional views showing cable entry position etc.
- (c) Rating calculations for transformer, rectifiers, diode, capacitor, inductor etc.
- (d) Detailed schematic and connection and control wiring diagram for all the equipments.
- (e) Complete bill of materials
- (f) Technical excerpts on operation.
- (g) The circuit diagram of charger including circuit diagrams of all cards to facilitate the maintenance of chargers

#### **B.8 SPECIAL TOOLS, PLANTS AND SPARES**

The tender shall quote for recommended special tools, plants and spares, considered necessary for installation and maintenance of batteries and charges for a minimum period of 5 (five years.)

**The following mandatory spares are to be quoted by the bidder in the price bid:-**

- a) Voltage regulator cards- 1 No/Charger.**
- b) protection card (if any)- 1 No/ Charger.**
- c) Thyristor (SCR)- 2 Nos. for F.C.+ 2 Nos. for B.C./ Charger.**
- d) Rectifier Diode- 2 Nos. for F.C,+ 2 Nos. for B,.C./Charger.**

- e) **Blocking Diode- 1 No. for F.C. + 1 No. for B.C./ Charger.**
- f) **Filter Capacitor- 1 Set/Charger.**
- g) **Auto-manual switch- 1 No. for F. C. + 1 No. for B.C./ Charger.**
- h) **Indicating LED- 10 Nos./Charger**
- i) **Indicating fuse (if any)- 10 Nos./Charger**
- j) **Input A.C. contactor- 1 No. for F.C., + 1 No. for B.C./ Charger**
- k) **Rectifier H.R.C. fuses- 4 Nos. for F.C. + 4 Nos. for B.C./Charger.**

**B.9 GUARANTEED TECHNICAL PARTICULARS**

The guaranteed technical particulars of this specification shall be furnished alongwith the tender. Any tender, lacking complete information in this respect is likely to be rejected.

**B. 10 DEVIATION FROM SPECIFICATION**

All deviations from the specification shall be separately listed in the technical deviation sheet, in the absence of which it will be presumed that the provisions of these specifications are complied with by the tenderer.

**B11. GENERAL TECHNICAL REQUIREMENTS FOR BATTERY CHARGER SUITABLE FOR 220 V/48 V LEAD ACID PLANTE BATTERY**

1	Type	Float & Float cum boost charger for 220 V & Float Cum Boost Charger for 48 V DC full wave, full controlled type.
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2.	RATINGS	<p>&gt;220V : 350 AH Plante Battery: 35A/60A Float &amp; Float cum Boost Charger.</p> <p>&gt;48V : 350 AH &amp; 550 AH Plante Battery: 35A/70A &amp; 50A/100 : Float cum Boost Charger.</p> <p>&gt;220 V : 645 AH Plante Battery:70/100 A Float &amp; Float cum Boost Charger.</p>	
3.	AC INPUT (a) Voltage (b) Frequency (c) Phase	<p>415VAC <math>\pm</math> 10%</p> <p>50Hz <math>\pm</math> 5%</p> <p>3-phase-4 wire</p>	
4.	D.C.OUTPUT VOLTAGE SETTINGS Nominal Float	<p>FC</p> <p>220V/48V</p> <p>253V/54.5V</p> <p>(adj. By + 20%, - 5%</p>	<p>BC</p> <p>220V/48V</p> <p>302V/66.5V</p> <p>(adj. By + 2%, - 5%)</p>
5.	OUTPUT CURRENT LIMIT	<p>35A</p> <p>70 A</p> <p>70 A for 48 V,350 AH</p>	<p>60A (for 350AH)</p> <p>100A(for 645AH)</p>
6.	POWER CONVERSION	AC to DC by means of three phase full wave, Half controlled bridge rectifier consisting of thyristors and diodes.	
7.	VOLTAGE REGULATION AT BRIDGE OUTPUT.	$\pm$ 1% of set value for $\pm$ 10% Input Voltage Variations, 0-100% Load variation.	
8.	RIPPLE VOLTAGE	Less than 3% RMS without battery connected.	
9.	EFFICIENCY	More than 75% at full load	
10.	PROTECTIONS		
	(a) Input side	AC input MCCB with input ON/OFF switch and fuses, contactor (for source-1&2 with interlocking)	
	(b) Output side	DC output MCCB with output ON/OFF switch and fuses contactor.	
	(c) Protection	Current limit protection, soft start feature, surge suppressor. Fast semiconductor fuses for rectifier bridge.	
	(d) control circuit	Fuses	
	(e) Capacitor circuit	Rectifier HRC fuses.	
	(f)	Over-voltage cut-back	
	(g)	Charger over load / short circuit	
	(h)	Blocking diode	
11.	CONTROLS AND SWITCHES	<p>Followings controls and switches are provided in the system</p> <p>a) AC input source MCCBs with interlocking</p> <p>b) DC output MCCB</p>	

		<ul style="list-style-type: none"> <li>c) Auto/Manual float/boost mode selector switch.</li> <li>d) Float and boost voltage variable potentiometers.</li> <li>e) Manual voltage adjustment Potentiometer</li> <li>f) Test push button</li> <li>g) Reset push button</li> <li>h) Battery current adjustment potentiometers</li> <li>i) Heaters power supply switch</li> <li>j) Socket power supply switch</li> </ul>	
12.	FEATURES	<p>The following features are provided in the systems:</p> <ul style="list-style-type: none"> <li>a) Soft start on DC side</li> <li>b) Class-F insulation for all magnetic</li> <li>c) Automatic voltage regulation.</li> <li>d) Automatic changeover from float to boost and vice versa based on current, drawn by battery.</li> <li>e) Filter circuit to eliminate ripple.</li> <li>f) Charger current limit</li> <li>g) Separate battery path current limit.</li> <li>h) Built-in auto phase reversal of operation.</li> </ul>	
13.	Meters	<p><b><u>F.C.</u></b></p> <ul style="list-style-type: none"> <li>(i) Input Voltmeter</li> <li>(ii) Input Ammeter</li> <li>(iii) Output Voltmeter</li> <li>(iv) Output Ammeter</li> </ul>	<p><b><u>B.C.</u></b></p> <ul style="list-style-type: none"> <li>(i) Common</li> <li>(ii) Input Ammeter</li> <li>(iii) Output Voltmeter</li> <li>(iv) Output Ammeter.</li> </ul>
		<p>Battery volt meter  Battery ammeter  Earth leakage ammeter</p>	
14.	Indications	<ul style="list-style-type: none"> <li>(i) R,Y,B Phase lamps</li> <li>(ii) Output lamp</li> </ul>	<ul style="list-style-type: none"> <li>(i) R.Y.B. phase lamps</li> <li>(ii) Output lamp.</li> <li>(iii) Charger float LED</li> <li>(iv)Charger boost LED.</li> </ul>
15.	Annunciation with audiovisual alarms.	<ul style="list-style-type: none"> <li>(i) AC input mains failure</li> <li>(ii) Input phase failure</li> <li>(iii) AC under voltage</li> <li>(iv) Input phase failure</li> <li>(i) Rectifier fuse failure</li> <li>(ii) Output fuse failure</li> <li>(iii) Filter fuse failure</li> <li>(iv) DC under voltage</li> <li>(v) DC over voltage</li> <li>(vi) Charger trip</li> <li>(vii) Capacitor fuse fail</li> <li>(viii) Output MCCB tripped</li> <li>(ix) Charger over load</li> <li>(x) Earth leakage</li> <li>(xi) DC earth fault</li> <li>(xii) Alarm supply fuse failure</li> </ul>	<ul style="list-style-type: none"> <li>v) Rectifier fuse failure</li> <li>vi) Output fuse failure</li> <li>vii) Filter fuse failure</li> <li>viii) DC under voltage</li> <li>ix) DC over Voltage</li> <li>x) Charger trip</li> <li>xi) Capacitor fuse fail</li> <li>xii) Output MCCB tripped.</li> </ul>

		(xiii) Battery low condition.
Note : All the alarms shall be provided through electronic display cards. Audio alarm through buzzer, visual indication through 10 mm LEDS & alarm ackn. / reset and LED provision is through push buttons.		
16.	Operating ambient temperature surrounding the panel	0 <sup>0</sup> to 50 <sup>0</sup> C
17.	Surrounding the panel Relative humidity.	0-95% non-condensing
18.	<b><u>PANEL</u></b> (a) Protective grade (b) Cooling (c) Paint	(a) IP . 42 (b) Natural air-cooled (c) Smoke Grey of ISS-692 shade
19.	<b><u>MAGNETICS :</u></b> (a) Average winding temperature rise over ambient temperature  (b) Insulation class (c) Insulation breakdown voltage.	As per relevant ISS.  ±q 3 KV for 1 min withstand.
20.	<b><u>CABLES</u></b>	1100 V grade PVC insulated copper. Ferrules shall be provided for identification of connection.

N.B. : - Besides the above general technical requirements, all other stipulations, as enumerated in this technical specification shall be followed. Any deviation should be clearly brought out with clear explanation.

Any extra feature/ equipment / instrument as necessary for operation and performance of the battery charger for the 220V /48 V battery set as per this specification shall be provided without any extra cost to OPTCL..

**ANNEXURE – IV-A**  
**(For Testing of Battery)**  
**(To be filled in by the bidder)**

**CALIBRATION STATUS OF TESTING EQUIPMENTS AND INSTRUMENTS/ METERS**

Name of the Test	Meters & Equipments required for the corresponding test with range, accuracy, make & Sl. No.	Date of Calibration	Due date of Calibration	Name of the Calibrating Agency	Whether Calibrating Agency is Govt. approved	Whether documents relating to Govt. approval of the calibrating Agency furnished	Whether the meters/ equipments fulfil the accuracy class as per calibration report.	Whether the calibrating agency has put any limitation towards the use of the particular meter/ equipment. If yes, state the limitations	Whether the calibrating agency has put any limitation towards the use of the particular meter/ equipment/ meter. State the colour of the affixed sticker	In spite of imposed limitations. Whether the particular meter / equipment can still be used ? Justify its use for corresponding test(s)	Remarks
1	2	3	4	5	6	7	8	9	10	11	12

**Signature of the tenderer with seal & date**

**ANNEXURE – IV-B**  
**(For Testing of Battery Charger)**  
**(To be filled in by the bidder)**

## CALIBRATION STATUS OF TESTING EQUIPMENTS AND INSTRUMENTS/ METERS

Name of the Test	Meters & Equipments required for the corresponding test with range, accuracy, make & Sl. No.	Date of Calibration	Due date of Calibration	Name of the Calibrating Agency	Whether Calibrating Agency is Govt. approved	Whether documents relating to Govt. approval of the calibrating Agency furnished	Whether the meters/ equipments fulfil the accuracy class as per calibration report.	Whether the calibrating agency has put any limitation towards the use of the particular meter/ equipment. If yes state the limitations	Whether the calibrating agency has put any limitation towards the use of the particular meter/equipment/ meter. State the colour of the affixed sticker	Inspite of imposed limitations. Whether the particular meter / equipment can still be used ? Justify its use for corresponding test(s)	Remarks
1	2	3	4	5	6	7	8	9	10	11	12

**Signature of the tenderer with seal & date**

### ANNEXURE V – A (To be filled in by the bidder) CHECK LIST TOWARDS TYPE TEST REPORTS FOR BATTERY

Name of the Type Test	Date of Test	Name of the Laboratory where the Test has been conducted	Whether the Laboratory is Government approved	Whether the Test report is valid as per Spn.	Whether the Test report in complete shape alongwith	Whether the type tested Plante lead acid battery fulfills the	If the type tested battery does not fulfill the technical requirements as per this specification, whether the bidder agrees to conduct he particular type test again at their	Remarks

					drawings etc. furnished or not ?	technical requirements as per TS	own cost without any financial liability to OPTCL in the presence of OPTCL's representative within the specified delivery period	
1	2	3	4	5	6	7	8	9

**Signature of the tenderer with seal & date**

### ANNEXURE V – B

**(To be filled in by the bidder)**

#### **CHECK LIST TOWARDS TYPE TEST REPORTS FOR BATTERY CHARGER**

Name of the Type Test	Date of Test	Name of the Laboratory where the Test has been conducted	Whether the Laboratory is Government approved	Whether the Test report is valid as per Spn.	Whether the Test report in complete shape alongwith drawings etc. furnished or not ?	Whether the type tested battery charger fulfills the technical requirements as per TS	If the type tested battery charger does not fulfill the technical requirements as per this specification, whether the bidder agrees to conduct he particular type test again at their own cost without any financial liability to OPTCL in the presence of OPTCL's representative within the specified delivery period	Remarks
1	2	3	4	5	6	7	8	9

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**Signature of the tenderer with seal**

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

## **TECHNICAL SPECIFICATION**

### **FOR**

**POWER LINE CARRIER COMMUNICATION  
(THE INDOOR PLCC PANELS WILL BE SUPPLIED BY  
OPTCL AS A OWNER SUPPLY ITEMS BUT OTHER  
MATERIALS AS REQUIRED ARE IN THE SCOPE OF  
SUPPLY BY BIDDER)**

#### **1. GENERAL**

Power Line Carrier Communication equipment shall be supplied with all associated equipment complete with all material and accessories, and installed at various substations as indicated in relevant schedules. The Contractor shall also include all equipment and accessories including modifications for remote end substations of the PLCC link even though the names of the substations do not appear in the Schedule.

The Contractor shall be responsible for the provision of training engineers of the Employer responsible for maintenance of the above equipment. The Contractor shall also be responsible for maintenance till the equipment is handed over to the Employer.

Panels shall be supplied complete with all accessories, meters, switches, indicating lamps, annunciation, and other devices completely wired and assembled as per approval of the Project Manager. The contractor shall also mount and completely wire the equipment to be supplied by others if any for installation on these panels.

## 2. LIST OF ABBREVIATIONS

The following abbreviations have been used in this document.

AC	Alternating Current
AIS	Alarm Indication Signal
BER	Bit Error Rate
CCIR	Consultative Committee International Radio
CCITT	International Telegraph and Telephone Consultative Committee
CPU	Central Processing Unit
CVT	Capacitive Voltage Transformer
dB	Decibel
DC	Direct Current
DTMF	Dual Tone Multi-Frequency
EEPROM	Electrically Erasable Programmable Read Only Memory
EMI	Electromagnetic Interferences
Ghz	Gigahertz
HF	High Frequency
ic	Integrated Circuit
IDC	Insulation Displacement Connector
IEC	International Electrotechnical Commission
IEC	International Electrotechnical Commission
IP	Ingress Protection
kA	Kilo Amperes
kb/s	Kilobits per second
kV	Kilo Volts
LED	Light Emitting Diode
LED	Light Emitting Diode
Mb/S	Megabits Per Second
msec	Millisecond
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
nm	Nanometers (meters X 10 <sup>-9</sup> )
PAX	Private Automatic (Telephone) Exchange
PCM	Pulse Code Modulation
PLC	Power Line Carrier
PSK	Phase Shift Keying
PSTN	Public Switched Telephone Network
PSU	Power Supply Unit
QA	Quality Assurance

RF	Radio Frequency
RFI	Radio Frequency Interference
RFI	Radio Frequency Interference
RLDC	Regional Load Despatch Centre
SDH	Synchronous Digital Hierarchy
SLDC	State Load Despatch Centre
SPC	Stored Programme Control
sub-LDC	Sub-Load Despatch Centre
VF	Voice Frequency
VSWR	Voltage Standing Wave Ratio

### 3. PLCC SYSTEM

The PLCC system shall be used to carry speech, protection and control signals, SCADA and computer data traffic. Interface connections shall be made directly with telephone equipment and equipment handling digital data.

The PLCC system shall be suitably designed to work over the high voltage overhead power transmission lines and shall comply with IEC 495. The system shall operate satisfactorily under all power system switching and weather conditions that may be encountered at any time. It shall be capable of operating properly during its period of service.

The mean time between failures shall be stated and proof in the form of calculations or actual in-service failure rates shall be provided.

A panel or enclosure shall be provided for paralleling the HF outputs for connection to the coaxial cable between the PLC and the Line Matching Unit. Suitable coaxial cable shall be used between the PLC and this panel. The HF cables from the PLC shall be terminated on the panel with plug-in connectors to allow each PLC to be interchanged between lines.

The PLCC system shall essentially consist of the following:

- Coupling Device, phase to phase or phase to ground.
- HF cable
- Carrier terminal (Owner supply item)
- Protection coupler(owner supply item)
- Telephone instruments
- Line traps

### 4. STANDARDS

All the PLCC equipment covered under the specification shall conform to the requirements of the latest edition of the relevant IEC/IS Specifications or equivalent National Standards, except to the extent modified by this specification.

The IEC/IS Specifications relevant to the equipment covered under this specification shall include but not be limited to standards indicated in relevant schedules of this specification.

## **5. DRAWINGS**

### **5.1 Reference Drawings**

The drawings attached to this specification shall be the reference drawings.

The Contractor shall evolve and furnish a comprehensive protection, control, interlocking and signalling scheme meeting all the requirements of the technical specifications based on these reference drawings.

The Contractor while preparing the drawings for control and relay panels shall co-ordinate with various other equipment suppliers for actual details of equipment to be directly or indirectly associated with the control and relay panels

The current and voltage transformer parameters are given in the relevant sections of this specification. The contractor shall ensure the supply of CVT to meet the needs of relays and meters being supplied by him.

Attached to Specification is a schedule indicating the existing features of PLCC system at the particular site along with details of remote end equipment.

### **5.2 Contractors Drawings**

Contractor shall furnish the complete scheme, system, and supply drawings as called for in this Specification.

Contractor shall provide a list of drawings and a programme for submission in accordance with the requirements of this Specification.

All drawing submitted by the bidder including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, bill of material, weight of each component, break-up for packing and shipment, external connection, fixing arrangement required, dimensions required for installation, interconnection with other equipment and components, clearance and space required for installation, interconnection between various points of equipment and any other information as called for in this Specifications.

## **6. FREQUENCY PLANNING AND SURVEY**

### **6.1 General**

A frequency planning study shall be carried out by the Owner / Contractor such that the SNR for various channels shall be as per IEC. For transposed lines the signal attenuation considered for frequency planning shall be justified through study reports.

The frequency and output power of the PLCC system for protection shall be planned such that the protection signal is received with full reliability even when one phase is earthed or is open circuit on the line side causing an additional minimum loss of 6 dB.

The frequency plan will be referred to Wireless Adviser/DOP Department for clearance. In case any changes to the Contractor's recommendations for carrier frequency and power output are proposed by these Authorities, the Contractor shall modify his proposal accordingly. Changes of power output shall not, however, involve repeater stations.

The frequency planning exercise shall also include the items outlined in the following sub-clause 6.2, 6.3 and 6.4.

The Contractor's study report shall include the followings

## **6.2 Proposed Arrangement**

Facilities shall be provided for immediate opening of local breaker under direct tripping command from remote end. The tripping of local/remote end breakers is to be achieved by exchange of commands on PLC system between the two ends of the line in direct tripping mode.

For security reasons each transmission line shall be protected by Main-I and Main-II protections as given below :

- Main-I Distance protection type with permissive inter-tripping.
- Main-II Distance protection of different design/ philosophy/manufacture to the relay under Main I.

## **6.3 Carrier requirements**

### 6.3.1 For 400kV Lines

- a) Two protection channels for Main-I and two for Main-II distance protection schemes.
- b) Two main and two back-up protection channels for direct circuit breaker inter-tripping.
- c) One speech channel with facility for superimposed telex and data signals.
- d) The arrangement shall be as per plate 7.1.

### 6.3.2 For 220 kV Lines

- a) One protection channel for Main-I and another for Main-II distance protection schemes.
- b) One main and one back-up protection channel for direct circuit breaker inter-tripping.
- c) One speech channel with facility for superimposed telex and data Signals.
- d) The arrangement shall be as per plate 7.2.

### 6.3.3 For 132 kV lines

- a) One protection channel for Main-I protection scheme.
- b) One speech channel with facility for superimposed telex and data signals.
- c) The arrangement shall be as per plate 7.3.

### 6.3.4 For 33 kV lines

No PLCC Equipment is envisaged on 33 kV lines.

### 6.3.5 General

The equipment for protection signals shall have high degree of reliability and speed. It shall be guaranteed to function reliably in the presence of noise impulse caused by isolator or breaker operation. The equipment shall be suitable for direct tripping of remote end breaker for fault in unswitched 400 kV shunt reactors. It shall also be possible to effect direct tripping of breaker at one end when the other end breaker is opened either manually or by protection relays such as Bus fault relay etc.

The time intervals between receipt of a trip command on the transmit side, its transmission over the carrier link, reception at the far end and giving command to the trip relays at the distant end shall not exceed 20 milliseconds for permissive inter-tripping and 30 milliseconds for direct inter-

tripping. The above timings are inclusive of operating time for auxiliary relays and interposing relays, if any, included in the PLCC equipment.

The requirement of protection signalling channel is such that security against incorrect signals being received shall be at least two to three orders higher than reliability against a signal not being received.

Requirement under speech and telex communication is elaborated elsewhere in this section.

The planning of frequencies for the PLCC terminals shall be done considering the existing PLCC Network as well as full communication channel requirement detailed above so that there is no problem of frequency allocation at a later date when the subsequent section communication requirements come up.

For reasons of security and reliability, phase to phase/inter-circuit coupling shall be employed. Double differential coupling shall also be considered for double circuit lines. Bidders shall furnish details of methods of coupling and recommend suitable coupling mode for double circuit lines along with the bids. The coupling mode shall, however, be fully confirmed by Contractor after conducting detailed computer studies, taking into account the transpositions of 400 kV lines, for optimum coupling mode over these line sections. The coupling arrangement shall be fully optimised by the Contractor after conducting detailed studies of every line section individually, taking into account temperature variations, transpositions, earth resistivity, conductor configuration, carrier channels requirements, security and reliability criteria and other relevant details. The line attenuation shall be calculated for complete range of frequencies. Earth resistivity data, existing frequency networks and other relevant details of each line will be furnished to the Contractor for carrying out computer studies and frequency planning. The Contractor shall complete the computer studies wherever required and submit the frequency plan and optimum coupling details within a period of one month from the date of receipt of above data. The cost of doing the computer studies wherever required shall be included in the lump sum bid price and details of computer study charges shall be indicated in the relevant schedule. Bidder must indicate the links on which computer study is required.

The 400 kV transmission lines may be transposed as shown in the relevant specification drawing. There are two transpositions in each line section at distances shown in the drawing. The third transposition is for achieving proper phase sequence at substation.

Transmission tower configuration and conductor details shall be made available to the successful bidder to enable the bidder to make his own computer study assessment of the carrier path based on wave propagation over transposed lines with each transposition point acting as "Modal Converter".

The parameters of the equipment quoted shall be such that the mode of wave propagation on 400 kV /220 kV/132 kV power lines (with transpositions indicated) shall not impose any limitation on the efficient and reliable performance of the information link.

The Contractor shall be required to check and prove, through the results of his computer studies, that attenuation due to transpositions in the EHV lines is within limits and the offered equipment will perform satisfactorily.

The Contractor shall submit curves illustrating 'incorrect tripping' and "failure to trip" probability plotted against corona noise level, in the presence of impulse noise due to switching of isolators and circuit breakers etc. Details of field tests and laboratory tests for successful operation of his equipment, under such adverse conditions shall be furnished by the Bidder. These are to be related to end-to-end signalling and shall take into account the type of communication link e.g. account shall be taken of transpositions in the phase to phase coupled HT. line. Details of field

tests and laboratory tests for successful operation of the equipment under the above circumstances shall be submitted by the Bidder illustrating the above parameters.

## **7. LINE TRAP (TO BE SUPPLIED BY THE CONTRACTOR)**

### **7.1 Technical Requirements**

Line traps shall be inserted into extra high voltage transmissions line to prevent undue loss of carrier signal for all power system conditions. Their impedance shall be negligible at power frequency (50 Hz) so as not to disturb power transmission but shall be relatively high over the frequency band appropriate to carrier transmission.

Line traps shall consist of a main coil designed to carry continuously the rated current without exceeding the limit of temperature rise. It shall be supplemented with a protective device and tuning device.

Line traps shall be broad band tuned for its entire carrier frequency range. Resistive component of impedance of the line trap within its carrier frequency blocking range shall not be less than 450 ohms for 400kV and 570 ohms for 220kV systems.

Line traps shall be provided with a protective device in the form of a lightning arrester. The protective device shall be designed and arranged such that neither significant alteration in protective function nor physical damage shall result from either temperature rise or the magnetic field of the main coil at continuous rated current or rated short time current. The protective device shall neither enter into operation nor remain in operation, following transient actuation by the power frequency voltage developed across the line trap by the rated short time current. The protective device shall be shunt connected to the main coil and tuning device.

The lightning arrester shall be station class current limiting active gap type. Its rated discharge current shall be 10 kA. Co-ordination, however, shall be done by taking 20 kA at 8/20 micro-sec. discharge current into account. Bidder has to furnish full justification in case the use of gap-less metal oxide arrester is recommended by them.

The lightning arrester provided with the line trap of each rating shall fully comply with the requirements of IS 3070-Part I (1974)/IEC 99-I (1970) Part I. It shall conform to type tests as applicable and type test certificates shall be submitted by the Bidder.

The lightning arrester provided with the line trap shall be subject to routine and acceptance tests as per IEC 99-1 (1970) (Part-I).

The line trap on 400kV/220kV/132KV lines shall show no visual corona discharge at a voltage of 320kV/187kV/105kV rms power frequency falling voltage. Suitable corona rings shall be incorporated in the line trap.

Line trap shall be equipped with bird barriers.

Line trap shall be spray painted with light grey paint (shade 631 of IS 5).

### **7.2 Rating plates**

The line trap shall be provided with a rating plate of weatherproof material, fitted so that it is readily visible. The inscriptions shall be indelibly marked. The rating plate shall give the following data:

- Manufacturer's name
- Type and serial number

- Rated inductance in mH
- Rated continuous current in amps
- Rated short time current in kA
- Rated frequency in Hz
- Temperature category
- Insulation level
- Diagram showing the terminal marking
- Year of manufacture
- Total mass in kg

Each tuning unit shall also be provided with a rating plate giving the following information:

- Manufacturers name
- Type and serial number
- Frequency band in kHz
- Rated impulse protective level of tuning unit

### 7.3 Technical parameters

Line traps shall conform to IEC 353 and the parameters given in Table. 8.3.

Parameter	400Kv	220kV	132kV
Rated power frequency (Hz)	50	50	50
Rated system voltage (kV)	400	220	132
Highest system voltage (kV)	420	245	145
Rated continuous current at 50C (A)	2000	1600	800
Rated short time current for 1 sec. (kA)	40	40	40
Nominal discharge current of protective device at 8/20 micro sec. wave (kA)	10	10	10
Type of tuning	Broad band		
Rated blocking bandwidth	90-150 & 150-500 (to be approved during detail Engineering)		
Minimum resistive component of impedance within rated blocking bandwidth (Ohms).	450	450	450
Rated inductance of main coil (mH)	1.0	1.0	0.5
Corona extinction voltage (kV)	≥320	≥187	≥105
Radio interference voltage (micro volts at 1.1. times $U_r/\sqrt{3}$ , where $U_r$ = maximum system voltage)	500		

### **Table 8.3. Parameters for line traps**

The exact quantities and rating of required line traps shall be decided by the Project Manager based on frequency planning and recommendations of the Contractor.

The Contractor shall indicate continuous current rating of the line trap at 65C ambient.

#### **7.4 Welding or brazing on line trap during manufacture**

All the welding included in the manufacture of line traps shall be performed in accordance with the relevant section of this Specification.

#### **7.5 Line trap mounting (to be supplied by the contractor)**

Line traps shall be suitable for outdoor pedestal mounting and shall be mechanically strong enough to withstand the stresses due to maximum wind speed specified in the schedules. The contractor shall recommend the mounting of line traps and prepare the lay out of the substation for the Project Managers approval.

Where pedestal mounting is recommended, each line trap shall be mounted on a structure fitted with insulators to provide mechanical stability and structural rigidity. The Contractor shall submit the design calculations to establish the adequacy of his recommendations. All the accessories and hardware, mounting stool, including bolts for fixing the line trap on insulators, shall be of non-magnetic material.

The Bidder shall submit along with his bid, typical drawings clearly indicating the above mentioned features of the line traps, line trap mounting arrangement and terminal connectors. Each transmission line fitted with line traps shall be charged in the presence of the Contractor's representatives.

### **8. COUPLING DEVICE (TO BE SUPPLIED BY THE CONTRACTOR)**

The coupling devices shall be interposed between the capacitor voltage transformer and coaxial line to the PLC transmitter/receiver. The coupling device, in conjunction with the capacitor voltage transformer, shall ensure efficient transmission of carrier frequency signals between the carrier frequency connection and the power line. In addition safety of personnel and protection of the low voltage parts and installation, against the effects of power frequency voltage and transient over voltages shall be ensured.

The coupling device in conjunction with the CVT shall form an electric filter of band pass type and have the following characteristics:

1. It shall match characteristic impedance of HT line to impedance of the carrier frequency connection. Impedance matching between power line and the carrier frequency connection may be done by a transformer or an auto-transformer. The phase to earth characteristic impedance of the HT line may be assumed to be 320 ohms for 400 kV lines and 400 ohms for 220 kV lines. The design details must be submitted along with the Bids.
2. Galvanic isolation between primary and secondary terminals of the coupling device shall be performed by the above mentioned transformer.
3. Power frequency currents derived by the CVT may be drained to the earth by a separate inductance termed drain coil of suitable rating.



## **9. HIGH FREQUENCY CABLE (TO BE SUPPLIED BY THE CONTRACTOR)**

High frequency cable shall connect the coupling device installed in the switchyard to the PLC terminal installed indoors. The high frequency cables supplied by the Contractor shall be suitable for laying directly in trenches or in ducts.

The cable shall be steel armoured and its outer covering shall be protected against attack by termites. Bidder shall offer his comments on method employed by him for earthing of screen and submit full justification for the same with due regard to safety requirements.

Bidder shall enclose in his bid a detailed construction drawing of the cable being offered, with mechanical and electrical parameters.

Impedance of the cable shall be such as to match the impedance of the PLC terminal on one side and the coupling device on the other side, over the entire carrier frequency range of 40-500 kHz.

Loop resistance of cable shall not exceed 30 ohm per km at 20C.

The cable shall be designed to withstand a test voltage of 4 kV between conductor and outer sheath for one minute.

Bidder shall specify attenuation per km of cable at various carrier frequencies in the range of 40 to 500 kHz. The typical attenuation figures for HF cable shall be in the range of 1 to 5 dB/km in the frequency range of 40-500 kHz.

The HF cable shall conform to type tests and be subjected to routine tests as per IEC 96-2/ BS 2316/ IS 5802.

The Bidder shall submit along with the bid, copies of type tests and performance reports of the cable being offered.

All HF cables within the scope of this specification shall be supplied, laid and terminated by the Contractor.

Cables shall be supplied wound on drums containing lengths not less than 500 metres each.

## **10. POWER LINE CARRIER TERMINAL (OWNER SUPPLY ITEMS -OPTCL )**

### **10.1 General**

As already indicated the information link shall be provided for speech, protection, fax and data services. PLC terminals shall be fully co-ordinated to match with the specific requirements. Because of strict requirement of high speed of operation, security, reliability and efficient operation of protection channel along with the carrier terminals, Bidder shall ensure the complete and fool-proof co-ordination of the PLC and protection equipment. It shall therefore be necessary to have these combinations as one unit without any mismatch or necessity of any intermediate co-ordination unit.

PLC terminal shall use amplitude modulation and shall have single side band transmission mode. These shall be equipped for fixed frequency duplex working and shall be fully solid state.

Characteristic input and output parameters of the PLC terminals shall be as per IEC 495 unless otherwise specified.

### **10.2 Features of PLC terminals**

Each PLCC channel shall be capable of carrying any of the following:

1. One speech channel plus telephone signalling channel, nominally 300 Hz to 3.4 kHz for speech. This is also required to carry facsimile transmission and computer data.
2. One restricted speech channel 300 Hz - 2 kHz plus a band of 2 kHz - 4 kHz for the transmission of data and a telephone signalling channel. Data signalling rates of 50, 200,300, 600 baud shall be possible.
3. Two 600 baud channels or one 1200 baud channel. It shall be stated if higher data rates up to 9600 bit/s can be transmitted.
4. One channel for the transmission of speech and tele-protection signals.
5. One channel for the transmission of speech, tele-protection signals and data.

The equipment shall preferably be capable of operation in all the above modes without the provision of additional modules and components. The telephone signalling channel shall be nominally 3.8 kHz out-of-band.

Subject to frequency allocation considerations, PLC equipment may be required to be expanded by the addition of channels to a link (i.e. upgrade to 2 or 4 channels as appropriate). The PLC equipment shall be modular in construction and shall permit such upgrading to be carried out.

The equipment shall be suitable for use with E and M signalling between telephone exchanges at both ends of the lines. Signalling shall be on the pilot tone using a 50 baud channel. If DTMF signalling is available as an alternative this should be stated.

### 10.3 Transmitter/receiver

The equipment shall use single channel amplitude modulated single sideband suppressed carrier transmission. The Bidder shall quote for terminals which have an output power of 20, 40 and 80 watts.

PLC equipment shall be designed to operate over a frequency band of 50 kHz to 500 kHz.

For each PLC link, the Bidder shall indicate the required frequency spacing between the transmitters and receivers. Spaced band and contiguous band operation should be possible. In twin channel versions, it shall be possible to operate both transmitters and both receivers in adjacent bands. The Bidder shall state the full range of carrier frequencies over which the equipment may be operated.

The carrier frequency output impedance shall be 75Ω or 125Ω unbalanced. Any alternative shall be stated in the tender. The return loss within the nominal carrier frequency band in the transmit direction shall be not less than 12 dB.

The maximum permitted level of spurious emissions shall meet the requirements of IEC 495 Section 8.3.2. Spurious emissions shall be measured as described in Clause 6.2.3 of the recommendations.

The receiver shall have high selectivity and the attenuation of out of band signals shall be as follows:

Frequency out of band (kHz)	Attenuation(dB)
0.3	70
0.3 - 4.0	70 - 90

The generation of carrier frequencies shall be fully synthesised. It shall be possible to select any carrier frequency within the whole carrier frequency range in discreet steps of 4kHz. The frequency synthesis shall be highly accurate such that the actual carrier frequency shall not differ from the nominal by more than 20 Hz.

#### **10.4 Speech and signal levels**

The voice frequency input impedance shall be 600Ω balanced. The return loss within the effectively transmitted frequency bands shall be not less than 14 dB.

The minimum send level shall be not more than -14 dBm. The maximum receive level shall be at least +4 dBm. Attenuators to facilitate interfacing and matching should be provided.

The absolute input and output levels for signal channels shall be chosen in accordance with the relevant ITU-T Recommendations.

In a pair of PLC terminals, the frequency difference between a voice frequency signal applied to the transmit end and that received at the receive end shall not exceed 2 Hz.

The linearity as a function of the voice frequency input level, shall be such that the overall loss of the speech circuit, of a pair of PLC terminals without companders and limiters, does not differ by more than ±0.8 dB from the overall loss at 0 dBm for any input level between -10 dBm and 0 dBm. The measurements shall be made at 800 Hz.

Automatic Gain Control: In the case of a 30 dB change in carrier frequency signal level within the regulation range, the change in voice frequency receive levels of both speech and signals shall be less than 1 dB.

Graphs showing frequency/attenuation response of the line filters shall be included with the tender.

The use of companders shall be optional and the final arrangement shall be agreed with the Project Manager.

#### **10.5 Maintenance facilities**

Set up and maintenance facilities shall be provided, preferably through the use of a portable PC. The facility shall enable the variable parameters of the equipment to be modifiable.

Details of test equipment required for the set-up and maintenance of the equipment shall be given.

Provision shall be made on each point to point PLC link for emergency and maintenance telephone communications together with audible and visible calling annunciators.

#### **10.6 Alarm facilities**

The failure of a module, fuses or loss of power or any other condition affecting the correct operation of individual components of the PLC system shall be automatically detected. Provision shall be made for the indication of these alarms on the affected equipment, and on the substation alarm annunciator panels or alarm monitoring system via potential free contacts.

#### **10.7 Technical parameters**

##### **10.7.1 General**

1. Carrier frequency range, 40 - 500 kHz

programmable.

2.	Mode of transmission	Amplitude modulation single side band with suppressed carrier or reduced carrier.
3.	Frequency difference	Between VF signal at the PLC terminal transmitting and receiving ends will not exceed 2 Hz with suppressed carrier. With reduced carrier frequency difference shall be zero. This shall include permissible ambient temperature variation and supply frequency and voltage variation of (+) 15% and (-) 10%.
4.	RF output power (PEP) at coaxial cable	20W, 40W, 80W as required.
5.	Nominal RF impedances	75-125ohm unbalanced 150ohm balanced, optional.
6.	Life expectancy	15 Years
7.	Carrier frequency output return loss	12 dB minimum
8.	Out of band selectivity	90 at 4 kHz
9.	Method of generating carrier	Synthesised
10.	Accuracy of carrier frequency generation	+/- 20 Hz
11.	Minimum VF send level	-14 dBm
12.	Maximum VF receive level	+4 dBm
13.	VF linearity	+/- 0.8 dBm
14.	Module/Card type	Plug In
15.	Operating Temperature Range	0-50C
16.	Number of AF channels	1 - 4
17.	Effective AF bandwidth	300 - 3600 Hz
18.	Alarms for	loss of transmit signal loss of receive signal inadequate S/N ratio
19.	Power supply, mains	230VAC, +15%, - 15%
20.	Power supply, battery	48VDC, +20%,-15% + ve earthed
21.	Ambient conditions according to	IEC 495 (revised )
22.	Automatic gain	For 40 dB change in control carrier frequency signal level within the regulation range, change in VF receive levels of both speech and other signals shall be less than 1 dB.

### 10.7.2 User interfaces

1. Telep 600 ohm  
hone interface, 4-wire

### 10.7.3

1. Number of separate audio 1  
I/O per channel
2. Number of commands with 4  
plugged-in Protection Coupler

### 10.7.4 Other system components

1. plug-in protection signalling plug-in AF modem programmable  
module

## 10.8 General requirement for PLC terminal

All the PLC terminals shall be of multi-purpose type. The Bidder shall confirm that the total transmission time for teleprotection shall not exceed 20 ms for permissive and 30 ms for direct tripping signals. Speech and teleprotection channels shall independently fulfil the SNR requirements out of the power allocated to its channel from the total power of the PLC terminals.

Detailed calculation for SNR requirement and power allocation over different channels should be furnished along with the bid.

Multiplexing equipment, VFTø and measurand and converters etc. for data are not included in the scope of present specification and shall be procured separately. The successful Bidder shall, however, be required to co-ordinate his carrier equipment with these equipments for successful operation of the system.

The final selection of the output power shall be based on the frequency planning and computer studies conducted by the Contractor. The evaluation of bids shall, however, be done on the basis of prices for carrier sets with power output as stated in this Specification.

In the input circuit of the PLC terminal protective devices shall be provided in the form of zener diodes or surge suppressers in order to eliminate any surge transfer through the coupling device or induced in the connecting path of HF cable.

To improve voice transmission characteristics for the system, compressors and expanders (companders) shall be provided. The companders shall have at least 2:1 compression ratio with a corresponding expansion ratio of 1:2. The operating range of compander shall be compatible with the audio power levels specified for four wire operation. The improvement gained by companders shall however not be taken into account for power allocation and shall be in-hand reserve.

Sudden changes in input level to the receiver shall not cause false tripping. The Bidder shall clearly indicate in his offer the methods adopted to ensure above phenomenon. The receiver design shall also provide protection against false tripping from random noise.

Fail safe devices shall be provided, so that a malfunction in one unit or sub-assembly cannot cause damage elsewhere in the system. All plug in equipment shall be fitted with features to prevent improper insertion. The electrical cables shall not be routed across sharp edges or near

sources of high temperature. The adjustments, which are susceptible to misadjustment from accidental contact/vibration, shall be equipped with suitable locking devices.

The PLC set shall be designed to give guaranteed performance from 0C to 50C ambient temperature. The thermal capability of the equipment shall be so designed that the equipment remains operational successfully up to 60C ambient temperature. Any ventilation fans provided for circulation of air inside the cabinets shall conform to relevant Standards.

Terminals shall be provided with a built-in indicating instrument to facilitate checking of important voltage and current values and signal levels in different parts of the PLC Terminals. Protection fuses shall be provided in all important circuits, and fuses shall be so mounted as allow their easy inspection and replacement. All test points shall be easily accessible.

The carrier set shall be provided with suitable supervision and alarm facilities. Individual parts of the carrier set should be accessible from front, making it possible to place the carrier cabinets side-by-side. All components and parts of the carrier set shall be suitably tropicalised.

PLC terminals shall be housed in floor mounting sheet metal cabinets, suitable for mounting on concrete plinth as well as channel frame by means of nuts and bolts or welding. The cabinets shall be properly cleaned and spray painted with two coats of synthetic enamel paint. Exterior of the cabinets shall be painted with smoke-glossy finish. Interior of the cabinets shall be painted with white enamel paint with glossy finish. All the panels shall be properly earthed to the Employer's earthing grid by the Contractor. Contractor shall submit detailed drawings for earthing connections.

All panels shall be protected against moisture ingress and corrosion during storage. Panels shall be properly dried before they are installed and energised. Bidder shall indicate measures adopted to prevent ingress of moisture during operation.

All cabinets having PLC terminals shall be provided with lamps of sufficient wattage for interior illumination with switch.

A name plate shall be provided on the front door of each cabinet indicating channel function, transmitter frequency and direction etc.

### **10.9 PLC Terminal Speech Communication**

PLC equipment offered shall provide telephone communication between the stations where the transmission lines specified in the schedules are terminating.

It shall be possible for a subscriber at any of the stations to contact the subscriber at all other stations connected in the system by dialling his call number. To achieve this an EPAX with four wire interface and remote subscriber units shall be provided at different stations.

The equipment shall contain all normal facilities such as ring back tone, dial tone, engage tone and priority tone, and suitable pulses to establish and disconnect communication between subscribers.

The equipment shall be provided with necessary alarm circuits and fuses etc.

The equipment shall be of 4 kHz bandwidth on either direction and be suitable for providing superimposed data and teleprinter facilities at a later date without major modifications and high cost. The Bidder shall clearly indicate in his bid the provision made in his proposal for future development and the extent to which such additional facilities can be added at a later date.

The system shall be completely automatic with a definite number allocated for each telephone. The numbering scheme for telephones, exchange and tie lines shall be developed by the Bidder

and indicated in the bid. Final numbering scheme shall be fully co-ordinated with the existing and proposed future systems by the Contractor.

Arrangement for over-riding facilities shall be provided by means of priority keys wherever specified. The over-riding facility shall enable cutting-in on ongoing calls with the priority key to ask the concerned parties to finish their conversation. The wanted number should then be automatically connected without having to redial the number.

All carrier telephone conversations shall be secret and it should not be possible for anybody to over hear a conversation going on between any two parties excepting those provided with over-riding facilities.

The necessary cables for connecting all the telephone instruments ordered for each substation (including wiring and terminations) shall be provided by the Contractor. These telephone instruments shall be located within the control room building at the respective substation.

All relays etc. used in the equipment shall be of sufficiently robust design to cope with the duty imposed on them. Electronic components used in the equipment shall be of long life type and as few types as possible shall be used.

The cabinets housing the equipment for EPAX, four wire E/M interface and remote subscriber units (four wire) shall have mounting arrangements similar to those for PLC terminals as elsewhere in this section of this Specification.

All the terminals for speech shall be supplied fully wired for addition of VFTs and transit filters in future.

Equipment for speech communication must be fully compatible with Employer's existing equipment. Any interfaces required for proper matching and connection with the Employer's existing equipment shall be provided by the Contractor.

Terminals for protection shall be suitable for operation between the two ends of each transmission line or on tandem operation basis with back to back connection at the intermediate stations.

Each PLC terminal for speech as well as protection purposes shall be provided with a plug-in type service telephone and buzzer. Further, four wire remote telephone instruments (parallel to service telephone) shall also be provided on one PLC terminal for protection for each link. These instruments shall be located in the respective switchyard control rooms to enable the operator to make emergency calls on point-to-point basis. Each such instrument shall be equipped with a buzzer and 'press-to-call' key and shall not require any additional power supply units.

There is also a requirement for express telephone links between substations and Area and State Load Dispatch Centres. A call from the substation shall be initiated by lifting the handset. This would cause a lamp to light on the communications console (to be provided under another contract) at the control centre.

## **11. ELECTRONIC PRIVATE AUTOMATIC EXCHANGE (EPAX) (TO BE SUPPLIED BY THE CONTRACTOR)**

### **11.1 General requirements**

Private automatic telephone exchanges (PAX) are required at substations as stated in the detailed description of work and Bill of Quantities.

The equipment shall be capable of providing proper performance throughout its fifteen year life expectancy.

All equipment shall be designed for ease of maintenance and shall include a variety of built-in alarms associated with vital operating parameters.

All equipment supplied under this specification shall conform with the latest IEC Specifications and CCITT Recommendations.

The topographical, meteorological and system operating conditions shall be as stated elsewhere in this Specification

Each interface shall be protected so that neither a short circuit nor open circuit on the telephone line shall cause permanent damage to the exchange equipment. The application of a 500 volt, 50 Hz, signal to either or both legs of the line, shall not cause permanent damage to, or malfunctioning of the exchange equipment.

The exchange equipment shall be protected from electrostatic discharges transmitted to, or occurring at the line interface units.

Each interface shall have an insulation resistance of greater than 10 Mohms at 500V DC between line terminals and earth.

Each interface shall be capable of withstanding longitudinal 2kV, 10/1000 microsecond voltage surges.

The equipment shall operate from a 48 V DC positive earthed battery supply.

Switching equipment shall provide for the following:

- Interconnection of calling and called extension.
- Interconnection of PAXs via circuits conforming to CCITT Rec. G703 and G705 and PLC channels conforming, to IEC 495.
- Interconnection with a central PAX telephone console at the State Load Dispatch Office and Area Load Dispatch Office.
- A traffic monitoring and reporting system.

## **11.2 PAX interfaces**

### **11.2.1 General**

The PAX requires both analogue and digital interfaces. It shall be capable of interfacing to existing and future GRIDCO telecommunications equipment, and to the public telephone system at selected sites. It shall be capable of interfacing with power line carrier, pilot cable, digital multiplexer, and the PSTN.

The PAX shall be capable of handling analogue and digital trunks, tie lines and extensions, and shall be able to provide the following interfaces:

- 2 wire loop extensions
- 2 wire loop tie lines
- 2 wire E and M tie lines
- 4 wire E and M tie lines
- 2 wire loop PSTN lines

The analogue interfaces shall be two and four wire interfaces, with and without E and M signalling and busy/test signalling, to suit telephone, PLC and pilot cable equipment.

The digital interfaces shall be 64 kbit/sec and 2048 kbits/sec with and without common channel signalling, to suit digital data links and inter-exchange trunks.

#### 11.2.2 Two wire analogue telephone interface requirements

The interface shall be suitable for both standard telephone instruments and telephone consoles for control centre, generating station and substation operators, using DTMF signalling. The interfaces shall provide BORSCHT functions, i.e. **B**attery supply, **O**vervoltage protection, **R**ing current supply, **S**upervision, **C**ode, **H**ybrid and **T**esting functions, for each line connection.

The line feed shall be sufficient to ensure the satisfactory performance of two telephones in parallel on a balanced line of between 0 and 1500 metres in length. The range of loop resistance over which the interface will operate will be 0 to 500 ohms, with a similar limit for the Transmission Equivalent Resistance (TER).

The two wire port impedance shall be 600 ohms, nominal, balanced and suited to the telephone instruments during ringing, signalling and voice transmission conditions.

#### 11.2.3 Analogue power line carrier (PLC) interfaces

The interfaces shall operate as four wire plus E and M interconnections, with the facility for equipment busy signalling wire and test signalling wire, for use with existing transmission equipment interfaces, i.e. PLC and pilot cable interfaces.

The electrical interface requirements are as follows:

- Transmit and receive pairs impedance 600 ohms balanced; return loss better than 20 dB; levels - 3.5 dBm;
- E wire 50 volt battery and relay coil;
- M wire voltage free relay contact to earth;
- Test/busy wires voltage free relay contact to earth;

#### 11.2.4 PAX to PAX interfaces operating over digital trunk circuits

The interfaces shall operate as analogue and digital trunk/tie line interfaces to enable existing changes to be interconnected with the digital PAX and multiplex equipment.

64 kbit/sec interfaces shall be in accordance with requirements of CCITT Recommendation G 70J, and shall be complete with channel associated signalling.

The Contractor shall be responsible for ensuring that these 64 kbit/sec interfaces enable the full range of network facilities to be available for the PAX extensions.

#### 11.2.5 Pilot cable interface

The interface shall provide facilities to interconnect telephone and other terminals to multiplex and exchanges sites via existing pilot cable systems. These interfaces generally conform to those of the PLC system, and are suitable for extending four wire analogue telephone interfaces beyond the 500 ohm limit.

64 kbit/s interfaces shall be in accordance with CCITT recommendation G703, and shall be complete with channel associated signalling,

The PAX shall have facilities for handling DTMF, decadic, feature and digital phones. It shall be possible to connect remote extensions directly to the PAX over four wire E and M circuits.

### **11.3 Exchange equipment**

The PAX shall be a full digital stored programme controlled type, suitable for the transmission of 64 kbit/s and 2 Mbit/s digital signals and for interfacing with PSTN and other public ISDN exchanges.

The PAX shall be capable of being connected via analogue PLC and pilot cable voice circuits utilising MF and E and M signalling to other PAXs installed in the GRIDCO PAX network.

The PAX shall be capable of automatically searching for alternative routes if the first choice route is unavailable.

The equipment shall be expandable to at least the specified maximum switching capacity without impairment of reliability or performance, and without the need for replacement of installed major software and equipment.

### **11.4 Extension features**

The PAX shall provide for the interconnection of any two extensions connected to the exchange without the participation of a telephone operator, on the basis of keyed or dialled numbers.

The PAX shall provide for:

- Normal inter extension communication.
- Automatic call-back on "Busy" or "No Reply". The calling extension shall have to enter a prefixed code for this facility to be operable
- Conference call, both three way established by an extension, or a multiple conference up to 20 extensions .
- Call transfer to transfer a calling party to another extension.
- Call transfer/follow me to reroute all incoming calls to another extension.
- Call transfer to allow a called extension to be answered at another extension by dialling a code at the other extension.
- Last number redial to allow a redial by using a code.
- Abbreviated dialling to allow codes or a telephone button to dial previously stored numbers.
- Call waiting indication.
- Extension group hunting to allow a number of extensions to be grouped on a common extension number, with incoming calls being assigned in cyclic order to free extensions.
- The facility to hold a call while making a second call.

The features shall be available on an assigned basis.

The exchange transmission performance shall conform with CCITT Recommendations G712, Q507 and Q517 for combined transit/local exchanges and related recommendations in regard to measurement techniques, interface characteristics, and definitions.

### **11.5 Software**

The preferred programming language is CHILL, as described in CCITT Recommendation Z200, Red Book. However other high level languages may be offered which can provide the reliability and maintainability required, and which conform to the basic structural requirements.

The software used on the system shall be of tried and tested modular construction. The Bidder shall state if software upgrades have been implemented and which version of software is being offered. The procedure for upgrading the system software shall be stated. Details of software licensing arrangements shall be provided.

### **11.6 Maintenance**

The exchange shall provide automatic monitoring and reporting functions to verify the proper execution of call handling and exchange software or hardware malfunctions, and report on the condition of interfaces and exchange resources, e.g. memory occupation, call queue levels, CPU utilisation, traffic levels.

Printed and visual display reports shall be date and time stamped and shall identify exchange and software version codes.

The exchange shall be equipped with the following alarm facilities:

- Urgent alarms indicating a major malfunction
- Non-urgent alarms resulting from transient conditions or self clearing (automatic partial restart) conditions

Local urgent and non-urgent alarm indications shall also be provided.

### **11.7 Hardware**

To meet functionality, reliability and performance requirements, the hardware for the exchange shall use:

- Duplicated call handling processors
- Duplicated memory and memory control
- Duplicated buses for common data, memory and control
- High speed RAM backed by non-volatile, e.g. EPROM, memory and duplicated hard disk storage (storage to have 50% spare capacity)
- Duplicated ringing/tone signalling
- Bulk software loading facilities, preferably of the floppy disc or hard cassette disc type
- System control and display panel

### **11.8 Numbering plan**

The PAX shall have facilities to transpose telephone numbers for routing to and from extensions on remote exchanges.

A closed numbering plan is being used for all extensions on new and existing SPC exchanges. There will be four numbering zones. It shall be possible to restrict interconnection between each numbering zone. However it shall be possible to give any extension interzone access.

### **11.9 Cables and cabling**

Supply, storage, and laying of all necessary telephone cables, special cables and other associated cables in order to render the exchanges fully functional and connected with the requisite number of telephones as detailed in the relevant sections of this Specification shall be within the scope of the Bidder.

## **11.10 Telephone operators console**

An operators console may be required for some PAXs. It shall be equipped with visual display unit, keyboard, handset, headset and exchange function controls, and be designed for stress free operation. Bidders shall include a cost for this optional item.

### **11.10.1 Voice message recording system**

The exchange shall be capable of incorporating a facility for recording of voice messages on a store and forward basis. Telephones connected to the system shall be able to send a voice message to the PAX, together with the called extension number. A message waiting indication shall be available to telephone stations to advise that a message has been stored when a prefix code is keyed. The system shall be capable of 30 hours message storage, with an indefinite retention period, message repeat and message erase codes.

### **11.10.2 Telephone signalling**

Line, information, tone and ring signalling shall be provided to suit analogue and digital telephone extension equipment.

Analogue telephone extension signalling, shall provide the line, information, tone and ringing facilities as follows:

- The extension line control signalling shall use line loop signalling to initiate and terminate extension calling and answer activities, in accordance with BORSCHT exchange and multiplex interface requirements.
- Information signalling will be DTMF in accordance with CCITT Recommendations Q23, Q16 and associated recommendations.
- Tone signalling will conform to the suppliers standard equipment and appropriate CCITT Recommendations.
- Ringing current shall be to manufacturers standard.

## **11.11 Remote end four wire E/M interface and subscriber unit**

The Remote end four wire E/M interface unit, wherever specified, shall be electronic type and be suitable for working on fixed frequency power line carrier systems with E/M signalling. This equipment shall be housed in the carrier set and be fully wired to the carrier terminal equipment.

This unit shall receive and register various signals on PLCC channels from remote end exchanges or other remote end subscriber units and associated four wire interface units.

The unit shall be equipped for routing transit calls and shall be supplied prewired to handle calls from a minimum of eight directions, in a form suitable for transmission over PLCC. The bidder shall indicate the total trunk line capacity for the unit.

The unit shall be suitable for connecting to two wire telephone sets. The associated telephone cables for connecting to the telephones within the control room shall be within the scope of supply.

## **12. 0 NETWORK PROTECTION EQUIPMENT (PROTECTION COUPLER)(OWNER SUPPLY ITEM – OPTCL)**

### **12.1 General**

The Bidder shall offer voice frequency transmission equipment which shall work on frequency shift or coded signal principle for transmission/reception of protection signals as single purpose channel. The equipment shall be suitable for connection to the power line carrier terminal mentioned in Clause above.

The voice frequency transmission equipment shall not only be insensitive to corona noise but shall also remain unaffected by impulse type noise which is generated by electrical discharge and by the opening and closing of circuit breakers, isolators, earthing switches etc. The equipment shall also be made immune to a field strength of 10V/m expected to be caused by portable radio transmitters in the range of 20-1000 MHz. In his offer, the Bidder shall clearly explain what measures have been taken to make the equipment insensitive to corona noise, white noise and to impulse noise of an amplitude larger than the wanted signal, and submit full field test and laboratory test reports. The guarantee on design data shall not be acceptable.

The equipment shall be unaffected by spurious tripping signals. The Bidder shall submit evidence to show how this is achieved satisfactorily.

The equipment shall be designed in accordance with IEC 834-1. All works shall conform with the Indian Electricity Rule, 1956, unless modified by this specification. All materials and equipment offered shall comply with the relevant Standards. These standards shall be stated by the Bidder.

Voice frequency transmission equipment is required for line protection signalling. The equipment shall be used in conjunction with distance protection systems and power line carrier. It shall operate in a duplex mode. It shall be housed in the power line carrier cabinet.

When a line fault occurs, the carrier channel to which the equipment is connected shall be switched over to the teleprotection unit. This shall simultaneously disconnect speech and other signals. This interruption will continue for the short period of the teleprotection command, after which the normal operation of the carrier equipment will be restored. During the transmission of teleprotection signals or when a fault has been detected by the protective relays, the entire output power of the carrier will be made available for transmission of the teleprotection signals. The transmission time of the teleprotection signal, from receipt of command from the transmit end of the channel to the output of the trip command at the receive end of the channel, shall not be more than 20 milliseconds.

The equipment shall allow speech and superimposed data to be transmitted by the carrier along with the teleprotection guard signal. The tripping signal shall be a tone in the speech band which shall be capable of boosting above the guard signal level. Its frequency shall be stable within  $\pm 4$  Hz.

The operating frequencies of the teleprotection shall be so chosen that under no circumstances shall a spurious tripping signal be transmitted. The equipment shall not issue false commands due to transient phenomena. It shall be insensitive to corona noise and noise generated by the operation of circuit breakers, disconnects and switches, and to electrical surges. It shall be insensitive to harmonics of speech signals.

The teleprotection equipment is to be used together with the PLC equipment. It shall comprise modules, which are directly plugged into reserved slots of the PLC equipment.

The Protection Coupler shall use microprocessor techniques with digital signal processing, to meet the stringent requirements for command transmission over PLC links even under adverse channel conditions.

Full duplex transmission of up to two non-coded permissive or blocking commands plus two coded prioritised direct tripping commands shall be possible for the protection of single and double lines including breaker failure protection.

## **12.2 Test Facilities**

The equipment shall be constructed such that in permissive line protection system, operational reliability of the protection channels may be checked over the carrier link by means of a Local and End To End loop test. It shall be possible to carry out the above test from either end of the carrier link. During healthy condition of the transmission line, the loop test shall not initiate a tripping command. In the event of a system fault, while loop test is in progress, protection signal shall over-ride the test signal.

It shall be possible to test the protection link from either end. This test procedure must not initiate a tripping command.

Facilities shall be provided for displaying and extending alarms (including the tone generator), trip and test conditions and for monitoring and measuring levels. The following operating conditions shall be visually indicated:

- Protection in service
- Protection out of service
- Equipment under test

A cyclic and a manual loop test procedure shall allow in-service testing of the teleprotection channel. Internal self-tests shall continuously supervise the equipment's operating ability.

A hand-held terminal shall be supplied and shall be connectable to a diagnosis interface to display service and operating information.

## **12.3 Channel Requirements**

The equipment shall be suitable for transmission of direct and permissive trip signal as well as blocking signals for protective gear of power system. The equipment shall be operated in the audio frequency range in speech band or above speech band as superimposed channel in 4 kHz band of SSB carrier. The equipment shall operate with full duplex frequency shift mode of operation. The protection signalling equipment shall be of solid state design, modular in construction and have a proven operating record in similar application over EHV systems. Details regarding application of the equipment over 400kV/220kV systems shall be submitted along with the bid.

In its minimum configuration, the Protection Coupler shall convey four independent commands. The four commands are grouped into two non-coded permissive and two coded direct tripping commands, the latter having priority. The first and second main protection schemes with redundancy features are shown in the relevant drawings in the schedules.

The arrangement shown in the drawings is for guidance only and actual arrangement shall be developed by the Contractor in co-ordination with protective relay supplier. The parallel wiring should however retain the concept of two protection channels of each type of protection with each backing up the other 100% during normal operation and also permit testing without affecting the

other. The Contractor shall submit drawings showing inter-connection between PLCC and protection panels for approval by the Owner.

The protection coupler shall be designed for transferring commands in blocking, permissive and direct transfer tripping schemes. An unblocking output to be used in deblocking schemes with overreaching first zones and without starters shall be available on the unit.

The command interfaces to the protection relays and alarms shall be free and *d.c. isolated* from ground and all other circuits. Each of the tripping outputs shall have associated auxiliary signal output. The standard relay interface modules are to be fitted with tripping signal counters.

The protection coupler shall use the pilot signal of the PLC as a guard signal. The guard signal is to be continuously evaluated on the receive side. In case of insufficient signal quality (signal-to-noise ratio or signal level) the protection coupler shall initiate an alarm.

In the command state, the protection coupler shall cut the guard signal (pilot) and transmit the command signal within the PLC speech frequency band. It shall be possible to boost the command signal to the maximum available transmitter power. The speech and data signals on the same channel are to be interrupted during the short time of command transmission.

As soon as the receiver recognises the missing guard signal and simultaneously detects a valid command signal, the corresponding command output relay is to be operated. Simultaneous loss of a command signal and the guard tone shall lead to an alarm.

A number of frequencies corresponding to the individual commands or command combinations are to be provided in the PLC speech frequency band. Depending on the application (permissive or direct tripping) these frequencies are to be assigned to the actual command. Setting up of the equipment and adapting to field requirements is to be done by means of programming switches on the modules.

It shall be ensured that under no circumstances should the protection channel share the power. Each protection channel shall be able to transmit the power for which the system is designed. For example, a 40 W PLC terminal shall transmit 40 Watt (max) for protection channel alone in the event of fault. Speech and super-imposed data channels, in the same protection terminal must be disconnected momentarily during the operation of protection channels.

The equipment shall be complete with built in counters for counting the number of trip commands sent and number of trip commands received.

The Contractor shall develop drawings showing interconnection between protection panels and PLCC panels and submit the drawings for Project Manager's approval. Supply, laying and terminating of control cables for interconnection between protection panels and PLCC panels at each substation, for the transmission lines covered under this specification, shall be included in the Contractor's scope of work.

#### **12.4 Operating time**

The equipment shall be designed for remote tripping/ blocking on permissive basis and direct tripping for reactor fault and others. The overall time of PLC, VFT and transmission path for permissive trip/blocking shall be 20 milliseconds or less.

Operating time lower than that specified above may be offered provided the equipment meets the following requirements of security and reliability:

- False - trip probability (noise burst of any amplitude):  $10^{-5}$
- Fail to trip probability (for S/N 6dB in 3.1kHz band - white noise measurement):  $10^{-2}$

The specified time mentioned above comprises the following :

- a) Back-to-back signal delay in frequency shift or coded signals protection equipment.
- b) Back-to-back delay in PLC terminal.
- c) Delay in transmission line.
- d) Operation time of interposing relay, if any, in frequency shift or coding equipment.

Reference is invited in this regard to the guide lines expressed in CIGRE Publication "Teleprotection" report by Committee 34 and 35.

## 12.5 Input/Output criteria

### 12.5.1 Transmit side

One potential free NO (normally open) contact of protective relays shall be provided for each of the following functions:

- Each Permissive trip command
- Direct trip command
- Contact Rating:

Maximum voltage:	660V
Maximum current rating:	5A
Maximum power rating:	1250 W / VA

### 12.5.2 Receive Side

Voice frequency transmission equipment for network protection shall be provided with one potential free NO (normally open) contact for each of the following functions:

- Permissive trip command
- Direct trip command
- Contact Rating:

Rated voltage:	250 Volts DC
Rated current:	0.1 A DC
Other parameters:	As per IEC-255-0-20

### 12.5.3 Alarm

In addition, the voice frequency protection terminal shall provide at least one potential free changeover contact for alarm purposes.

- Rated voltage: 250V DC
- Rated current: 0.1A DC
- Other parameters: As per IEC 255-0-20

## 13. MODEMS (OWNER SUPPLY ITEMS – OPTCL)

### 13.1 General

The PLCC System shall be equipped with modems for data communication to the LDC SCADA over the bearer circuits.

The signalling data rate of the modems shall be adjustable between 200 - 2400 Baud. The modulation method shall be Frequency Shift Keying (FSK) and modem frequencies and audio bandwidth shall be in accordance with ITU recommendations.

Where necessary, modem audio connections to the site cables shall be protected by barrier transformers and surge arresters, and shall provide 15 kV of isolation.

The modems shall have front panel indications for Carrier Detection and Rx /Tx Data.

The transmit output level should be adjustable between 0dbm and -25dbm with the typical output level being set at 13dbm.

### 13.2 Channel parameters

Channel parameters are given in Table. 14.3. below.

CCITT channel	Transmission rate (Baud)	Frequency deviation (Hz)	Channel spacing bandwidth (Hz)	Channel mean frequency adjustable in steps of 120 Hz	
				Lowest	Highest
R35	50/75	±30	120	420	3900
R37	100/150	±60	240	480	3840
R38B	200/225	±90	360	540	3780
R38A	200/200	±120	480	600	3840
R38A	300/300	±120	480	600	3840
	600	±240	960	840	3600
V23	1200	±400	2400	1700	
	1200 + speech	±400	1640	2860	
	2400	±800	3200	1800/2000	

**Table. 14.3. Channel parameters**

### 13.3 Fax equipment (To be supplied by the contractor)

The FAX equipment to be supplied shall be compatible to CCITT Group 3 and shall be of plain paper type . The equipment shall be suitable for operation with PLCC equipment as well as with PSTN telephone network. The equipment shall be suitable for operation with 230V single phase supply.

### 13.4 AC/DC distribution board (To be supplied by the contractor)

#### 13.4.1 General

The Contractor shall provide and install power distribution boards for the PLCC equipment defined in the previous sections. The distribution boards shall distribute power to the equipment and protect against failures on feeder circuits supplying the equipment. The scope of supply shall include distribution boards, installation, cabling, conduit and all associated hardware and

accessories required to provide power from the station auxiliary power supplies to the PLC equipment loads.

#### 13.4.2 AC distribution boards

One AC distribution board shall be supplied at each control room/PLCC room for power distribution to the PLC loads. Each panel shall include a minimum of twenty (20) load distribution moulded case circuit breakers. Contractor shall co-ordinate breaker sizing and protection with the PLCC equipment.

#### 13.4.3 DC distribution boards

Separate DC distribution boards shall be provided at each control Room/PLCC room. The DC distribution boards shall provide 48 volt DC power supplies to communication equipment.

DC distribution board shall be fitted with a main MCCB of bi polar type rated for 3,000A at 48V DC and a minimum of 20 manually operated, single pole, feeder circuit. The Contractor shall co-ordinate feeder breaker sizing and protection with the communication equipment. All breakers shall be fitted with magneto thermal tripping and shall comply with IEC 157-1.

### **14. TESTING AND MAINTENANCE EQUIPMENT (OWNER SUPPLY ITEMS – OPTCL)**

Besides the stipulations made elsewhere in this Specification the testing and maintenance equipment shall conform to following technical particulars. Each set of these equipment shall consist of one of the following items.

1. 200HZ to 620kHz Selective Level Meter (SLM) including impedance and return loss measuring attachments compatible with level generator (item 2 below).
2. Level Generator with a range of 50Hz to 620kHz including facility for synchronisation with SLM.
3. Eight digit time interval and frequency counter with a frequency range of 1Hz to 10MHz and timer range of one microsecond to one second in decade steps.
4. Dual trace 15MHz oscilloscope with a display screen 8 x 10 cm and input impedance of 1 Mohm/25 pF with a deflection co-efficient of 5mV/div to 20V/div.
5. Four and a half digit LCD Multimeter with an input impedance of 10 Mohm and a range of 0.1 mV to 1000V DC, 0.1 mV to 600V AC, 0-10A DC and 0-10A AC (40Hz to 10kHz) and 0 - 20 Mohm with built-in power-supply.
6. Print test kits for PLC terminal, E/M interface, and subscriber unit, protection coupler, EPAX etc..

### **15.**

#### **15.1 General**

#### **15.2 Factory tests to be performed on line traps**

The following type tests in accordance with IEC 353 shall be performed on each type of line trap in presence of the Project Manager. Test reports shall be subject to the approval of the Project Manager before shipment of the equipment. The cost of doing each of these tests shall be indicated in the relevant Schedule of the Bidding Document.

- a) Measurement of inductance of the main coil
- b) Measurement of temperature rise
- c) Insulation tests
- d) Short time current tests

The following additional type tests shall be conducted on line traps along with other type tests mentioned in IEC 353.

- a) Corona extinction voltage test
- b) Radio interference voltage measurement

Procedure for these tests shall be mutually agreed. Prices for these type tests shall be quoted in relevant Schedule of the Bidding Document.

The line traps shall be subject to routine tests as per IEC 353.

The Bidder shall furnish along with his Bid the reports of type and routine tests conducted on similar equipment earlier as per IEC 353.

### **15.3 Factory test requirements for coupling device**

The coupling device including the drainage coil, surge arrester and earthing switch shall conform to type tests and shall be subject to routine tests as per IEC 481/IS 8998.

Routine tests shall include but not be limited to the following :

- Composite loss and return loss tests on coupling device.
- Turns ratio test and insulation tests on the balancing transformer.
- Milli volt drop test, power frequency voltage test and mechanical operation test on earthing switch.
- Power frequency spark over test for lightning arrester as per relevant IS/IEC.

Bidder shall furnish along with his Bid copies of all type and routine test conducted earlier on similar coupling devices in accordance with relevant standards.

### **15.4 Factory test requirements for HF coaxial cables**

The HF cable shall conform to type tests and be subjected to routine tests in accordance with IEC 96-2/BS 2316/IS 5802.

### **15.5 Factory tests on EPAX**

The PAX shall be tested in accordance with the relevant CCITT Recommendations and IEC specifications. In addition, all the functions and features specified shall be tested.

### **15.6 List of commissioning tests on complete system**

The following tests shall be carried out on complete system/subsystem during commissioning:

1. Composite loss and return loss on coupling device using dummy load.

2. Composite loss (attenuation) for HF cable coupling device.
3. End to end attenuation measurement for verification of optimum coupling mode. Test shall be done for all combinations.
4. End to end return loss for optimum coupling mode with.
  - open behind line trap.
  - grounded behind line trap.
5. If end to end return loss for optimum coupling mode is not satisfactory, same shall be measured for other coupling modes also.
6. Adjustment of Tx/Rx levels on PLC equipment as per test schedule.
7. AF frequency response (end to end) for the entire 4kHz bandwidth for speech and operation channels.
8. Measurement of noise in 2kHz bandwidth with and without line energised.
9. SNR (test-one) with line energised noting down weather conditions.
10. Transmission time for teleprotection and other data channels.
11. Observation of Tx/Rx levels (test-tone) for each channel at both ends by sequential switching on/off parallel channels using dummy load and also with the transmission line.
12. Observation of end to end and trunk dialling performance.
13. Observation of end-to-end protection signalling (command sent and received) in conjunction with protective relays, noting down transmission/receipt of unwanted commands under switching operations in the switchyard during protective relay testing.

### **15.7 Notes on testing**

All measurements for link attenuation, composite loss and return loss shall be carried out for the entire range of carrier frequencies with specific attention to the frequencies as follows:

- Frequencies within coupling device bandwidth.
- Frequencies within line trap bandwidth
- Operating frequencies.

The following tests shall be carried out independently at each end:

- Composite loss and return loss for coupling device.
- Attenuation test for HF cable + coupling device.
- Levels and other local adjustments (on dummy load). Final adjustment shall be on end to end basis.
- Test for loading by parallel channels with dummy line load. This test can be done along with tests for coupling device.
- Protection signalling under local loop-test (dummy load).

All end to end tests shall require availability of healthy complete line for a duration of approximately 5 days.

Necessary test instruments required for all the above tests shall be brought by commissioning engineers of the contractor.

## **16. NOTES ON COMMUNICATIONS RELATED ASPECTS**

### **16.1 General**

The OPTCL have proposed a unified telecommunications and control scheme. Under this scheme the State Load Despatch Centre at Bhubaneswar will be improved and four Sub-Load Despatch Centres will be established. An Interim Augmented Scheme has already been implemented to provide a limited capacity master station and a relatively small number of RTU outstations. A further interim development phase known as the Enhanced Interim Augmented Scheme (EIAS) is currently under examination.

Overall telecommunications planning has to be considered in relation to the complete transmission network. Services required between locations have to be decided as does the bandwidth they require. Transmission media and routing are then to be planned. Services at some stations require links not alone to the adjacent station but also tandem through other stations in the network, for instance SCADA or express speech to the SLDC. Some of the projects under PMU's scope are included in the EIAS project. The EIAS project has already specified services required to specific locations in respect of :

- Conduction of condition survey in respect of existing PLC equipment, both outdoor and indoor removal of old equipment and addition of new equipment including reallocation of equipment wherever necessary/possible.
- Administrative telephone and fax network requirement and advanced PAX systems
- Express telephone requirement to SLDC/Sub-LDC
- Requisite SCADA data channel network (main/standby)
- Provision of settlement metering data channels only
- Provision of high capacity communication network

EIAS project however does not cover the following :

- Provision of protection couplers for lines under this package for 220 KV and 400 KV lines.
- Provision of EPAX for the sub-station:
  - *As indicated in the BPS sheet.*

The scope of work under this contract and the facilities required in the network shall be broadly classified under the following heads.

- 1) Supply, erection, testing and commissioning of the equipments and materials at remote and new end of the sub-station (except indoor PLC panels, which is owner supply items).
- 2) The erection, testing, commissioning works at both new sub-station and remote end are to be taken care.

## **16.2 The administrative telephone network**

The purpose of this network is to provide a means of non-urgent operational and/or administrative telephone speech or fax communication throughout the whole OPTCL. This scope includes supply and installation of equipment to sites which require the same.

This will comprise of a mesh of mainly PLC based telephone circuits between adjacent substations, each of which will require a EPAX to cater for telephones at that site, and the switching of incoming and outgoing calls.

It is required that these switches are configured so as to provide a "closed" numbering system, i.e. one in which each station and each telephone has a unique telephone number which can be accessed from anywhere else on the network by simply dialling its unique number, routing then being carried out automatically by the system. This numbering system is to be compatible with the national numbering scheme being developed by POWERGRID.

In order to support FAX traffic it is necessary that the full available bandwidth of the communications circuits is usable and therefore the Administrative telephone network cannot also support data, teleprinter or protection over its constituent circuits. It is planned that the teleprinter system wherever existing be allowed to run down, and that FAX facilities be used instead.

The administrative telephone network, being composed of short lines between adjacent substations, is to be completely supported on PLC circuits and has to be configured with a certain degree of interconnection so as to allow simultaneous calls to be set up over parallel routes in some cases, and to give some resilience against outages. Whenever possible existing PLCs using modern equipment already in place shall be specified for this network. It shall be possible to extend the network detailed by the addition of extra lines and EPAXs as necessary. Where optical fibre trunk routes have been specified for administrative speech channels, two or more such channels have been allowed.

At the outer edges of this network there are some less important substations which already have PLC circuits from an adjacent more important site. In these cases a single telephone is to be installed, configured as a 'long-line' extension from the EPAX at the larger site.

Where the remote site is also defined as providing metering data and only has a single channel existing PLC circuit then, rather than installing a separate PLC simply for infrequent use of metering data transfer, the ability to relay FAX traffic has been sacrificed and the data channel superimposed on the existing PLC with consequently reduced bandwidth for only speech.

The plan of the proposed administrative speech and fax network is shown in the sketches with this Specification. The existing /proposed PAX installation list is given in the relevant schedule.

## **16.3 The express speech to SLDC network(Owners supply)**

In order to impose effective control, the SLDC will require rapid call set-up to its constituent substations and power stations. For this reason direct speech lines have been planned from the SLDC to each such site, but instead of each terminating on a separate telephone in the SLDC (as in the present SLDC) they will be presented on a communications console with key and lamp control.

The bandwidth of these circuits need not be as wide as that for the administrative network and hence the use of cut-off filters will allow the upper frequencies to be used for data transmission and/or teleprotection as necessary.

#### **16.4 Data to the SLDC (owners supply)**

The upper bandwidth of the express speech to the SLDC circuits will be used to carry the associated data from the RTU's. By cutting off the speech band at 2.0 kHz a 200 baud data path can also be carried, as well as up to two 50 baud metering data channels and teleprotection as needed.

Where required for critical substations, it shall have two such 200 baud data channels to the SLDC and the all other substations have only one data channel. Whenever possible the routes of the main and standby data channels shall be different in order to maximise reliability and resilience.

The plan of the main and standby RTU data networks are shown in the schedules as is a list of the RTU's giving their facilities and recommended sizes.

#### **16.5 Settlement metering data (owners supply)**

The OPTCL distribution system is to be divided into ten distribution 'circles' formed into four distribution 'groups'.

Settlement metering data will be required from the power stations, 400 kV supply points and the inter-state connectors as well as the distribution bulk supply points.

The groups, and the bulk supply points (BSPs) in each group have been decided but the geographic boundaries between the groups are not consistent with the boundaries between the future generation and transmission sub-LDC areas.

Settlement metering data comprising half hourly data on MW, MWhr, MVAR and MVARh is required, initially to be gathered at the SLDC but with facilities to allow the derived data to be available to the future distribution companies.

A metering data network operating at 50 baud will therefore be required. This is shown in the schedules.

This network is to be provided under this Contract. This will allow all distribution metering data to be available at the SLDC, and in due course when the distribution companies are in existence, data links from their respective offices to the SLDC will allow selected distribution metering data to be supplied to them as required.

#### **16.6 Teleprotection (owners supply)**

Teleprotection equipment already exists in OPTCL for the protection of most 400 KV AND 220 kV lines and some 132 kV lines.

The protection coupler requirements for 400kV , 220kV, and 132 kV levels have been shown in the schedules.

It is proposed that the same philosophy be adopted. Therefore all 400 KV and 220 kV lines will have teleprotection as well as the important 132 kV links.

#### **16.7 Trunk networks (owners supply)**

The requirements of the Load Despatch Communications network in the scope of EIAS cannot be met by PLC equipment alone. Therefore there will be an additional trunk network which will interconnect the proposed sub-LDCs and the SLDC. In addition a number of key power stations and substations have been included.

Scope of EIAS already covers the required communications between the SLDC and the future sub-LDCs. There will be a full network of high capacity optical fibre links/microwave between these sites. These are shown in schedules. While designing the PLC network under the present scope of work these high capacity communication networks shall be kept in view and shall be utilised wherever possible.

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**TECHNICAL SPECIFICATION**

**FOR**

**DISTRUBUTION BOARDS**

- 1) ACDB**
- 2) DCDB**
- 3) OTHER CONSOLES INCLUDING BMK**

**1) TECHNICAL SPECIFICATION FOR DISTRIBUTION BOARDS**

**General**

**Requirements of AC and DC systems**

The electrical auxiliary systems shall be of a quality commensurate with the performance, reliability and availability requirements of the substation.

The electrical station services shall be in accordance with all the relevant standards, shall satisfy the requirements specified herein and shall be designed to operate in the environmental conditions specified in the relevant sections of this Specification.

The electrical station systems shall be required to provide the voltage classes indicated in Table 1.1. for operation of various plant equipment operating mechanisms, plants, control and communication systems

Nominal Voltage V	Tolerance	Frequency Hz or DC	Phases	Wires	Neutral Connection
430	±10%	50±5%	3	4	Solidly earthed
240	±10%	50±5%	1	2	Solidly earthed
220	187V to 242V	DC	DC	2	Isolated 2 wires
50	±10%	DC	DC	2	+ve earthed

**Table 1.1. Voltage classes**

The auxiliaries shall be capable of withstanding all over frequency and undervoltage conditions without loss of supply to the power circuits or shutdown of any auxiliary system meeting the essential loads of the substation plant and equipment.

### **Configuration**

The basic design of the substation electrical auxiliary services shall be as shown in the schematic drawing. This drawing is for guidance only and the Contractor may propose an alternative keeping in view the design philosophy stipulated in this section of the Specification. The design philosophy for auxiliary supply systems shall be as follows:

- a) The AC supply for station auxiliary systems shall generally be obtained from a single source from the local distribution network having a track record of good power availability. For 400/220kV substations two separate sources shall be used.
- b) Where 11kV or 33kV busbars are available at the substation site station auxiliary transformers shall be installed to provide reliable auxiliary power supplies. At least two auxiliary transformers of a rating sufficient to feed the substation load shall be installed. Where specified, in order to meet the station essential loads a back-up supply from a standby diesel generator set shall be provided. The requirement of diesel generator sets have been indicated in the bill of quantity of relevant schedules.
- c) The Contractor shall estimate loads of the substation and determine the required capacity of station auxiliary transformers and diesel generator set and submit same for the approval of the Project Manager. The contractor shall classify the loads based on the principles defined in the following clauses.

### **Load Classes**

#### **Essential loads**

These are loads whose failure will affect the capability of the station and station plant and equipment. These loads shall include cooling and other auxiliaries of transformers and reactors, non-interruptible power units, auxiliaries of reactive power compensator, and station services of the relays in the substation.

#### **Emergency loads**

These are loads that must remain in service during complete loss of the ac power supply. These loads shall include the station battery chargers, disconnecting switch and circuit breaker operating mechanisms, control room air-conditioning and the emergency lighting of the switchyard and control building. Some emergency loads operate on ac voltage and the others on dc voltage.

#### **Normal loads**

These loads, whose failure does not affect capability, shall include but not be limited to control building and switchyard lighting, control building air-conditioning except in control room, air compressors, normal and fire-fighting water pumps, oil treatment loads, etc.

### **Basic design criteria**

The failure or the disconnection for maintenance of any motor, feeder, motor control centre, or 415V power centre or auxiliary transformer shall not affect the power transmission capability of the substation.

To achieve the above criteria, the following facilities shall be incorporated, by the Contractor, in the design of the auxiliary systems :

1. Highly reliable duplicate primary supply sources, with automatic change-over facilities.
2. Duplicate essential loads (e.g. cooling pumps, fans, heat exchangers, etc.). Duplicated loads shall be supplied from two different 430VAC distribution boards (ACDB). Essential loads which are not duplicated shall have duplicated supply circuits with the source having auto change over facility.
3. Provision of a diesel generator set for the essential loads. The generator shall start up automatically, in case of loss of all normal and stand by supplies, to feed the essential loads and emergency loads.
4. In order to limit fault currents, to prevent back feed into the AC bus, and to ensure independence of supply sources, parallel operation between station service transformers shall not be permitted at any voltage level. Also parallel operation shall not be permitted between transformers and diesel generator.
5. System shall be clear and simple to operate to minimise the risk of loss of supply due to human error.
6. The Contractor shall design the LV distribution system to ensure that the voltage supply limits are maintained at all times and that the switchboards and cabling are never overloaded. On larger stations it may be necessary to supply more than one main LVAC switchboard.

### **415V AC distribution system**

#### **General**

The 430V secondary distribution system shall comprise 430V power centres serving the different classes of loads either directly or through motor control centres.

Each power centre shall consist of two sections, supplied through two station service transformers of adequate capacity. Each transformer and each section of the 430V power centre shall be designed to carry the total load of both sections. The two sections shall be interconnected through normally open bus tie breakers and normally closed fuse disconnects. An automatic transfer scheme shall be incorporated within each power centre. This transfer scheme shall automatically disconnect the voltage deficient bus and then re-energise it from the healthy bus.

Restoration of normal supply conditions shall automatically return the power centre to the normal operating mode. The 430V power centres shall be of the metal enclosed switchgear type according to the relevant IEC or Indian Standards.

#### **AC distribution board.**

The ACDBs shall be in accordance with the relevant IEC or Indian Standards and shall also comply with the following requirements:

- The MCC shall be located near the supplied loads or inside the control room at a suitable place.
- The circuit breakers of the MCC shall be individually interlocked to prevent paralleling of two different power centre buses.
- The 240V loads shall be supplied by 240V panels located in the MCC or outside the MCC where it is required.

### **Supply of essential loads**

Essential loads shall be fed from ACDB-1 and ACDB-2 respectively. A diesel generator set shall be connected as indicated in schematic drawing so as to meet the complete requirement of the essential loads of the substations. ACDBs shall be independently fed from two different sections of the main distribution board.

### **Supply of emergency loads**

The emergency loads shall also be supplied from essential bus ACDB-1, ACDB-2, 220V DCDB-1 and 220V DCDB-2, and 50V DCDB-1 and DCDB-2 as shown in the schematic drawing.. These loads shall be supplied from the two different buses under duplicate supply philosophy. Switchyard bay kiosks shall be fed from the two different buses alternatively and interconnected locally with auto changeover switches. Power supply to equipment operating Mechanisms shall be fed from the respective bay kiosks.

### **Supply of normal loads**

Normal loads shall be fed through motor control centres connected with two cables to two different sections of the 415V power distribution centres. A manual change-over switch shall be installed in each MCC, so that the supply is not lost in case of maintenance of one section of the 415V power centre or for a fault. These MCC shall also supply the lighting and small single-phase loads through 240V lighting or distribution panels, located in the MCC and all over the substation.

Some loads, such as switchyard lighting and air-conditioning of the control buildings, normal and fire-fighting water pumps, shall be supplied by duplicate feeders so as not to interrupt working in case of maintenance of one of the sections of the power centre.

For oil treatment and welding, special service outlets shall be provided in local 415V motor control or distribution centres.

## **2.0 LVAC supplies and equipment**

### **General**

Switchboards shall be of the free standing design, suitable for mounting directly above the cable trenches laid inside the control room. Cable trench walls shall be flush with the control room floor. Switchboards shall be suitable for terminating all incoming and outgoing cables and will normally be of the bottom rear entry type, generally in accordance with IEC 947 and 439 and of metal clad design arranged for drawout isolation. Switchboards shall be equipped with circuit breakers and moulded case or miniature circuit breakers. The use of fuse switches will not be permitted.

### **LVAC scheme**

#### **General requirement**

The 415V incoming supplies shall be derived from the station auxiliary transformers or in the case of a loss of supplies, from the standby diesel generator where ever applicable. The two incoming supplies shall be interlocked to ensure that only one of the two circuit breakers can be closed at any one time. Where a bus section circuit breaker is provided it shall also be suitably interlocked to prevent the station auxiliary transformer from being backfed.

#### **Main distribution board**

The two sections of the main distribution board shall be supplied from separate station auxiliary transformers. The two sections shall have automatic change over facilities in the event of failure of supply from one source. Each section of the board shall feed the following panels:

- Main lighting distribution board
- Fire fighting pump house.
- AC and ventilation plant

- Maintenance equipment and oil treatment plant supplies.

### **AC distribution board**

This shall comprise two sections each of which shall be supplied through different cables from both sections of the main distribution board. Each sections shall be equipped with a back up feed from the standby diesel generator set with automatic change-over facility to generator in the event of loss of supply from the main distribution board.

The AC distribution board shall supply the following loads:

- Control room supply for panels, computers, etc..
- One section of the 220V battery charger / rectifier.
- One section of the 50V battery charger / rectifier .
- 50% of switchyard bay marshalling kiosks.
- Emergency AC lighting system.
- Transformers and reactors (cooling devices and OLTC panels)
- Fire water and civic water pumps
- Spare feeders for future use.

### **Main lighting distribution board**

The main lighting distribution board shall receive incoming supplies from the two sections of the main distribution board as well as a supply from the diesel generator set. This board shall be further connected to lighting panels through a lighting sub-distribution panel. The panel supplying emergency lighting load and the income from the diesel generator shall be equipped to switch on in the event of failure of supply from the primary source.

## **3.0 Construction**

### **Panels**

For indoor applications the switchboards shall be of the cubicle pattern, each circuit being self contained within its own cubicle (compartmentalised type). An access door shall be provided for each cubicle such that access can only be obtained to individual circuits. Circuits shall be segregated one from the other by earthed metal. For outdoor installation they shall be of multi-box construction.

Sheet steel for fabrication of the panels shall be a minimum of 2 mm thick cold rolled grain oriented sheet steel or 2.5 mm hot rolled sheet steel.

All panel edges and cover/door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.

### **Switchboard**

Switchboards shall be vermin proof and suitable for use in a tropical climate. All ventilating louvers shall be covered with a fine mesh from inside.

All switchboards shall be provided with a degree of protection of IP 52 as per IEC 947 or equivalent Indian standard. Provision shall be made in all compartments for providing IP 52 degree of protection, when circuit breaker or module trolley, has been removed.

Switchboards shall be of uniform height and shall not exceeding 2450 mm.

Switchboards shall be easily extendible on both sides, by the addition of the vertical sections after removing the end covers.

All switchboards shall be divided into distinct vertical sections, each comprising:

1. A completely enclosed busbar compartment for horizontal and vertical busbars. Busbar chamber shall be completely enclosed with metallic partitions. Bolted covers shall be

provided for access to horizontal and vertical busbars and all joints for repair and maintenance. Access shall be possible without disturbing feeder compartment.

2. Completely enclosed switchgear compartment(s), one for each circuit for housing circuit breaker or motor starter.

3. A compartment or alley for power and control cables. Cable alley door shall preferably be hinged. Cable alley shall have no exposed live parts, and shall have no communication with busbar chamber.

4. A compartment for relays and other control devices associated with a circuit breaker.

All access doors shall be provided with facilities for locking in the closed position. It shall be possible to move each circuit breaker or MCCB to the disconnected position without the need to open the cubicle access door. Attempted disconnection of a circuit breaker or MCCB when in the closed position shall not result in tripping of the particular equipment.

#### **4.0 Cubicle**

Cubicles may be arranged vertically in tiers, the number being limited only by the need to ensure that circuits are thermally independent.

It shall be possible to work within each cubicle with the equipment withdrawn whilst the incoming contacts are energised. The minimum requirements for protection shall be:

- Insulating barriers installed between phases within the cubicle.
- An insulating cover to be affixed over the protruding feeder and busbar connections when the equipment is withdrawn.

Where this is not available, protection shall be provided by automatically operated shutters. It shall be possible to open the shutters intentionally, against spring pressure for testing purpose.

Each phase of the down dropper connections from the busbars to the equipment isolating contacts shall be separated from the incoming or outgoing connections and from the other phases by barriers.

Cubicles shall be suitable for terminating all necessary cabling whether of copper or aluminium conductor design. It shall be possible to terminate any cable whilst adjacent circuits are energised.

#### **5.0 Busbar and other equipment housing**

All incoming connections, busbars and feeder connections up to the particular MCCB shall be capable of the short time current rating specified, but connections beyond the MCCB need only be matched to the MCCB characteristic.

The overall height of each tier of cubicles shall be such that the operating handles of all equipment are within the reach of a person standing at ground level. Control switches as specified shall be fitted and suitably labelled to indicate their function.

The equipment shall be complete with cable boxes and glands suitable for XLPE or PVC insulated cables.

The switchboard shall be provided with 240V single phase ac illumination and anti-condensation space heaters and each heater shall be provided with an ON/OFF switch.

Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. Each shipping section shall have full metal sheets at both ends for transport and storage.

All equipment associated with a single circuit shall be housed in a separate compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides with the withdrawable units in position or removed. The front of the compartment shall be provided with a hinged single leaf door complete with locking facilities. The main switch shall be operable from outside and will be interlocked with the compartment door such that the latter can be opened only when the switch is off. However, it shall be possible to defeat this interlock and open and close the door with the switch ON. The main switch shall have the facility of being pad-locked

in both ON and OFF positions. The switch handle shall clearly indicate the position of main switch.

After isolation of power and control circuit connections it shall be possible to safely carry out maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose over the cable termination located in cable alley. The temperature rise of horizontal and vertical busbars when carrying rated current along its full run shall in no case exceed 55C, with silver plated joints and 40C with all other type of joints over an outside ambient temperature of 50C.

All single front switchboards shall be provided with removable bolted covers at the rear. The covers shall be provided with danger labels.

All identical circuit breakers and module chassis of same test size shall be fully interchangeable without having to carry out modifications.

All 415V switchgear cubicles shall be of single front type, with fully withdrawable circuit breakers, which can be drawn out without having to unscrew any connections. The circuit breakers shall be mounted on rollers and guides for smooth movement between **SERVICE**, **TEST** and **ISOLATED** positions and for withdrawal from the switchboard. Testing of the breaker shall be possible in the **TEST** position.

Wherever two breaker compartments are provided in the same vertical section, insulating barriers and shrouds shall be provided in the rear cable compartment to prevent accidental contact with the live parts of one circuit when working on the other circuit.

All disconnecting contacts for power circuits shall be of robust design and fully self aligning. Fixed and moving contacts of the power drawout contact system shall be silver plated. Both fixed and moving contacts shall be replaceable.

All modules shall be fixed type except circuit breaker and motor feeder modules, which shall be drawout type.

The connections from busbars to the main switch shall be fully insulated/shrouded, and securely bolted. The partition between the feeder compartment and cable alley may be non-metallic and shall be of such construction as to allow cable cores with lugs to be easily inserted in the feeder compartment for termination.

All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. The internal layout of all modules shall be subject to approval of the Project Manager.

All sheet metalwork shall be painted in accordance with the painting clause specified elsewhere in this Specification. The shade of the paint shall be 692 as per IS 5 (smoke grey).

### **Earthing**

It shall be possible to earth all incoming supplies to the switchboard by means of a fully rated earthing device, either by using the circuit breaker with earthing attachments, a separate earthing truck, or a fixed fully rated earth switch.

Busbars and dead end feeders may be earthed by means of a voltage checking device and hand applied portable earth switches. These shall normally be applied from the front of the switchboard.

Earthing of current free metallic parts on the body of the switchboard shall be done with soft drawn bare copper bus. Tail connections shall have a minimum cross sectional area of 16 mm<sup>2</sup> and the main earth bar for the switchboard shall be brought out to two terminals for connection to the station earth grid.

Earthing connections shall be carried out with green wire and the earthing studs shall be identified as such by an earthing symbol.

### **Clearances and insulation level**

Clearances and creepage distances in air shall be those stated in IEC 158 and 947 and be such that the equipment can withstand the dielectric tests specified.

### **Thermal performance of switchboard and equipment**

The complete switchboard shall be capable of carrying rated load current without the temperature rise of any portion exceeding a level of 65C. Parts that may be touched by operating personnel shall not exceed a level of 35C. In determining the load current performance of tiered cubicles it shall be assumed that all circuits are carrying rated current. The cross sectional area of the busbars may be graded according to the current rating, but shall remain capable of the short time current rating stated in the Schedules.

### **Protection co-ordination**

It shall be the responsibility of the Contractor to fully co-ordinate the overload and short circuit tripping of the circuit breakers with the upstream and down stream circuit breakers/fuses/motor starters, to provide satisfactory discrimination.

## **6.0 EQUIPMENT TO BE FURNISHED**

### **General**

The Contractor shall supply all equipment in accordance with this Specification in each of the modules as specified in the following sub clauses.

### **Type Designation /Description of Modules**

Each 415V switchgear and distribution board shall comprise of a number of different type of modules as detailed in the following clauses. The Contractor shall obtain the approval of the Project Manager for the details of the modules to be provided in each of the Boards. The Employer has classified and type designated the modules to be used in the various Boards.

<b>Module type</b>	<b>Application</b>
AE	Electrically controlled circuit breaker for incomer and bus coupler
M1	Circuit breaker controlled motor feeder
M2	MCCB controlled motor feeder
E	
G1	VT module with undervoltage relay
G2	
H and H(BC)	Isolating switch controlled incoming circuit
S	DC metering and protection module
X	
DC	Incomer from battery and charger
DG1	Electrically controlled circuit breaker for incomer from DG set
H1	
EL	
K2	Non reversible motors having star stop control at MCC
AN	Annunciator module

**Table 4.2. 430V switchgear modules and applications**

### **Composition of the Modules**

The following are the preferred composition of various modules along with their Bill of Materials. However the Contractor may suggest alternatives keeping in view the requirement of the specification. Such changes shall be subject to approval of the Project Manager. In addition to the items listed all other items required to provide the necessary functionality as specified in this Specification, shall be deemed to be included in the scope of supply for the module.

### **7.0 (A) Module type AE**

1. Triple pole air circuit breaker (Device No. 52) complete with all accessories and power operated mechanism as specified. 1
2. Neutral link. 2
3. Circuit breaker control switch with spring return to normal. 1

4.	Current transformer for metering.	3
5.	Ammeter	1
6.	Ammeter selector switch.	3
7.	Current transformer for relaying.	3
8.	Triple pole instantaneous over-current relay having the setting range of 200-800% or 500-2000% of CT secondary and adjustable definite minimum time. Alternatively suitable overcurrent releases capable of proper discrimination with all down-stream protection are also acceptable.	1
9.	HRC control fuse.	8
10.	Auxiliary relays	4
11.	Indicating lamps with series resistors and selector lenses (e.g. red, blue, green, white and amber	5
12.	Instantaneous earth fault relay having an adjustable setting range of 10-40% or 20 - 88% of CT secondary current. The earth fault relay shall be provided with a stabilising resistor.	1

### 7.0 (B) Module type M1

1.	Triple pole air circuit breaker complete with accessories, and power operated mechanism as specified.	1
2.	Circuit breaker control switch with spring return to normal.	1
3.	Three position 6 pole selector switch SWITCHGEAR / NORMAL / TRIAL.	1
4.	Current transformer for metering.	3
5.	Ammeter	1
6.	Ammeter selector switch.	1
7.	Current transformer for relaying.	3
8.	Triple pole instantaneous over-current relay for providing positive sequence current protection in all the three phases. The relay setting range shall be continuously adjustable between 200-800% or 400-1600% of CT secondary rated current as require	1
9.	Double pole inverse definite minimum time overcurrent relays connected in R and B phases for over current protection of motor rated 110 kW - 200 kW. The relay shall have an adjustable setting range of 50% - 200% of CT secondary current and time setting range of 0-30 seconds. The relay shall be CDGM-22 (GEC Alsthom) or equivalent.	1
10.	Single pole adjustable definite time delay relay for motor overload alarm connected in Y-phase only. The relay shall have resetting ratio of not less than 90%. The relay shall have continuously adjustable time delay range of 2.5 to 25 seconds.	1
11.	Instantaneous earth fault relay having an adjustable setting range of 10-40% or 20-80% of CT secondary current. The earth fault relay shall be provided with a stabilising resistor.	1
12.	Auxiliary relays	4
13.	Indicating lamps with resistors and coloured lenses suitable for 220V DC.	5
14.	HRC control fuses.	8

### 7.0 (C) Module type M2

- |    |   |   |
|----|---|---|
| 1. | 415V, 250A, P2 duty 20 kA, 50 Hz MCCB having 4 NO and 4 NC Aux. contacts. | 1 |
| 2. | Auxiliary relays  | 1 |
| 3. | Indicating lamps with resistors and coloured lenses suitable for 240V AC. | 3 |

### 7.1 Module type E

- |    |   |   |
|----|---|---|
| 1. | Triple pole load break isolating switch | 1 |
| 2. | Neutral link                            | 1 |
| 3. | HRC fuses                               | 3 |

### 7.2 Module type G1

- |    |  |   |
|----|--|---|
| 1. | ( $415/\sqrt{3}$ )/ ( $110/\sqrt{3}$ ) volts single phase voltage transformer star/star connected with star point solidly earthed mounted on common draw out chassis. Accuracy Class 0.5 for protection and metering with 50VA burden. | 3 |
| 2. | HRC Fuses mounted on the above chassis.  | 6 |
| 3. | Four position voltmeter selector switch.   | 1 |
| 4. | Voltmeter (0-500V)   | 1 |
| 5. | Double pole instantaneous undervoltage relays with continuous variable setting range of 40-80% of 110 Volts.   | 1 |
| 6. | Time delay pick up relay having a time setting range of 0.5 to 3 seconds. With 3 NO self reset contacts, suitable for 220V DC.   | 1 |
| 7. | Auxiliary relay 220V DC with 2 NO. self reset contacts.  | 1 |
| 8. | Indicating lamps with series resistor and colour lenses (Red, blue and yellow).  | 3 |

### 7.3 Module type G2

- |    |  |   |
|----|--|---|
| 1. | HRC Fuse   | 3 |
| 2. | Voltmeter (0-500V)   | 1 |
| 3. | Voltmeter selector switch four position (R-Y, Y-B, B-R OFF). | 1 |
| 4. | Indication lamps (Red, blue and yellow)                      | 3 |

### 7.4 Module type H and H (BC)

- |    |  |   |
|----|--|---|
| 1. | Triple pole load break isolating switch with padlocking facility in OFF position and arrangement to defeat door interlocking | 1 |
| 2. | Neutral link.  | 1 |
| 3. | Red indicating lamp to indicate isolating switch closed position.  | 1 |

### 7.5 Module type S

- |    |  |   |
|----|--|---|
| 1. | Voltmeter 0-300V DC for 220V DC DB   | 1 |
| 2. | Voltmeter 0-75V DC for 50V DCDB.   | 1 |
| 3. | Three (3) position voltmeter selector switch   | 1 |
| 4. | Instantaneous under voltage relay with 95% of 220V DC. The resetting ratio of relay of relay should not be more than 1.25. The relay shall be provided with a series resistor and a push button across if for resetting (pick up) the relay at about 105% of the drop out voltage. | 1 |
| 5. | Instantaneous over voltage relay with setting range of 110% of 220V DC. The resetting ratio of relay should not be less than 0.8. The relay shall have a push button in series capable of resetting  | 1 |

- the relay at about 95% of the operating voltage.
6. Earth leakage relay only for 220V DC system having adjustable pick up range between 3 to 7 milliamps the relay shall be suitable for 220V DC/240V AC Auxiliary supply. 1
  7. Indicating lamp each for fault annunciation and for 220V DC with earth leakage relay mentioned above. 2
  8. HRC control fuses. 2

### 7.6 Module type X

1. Double pole single throw 250V DC air break isolating switch. 1
2. HRC fuses 2

### 7.7 Module type DC (Incomer from battery and chargers)

1. HRC fuses for incomer from battery. 2
2. DC ammeter with shunt and range of 40-0-50 Amps. For 220V DC DB and 60-0-150 Amp for 50V DC DB. 1
3. Double pole single throw 250V DC air break switch. 2
4. HRC fuses for incomer from charger. 2
5. Double pole single throw 250V DC air break switch connecting battery and charger sections to DCDB 1

### 7.8 Module type DG1

1. Triple pole circuit breaker complete with all accessories and power operated mechanism as per the relevant sections of this Specification. 1
2. Frequency meter. 1
3. Voltmeter with selector switch. 1
4. Remote/Local selector switch. 1
5. Circuit breaker control switch with spring return to normal. 1
6. Current transformer for metering. 3
7. Current transformers for differential protection (out of this 3 Nos. will be supplied loose for mounting in DG set panel). 6
8. Current transformer for relaying. 3
9. HRC Control fuses 8
10. Ammeter selector switch. 1
11. Ammeter 1
12. Wattmeter of range 0-300 kW. 1
13. Three pole voltage controlled definite time delay relay having current setting range of 50-200% of CT secondary current and adjustable time delay 0.3 to 3 seconds. 1
14. Watt hour meter with six (6) digits and minimum count of one (1) kWh. 1
15. Single pole definite time over current relay having a continuous setting range of 50-200% of CT secondary current and a time delay of 2.5-25 seconds connected in CT of Y phase for overload alarm. The relay shall have a setting ratio of not less than 90%. 1
16. Three pole differential protection relay having an operating current setting range of 10-40% of generator full load current. The relay shall be of high impedance type, with necessary stabilising 1

	resistors.	
17.	Indicating lamps with resistors and enclosed lenses.	5
18.	Push buttons for remote starting and stopping of diesel generator set (Red and green).	2

### 7.9 Module type H1

1.	Double pole DC switch with pad locking facility in off position.	1
----	--	---

### 7.10 Module type EL

1.	Triple pole and neutral switch	1
2.	HRC fuses	3
3.	Contactor	1
4.	Electronic timer suitable for continuous operation.	2
5.	Control Switch.	2

### 7.11 Module type K1

1.	Triple pole load break isolating switch (device identifier - SW) with neutral link.	1
2.	HRC fuses (device FU) and one control fuse.	3
3.	Triple pole contactor 240V AC rated (device No. 42) with hand reset thermal overload relay (device No. 49) for thermal overload relay for more than 30 kW feeder, connection through suitable current transformers may be taken.	1
4.	Auxiliary relay (device No. 42 X) 240V AC rated with 3 NO and 3 NC self reset contacts.	1
5.	Indicating lamp 240V AC rated red coloured to give motor ON indication.	1
6.	Indication lamp 240V AC rated, green coloured to give motor OFF indication	1
7.	Push button labelled (STOP).	1
8.	Push button labelled `START'	1
9.	Switch fuse unit for space heater supply for motors rated 30 kW and above.	1
10.	Current transformer and an ammeter for all motors rated 50 kW and above.	1

### 7.12 Module type K2 (mounted at motor)

1.	Triple pole load break isolating switch with neutral link.	1
2.	HRC fuses and one (1) Control fuse	3
3.	Triple pole contactor rated for 240V AC	1
4.	Indicating lamp 240V AC rated red/green coloured to give ON/OFF indication.	2
5.	Push button labelled STOP	1
6.	Push button labelled START	1

### 7.13 Module type DG- ( mounted at generator)

1.	Indicating lamps	9
2.	Push buttons	7
3.	DC Ammeter (0-40A)	1
4.	DC Voltmeter (0-30V)	1
5.	Voltmeter selector switch	1
6.	AC ammeter	1
7.	AC voltmeter	1
8.	Timers (24V DC)	3
9.	Auto/Manual selector switch	2
10.	Auto/test/Manual selector switch	2
11.	CT's for metering	3
12.	PS class CT's for differential protection of diesel generator set	3
13.	Auxiliary contactors suitable for 24V DC	11
14.	Motorised potentiometer for voltage adjustment	1
15.	Battery charger as per clause no <b>Error! Reference source not found.</b> of this section	1
16.	HRC control fuses	12
17.	Set of phase and neutral busbars.	1

#### **Module type AN (Annunciation module)**

Where an integrated PC based system is not provided at the substation a central alarm annunciator shall be provided for the auxiliary power systems. The annunciation system shall consist of 30 annunciator units each having an engraved translucent plastic window of 35 mm x 50 mm (minimum) size. Engraving shall be black letters and indicate the alarm function. Annunciators shall be suitable for operation on 220V DC and shall have a single common audible alarm.

Push buttons with appropriate nameplates shall be provided for audible alarm acknowledge, alarm reset and lamp test. The push buttons shall be common to all alarm points. Annunciators shall be suitable for operation with both normally open and normally closed alarm contacts. Annunciation system shall be solid state type of reputed make.

On receiving any alarm pulse, including fleeting pulses, the appropriate alarm relay shall pick up energising the corresponding visible and audible alarm units. It shall be possible for the operator to reset the audible alarm even if the alarm condition persists. However, visible alarm shall not reset unless the alarm condition has disappeared and the reset push button is operated. Annunciator shall provide sealed in lamp indication and audible alarm shall be ready to operate for any new alarm condition immediately after the alarm is reset push button. Annunciator shall operate satisfactorily between 80% and 110% of rated supply voltage.

#### **Module equipment and instrumentation.**

Circuit breakers, MCCB $\phi$ s, MCB $\phi$ s, selector switches, instrumentation, relays and protection equipment for LV supplies etc. shall generally conform to the requirement of the stipulated under relevant sections of this Specification.

### **7.14 TECHNICAL SPECIFICATION FOR INDOOR TYPE 415/240 V.A.C POWER DISTRIBUTION SWITCH BOARDS.**

#### **7.14.1 SCOPE**

The specification covers manufacture, assembly and testing at manufacturer's Works, supply and delivery at site of Indoor and out door type 415/240 volts A.C. power distribution switch-boards, A.C consoles, Bay Marshalling Kiosk, Receptacle panels complete in all respects as per system requirement for S/S and switchyards 20% spare feeders shall be provided in each Distribution Boards.

#### **7.14.2 STANDARDS**

The equipment covered by this specification shall unless otherwise specified be built to conform to Indian Electricity Rule 2956 wherever applicable and shall satisfy the requirements of the latest Indian Standard. Permissible temperature rise shall be as per relevant ISS.

#### **7.14.3 SWITCH BOARD DESIGN**

The switch board shall be self supporting, steel cubicle, compartmentalized, fully enclosed with doors for access to the interior. The switch boards shall comprise a non/draw out type panels placed side by side to form a continuous unit with access door for each panel at the rear 3 mm sheet shall be used for fabrication of the panels. Modular type construction for interchangeability will be preferred.

The complete panels shall not be more than 2450 mm. high with the channel base and 500 mm. depth measured from rear to front faces and of suitable width. The working height shall be limited to maximum 2200 mm. The design shall be such as to permit extension at site on either end. The bottom of the switch board frame shall be suitable for erecting flush on concrete floor by securing it by means of evenly spaced grouting bolts projecting through the base channels. The panels shall be designed to facilitate cable entry from the bottom and removable plates shall be supplied along with the panels for this purpose which will be drilled at site to fit the cable glands.

The switchboard shall be vermin proof and suitable for use in tropical climate. All ventilating louvers and holes shall be covered with fine wire mesh from inside (for indoor use). All control and power cables will be laid in open distribution trenches running under the A.C. switchboards. The cable will enter the cubicles through entry holes of removable plates provided at the bottom of the cubicles. The cable entry holes required and the position of the foundation bolts.

The switchboards shall be supplied complete with channel base, removable bottom plates grouting bolts, lock nuts, washer, etc. and cable glands as specified hereafter. All unfinished surfaces of the steel panels and frame work shall be free from adhesive matter or greases. A suitable rust resisting primer paint shall be applied on the interior and exterior surface of the steel housing allowed by application of an undercoat to serve as base and binder for the finishing coat. The finishing coat on the exterior of the switchboards shall be polished cellulose enamel or dark batter ship grey, evenly sprayed to present a fine appearance while the interior faces shall be sprayed with a finishing coat of light grey paint to provide contrasting background for the wiring inside the cubicle. The internal illumination for working should be of adequate intensity CFL lamps.

A small quantity of finishing paint shall be supplied with the consignment of the Switchboards to enable the employer to restore at site any surface finish which may get damaged during transit.

#### **7.14.4 BUS BARS**

The bus bars shall be of E.G. copper/aluminum alloy, liberally sized for the specific current ratings (both short circuit and continuous currents). The size of the bus bars shall be such that the current density is not more than 1A/1.75 A per sq.mm. for aluminum alloy and copper respectively at rated capacity. Necessary precaution shall be taken to avoid bimetallic action where copper conductors shall be connected to the aluminum bus. Means shall be provided for identifying various phases of bus bars. Bus support shall be of arc resistant, non-tracking, low absorption type insulators of high impact strength and high creepage surface. Buses shall be spaced with adequate clearance between phases and phases to ground.

The bus and connections shall be so supported as to be capable of safety withstanding stresses due to maximum short circuit current and also take care of any thermal expansion.

The droppers/riser from or to the bus bars should not be twisted but reasonable bend or joint may be allowed. The bidder shall submit necessary calculations about the adequacy of selected bus support insulator cantilever strength w.r to short circuit forces.

#### **7.14.5 AIR CIRCUIT BREAKER FOR INCOMER**

A.C. air circuit breaker shall be triple pole, non-draw out type, suitable for 1100 volts grade/650 volts grade service, having continuous current carrying capacity of 400 Amps with breaking capacity of 20 KA at 415 volts. The breaker shall be provided with trip free manually operated mechanism and a push button to trip the breaker electrically.

The breaker shall be provided with mechanical OFF/ON indicators.

The breaker shall be provided with sets of auxiliary contacts for OFF/On indicating lamps, trip circuit and inter-locking circuit along with two sets of spare contacts. The door of the circuit breaker compartment shall be so interlocked that :

- i) The door cannot be opened whilst the breaker is in closed position (i.e. ON)
- ii) When the door is opened, the breaker shall be locked so that it can not be closed (i.e. it cannot be made ON). The circuit breaker shall comply with the relevant I.S.S.

The breaker shall be complete with cable glands suitable for entry of 3 x 400 sq.mm. 1100 V/650 V grade aluminum cables.

One number 195 sq.mm. aluminum cable of same voltage grade as above shall be used for neutral, and cable gland suitable for entry of this cable shall also be provided in the switchboard. Thermal overload relay range shall be 100 Amps to 200 Amps calibrated at 55%, 75%, 100% of the height setting and suitable time settings.

Drop out and pick up voltage of the under-voltage release shall be 60% and 80% respectively of the rated voltage.

For incoming circuit 1 no. ACB( as per requirement, it differs from sub-station to sub-station) of suitable capacity according to the system should be design and furnished provided in the panel. The details of main ACDB is as below.

1) Station Transformer capacity: 33/0.433 KV, 250 KVA . Each substation there will be two nos station transformer, hence in Main ACDB there will be two incomer i.e., as source I and source II. There will be a bus coupler in main ACDB for extending the supply as and when required.

All outgoing feeders shall be provided with MCCB & SFU of suitable capacity according to the systems are to be provided.

#### **7.14.6 INDICATING LAMPS**

Indicating lamps shall be LED type provided with suitable safety resistor, and coloured dust-tight lens. Lamps shall be of very low wattage consumption and heat generated due to continuous burning shall not deteriorate lamp cover. The lamp holders shall preferably be screwed type.

#### **7.14.7 SPACE HEATERS**

The A.C. switchboards shall be provided with space heaters rated for 240 volts single phase A.C. Each heater shall be provided with ON/OFF switch. The wattage of the heater shall be such as to keep 10 deg. C. above the ambient temperature during rainy season but the temperature shall not damage the wiring.

#### **7.14.8 CABLE TERMINATION**

Switchboards shall be designed to facilitate PVC cable entry from the bottom of the switchboards. Removal plates shall be supplied for this purpose which will be drilled at site to fit the cable glands.

Sufficient space shall be provided to avoid sharp bending and for easy connection.

Cables shall be PVC insulated, armored and PVC sheathed with 7/0.029ö copper conductor for control and Aluminum for cables feeder up to 15 Amp. Rating. Rest of the power cable shall be of aluminum conductor of suitable size as per feeder rating.

Multiway terminal blocks of sturdy construction complete with terminating the internal wiring and outgoing cables.

Power terminals shall be complete with lugs and control terminals shall be clamp type. Screw type terminals with screw directly impinging on conductor shall not be supplied.

Each terminal for 15 Amps. Feeders shall be capable for connection of 2 Nos. 7/0.0296 copper wires at one end without any damage to the connector or any looseness of connection.

The terminal shall be properly tagged and ferruled in compliance with approved drawings. The terminal blocks shall be readily accessible and those shall be rust proof and of best quality. Terminal block connector built from cells of moulded dielectric and brass-stud inserts shall be provided. The connection stud shall project at least 6 mm. from the lock nut surface. All blocks shall be shrouded of easily removable shrouds moulded of transparent dielectric material of non-breakable type.

#### **7.14.9 WIRING**

The wiring shall be complete in all respect so as to ensure proper functioning of control, protection and inter-locking schemes.

All wiring shall be complete up to the terminal blocks at the factory.

Control wiring shall be carried out with flexible, heat resistant, switchboard wires. PVC insulated with 2.5 sq.mm. stranded copper conductors. Each wire shall be identified at both ends with wire destinations numbered ferrules in accordance with bidder's wiring diagram.

Wires shall not be spliced or tapped between terminal points. Each wire shall be continuous and there shall not be any joint within itself. Individual wire shall be connected only at the connection terminal, blocks, meters, relays, instruments, and other devices used in the switchboards. Red, Yellow, Blue and Black ferrules shall be used for Red, Yellow, Blue phases and Neutral respectively.

Wires shall be neatly bunched and adequately supported so as to prevent sagging and strain on termination.

All spare contacts of the equipment shall be wired up to the terminal block. The wiring shall be of 1.1 KV grade. At least 20% spare terminals shall be provided.

7.14.91 Terminal connection shall be such that the conductors. LM10 may be connected by means of screw or other equivalent means so as to ensure that the necessary contact pressure is maintained permanently.

7.14.9.2 Terminal shall be such that they cannot turn or be LM10 displaced when the connecting screws are tightened and such that the conductor can also not become displaced.

7.14.9.3 Terminals should be so mounted that the appropriate wire may be connected without impairing the normal performance of the unit.

#### **7.14.10 SAFETY EARTHING**

Earthing of current free metallic parts of metallic bodies of the equipment on the switchboard shall be done with soft drawn bare copper bus. Tail connections shall have minimum area of 16 sq. mm. and the main earth connection for earth switchboard shall be brought out of two terminals for connection with the station earthing system.

7.14.10.1 Earthing terminals should be identified by means of the sign marked on a legible and indelible manner on or adjacent to the terminals.

Earthing lugs shall be provided and all earthing connections shall be carried out with green wires.

#### **7.14.10 SWITCHBOARD LIGHTING**

The switchboard illumination by providing CFL lamps and space heating arrangement to be provided.

#### **7.14.11 INDICATING INSTRUMENT & ENERGY METERS**

All instruments shall be switchboard type, back-connected, suitable for flush mounting. The construction shall conform to appropriate Indian Standard Specifications. The

instruments shall be capable of indicating freely without error when operated continuously at any ambient temperature from 0 deg. to 50 deg. C. They shall withstand the effects of shock, vibration and humidity. All circuits of instruments shall be capable of withstanding 20% overload for a period of at least 8 hours. All instruments shall be provided with suitable means of adjusting the accuracy in a laboratory. KWH meters specified shall be of commercial grade accuracy. Ammeter and voltmeter shall be with accuracy of +/- 1% of full scale value.

#### **7.14.12 RELAYS**

The relays shall be suitable for operation within a temperature range of 0 deg. c to 50 deg. C. The contacts of the relays shall be silvered. When open, the contacts shall withstand a voltage of 110% of the normal circuit voltage of the contacts. The relays shall not deteriorate in performance due to ageing of any constituent material. The relays shall generally comply with the requirements of I.S.S. 3842.

#### **7.14.13 A.C. DISTRIBUTION BOARD SCHEME**

Power will be fed to A.C. distribution board through 2 Nos. incoming breakers separately from one no. 250 KVA station service transformer. Normally two feeders will feed power to two sections of A.C.D.B. coupled through a bus coupler breaker. Normally this coupler breaker will be kept upon when both the incomers are kept on. In case of failure of any one of the incomer, this bus-coupler will be made ON. These two incomers breakers and the bus coupler will be interlocked through castle interlock so that any two of the three breakers can be kept on at a time, Suitable scheme for electrical interlock and automatic switching on of the bus-coupler in the event of tripping of any of the healthy incomer is to be taken up by the bidder. Suitable annunciation for failure of A.C supply and for any of the incomer is to be provided.

A 415 V single line diagram accommodating the above facilities and to suit the system is to be design and submitted to the Employer for approval. However, exact requirement layout is to be taken up by the contractor depending on the layout, rating and type of equipment for preparation of drawing.

#### **7.14.14 PROTECTION SCHEME FOR INCOMING CIRCUIT BREAKER**

Each incoming circuit to the L.T. switchboard shall be preceded by thermal overload relays, short circuit release and over current and earth fault relays. The breaker shall also be provided with under-voltage release of tripping out in case of supply failure. 220/240 volts D.C. operated audible as well as visible alarm with cancellation device shall be provided for the auto trip of the breakers.

#### **7.14.15 CURRENT TRANSFORMERS**

The current transformer to be provided with the incoming/outgoing circuit for metering shall be air-cooled of class -CM $\emptyset$  accuracy. The VA burden should be such as to suit the requirements. C.Ts shall be bar primary type moulded/cast resin type. The current transformer shall be manufactured and tested according to relevant I.S.S.

#### **7.14.16 INSULATION LEVEL**

The insulation at any point of the wiring in switchboards shall be suitable for 1100/660 volts grade service. TEST  $\delta$  TYPE TEST REPORT shall be furnished.

### **7.15 DC supply equipment**

#### **General scheme**

At 400kV and 220kV substations, each DC supply system (50V and 220V dc) shall comprise duplicate batteries and battery chargers, a dc distribution board and control gear. The system shall be arranged such that only one of the station batteries and one of the battery chargers shall

be in service at any one time, but should either item of equipment fail or need to be taken out of service for maintenance, then the duplicate item of equipment can be brought into service without disruption of supplies. Battery chargers shall be provided with an automatic change-over facility that will operate should one of the charger units fail.

At 132kV substations, each DC supply system shall be provided with one battery and one battery charger, dc distribution board and control gear for 220V DC. However the 50V DC system shall be duplicated as in case of 400/220kV substation.

Each battery shall be either of the lead acid or alkaline type and comprise a sufficient number of cells to provide the required rating. The battery charger shall be capable of float charging the battery, from the AC supply voltage specified. A facility shall be provided for boost charging individual battery cells in situ, by means of wander leads.

The batteries shall be located in a battery room and connected to the distribution boards and battery charger located in an adjacent room via a fuse box located in the battery room.

Where the battery size is less than 200 Ah, and the cells are of the totally enclosed type, consideration will be given to housing the battery in a sheet steel cubicle mounted alongside the charger and distribution board so as to form a complete suite of panels.

The 220V DC power supplies system will operate with both battery terminals free of earth whilst that for communications equipment ( the 50V DC power supply ) will operate with the positive pole permanently earthed. A suitable earth fault detection scheme shall be provided. The battery rated output shall be that available at the outgoing terminals, after making due allowance for the resistance of inter cell connections.

The battery size selected by the Contractor shall be proved by calculation which shall be subject to the approval of the Project Manager. Allowance shall be made for ageing of the battery during its service life.

Earthing of current free metallic parts on the body of the distribution boards shall be done with soft drawn bare copper bus. Tail connections shall have a minimum cross sectional area of 16 mm<sup>2</sup> and the main earth bar for the distribution shall be brought out to two terminals for connection to the station earth grid.

Earthing connections shall be carried out with green wire and the earthing studs shall be identified as such by an earthing symbol.

The distribution board shall be provided with 240V single phase ac illumination and anti-condensation space heaters and each heater shall be provided with an ON/OFF switch.

### **7.15.1 TECHNICAL SPECIFICATION FOR INDOOR TYPE 220 VOLT D.C. SYSTEM POWER DISTRIBUTION SWITCH BOARDS**

#### **7.15.2 SCOPE**

This specification covers manufacture, assembly and testing at manufacturer's works, supply and delivery of Indoor Type 230 volts D.C. Power Distribution on Switchboards complete in all respects as per system requirement for 220/132/33 KV substation and switchyards. 20% spare feeders shall be provided in each DCDB.

#### **7.15.3 STANDARDS**

The equipment covered by this specification shall unless otherwise specified, be built to conform to Indian Electricity Rules 1956 wherever applicable. Permissible temperature rise shall be as per relevant ISS.

##### **Switchboard Design**

The switchboards shall be self supporting steel cubicle compartmentalized fully enclosed with doors for access to the interior. The switchboards shall comprise of non/draw out type panels placed side by side to form a continuous unit with access door for each panel at the rear. 12 SWG sheet shall be used for fabrication of the panels. Modular type construction for interchangeability will be preferred. The complete panels shall not be more than 2250 mm. high with me channel base and 600 mm. depth measured from rear to front faces and of suitable width.

The working height shall be limited to maximum of 2000 mm. The design shall be such as to permit extension at site on either end. The bottom of the switchboard frame shall be suitable for erecting flush on concrete floor by securing it by means of evenly spaced grouting bolts projecting through the base channels. The panels shall be designed to facilitate cable entry from the bottom and removable plants shall be supplied along with the panels for this purpose which will be drilled at site to fit the cable glands.

The switchboards shall be vermin proof and suitable for use in tropical climate. All ventilating louvers and oleos shall be covered with fine wire-mesh from inside or inbuilt type. All control and power cables will be laid in open distribution trenches running under the D.C. Switchboards. The cable will enter the cubicles through entry holes of removable plates provided at the bottom of the cubicles. The successful bidder shall furnish foundation drawings for the switchboards showing the cable entry holes required and the position of the foundation bolts.

The switchboards shall be supplied complete with channel base, removable bottom plates, grounding bolts, lock nuts, washers, etc. and cable glands as specified hereafter. All unfinished surfaces of the steel panels and frame work shall be free from adhering matter or grease. A suitable rust resisting primer paint shall be applied on the interior and exterior surface of the steel housing followed by application of an undercoat to serve as base and binder. The finishing coat on the exterior of the switchboards shall be polished cellulose enamel, or dark battleship grey, evenly sprayed to present a fine appearance, while the interior faces shall be approved with a finishing coat of light grey paint to provide a contrasting background for the wiring inside the cubicle.

A small quantity of finishing paint shall be supplied with each consignment or the switchboards to enable the Employer to restore at site any surface finish which may get damaged during transit.

#### **7.15.4 BUS BARS**

The bus bar shall be of E.G. copper/aluminum alloy, liberally sized for the specified current rating (both short circuit and continuous currents). The size of bus bars shall be such that the current density is not more than (1A/1.75A) per sq. mm. for aluminum alloy and copper respectively at rated capacity. Necessary precaution shall be taken to avoid bimetallic action where copper conductors shall be connected to the aluminum bus. Means shall be provided for identifying the positive and negative bus bars. Bus supports shall be of arc resistant, non-tracking, low absorption type insulators of high impact strength and high creep age surface.

The bus and connections shall be so supported as to be capable of safety withstanding stresses due to maximum short circuit current and also take care of any thermal expansion.

The droppers/risers from or to the bus bars should not be twisted but reasonable bend or joint may be allowed.

#### **7.15.5 MCCB/MCB**

All incomer feeders will be provided with DC MCCB and all outgoing feeders with DC MCB conforming to latest IS : standards as per system requirements.

#### **7.15.6 FUSE**

Fuses shall be HRC link type of renowned make conforming to latest issue of ISS 2208. Rewirable fuses shall not be supplied.

Fuse shall be complete with fuse bases and fittings of such design as to permit easy replacement of the fuse elements.

Link shall also be easily replaceable. Visible indication shall be provided on blowing of the fuse.

#### **7.15.7 INDICATING LAMPS**

Indicating lamps shall be LED type provided with suitable safety resistor and coloured dust-tight lens. Lamps shall be of very low wattage consumption and heat generated due to continuous burning shall not deteriorate lamp cover.

#### **7.15.8 CABLE TERMINATION**

Switch boards shall be designed to facilitate PVC cable entry from the bottom of the switchboard. Removable places shall be supplied for this purpose which will be drilled at site to fit the cable glands.

Sufficient space shall be provided to avoid sharp bending and for easy connection. Cables shall be PVC insulated, armored and PVC sheathed with 7/0.029ø copper conductor for control and for feeders up to 15 Amps. Rating. Rest of the power cable shall be of aluminum conductor of suitable size as per feeder rating.

Multiway terminal blocks of sturdy construction complete with screws, nuts. Washers and marking strips shall be furnished for terminating the internal wiring and outgoing cables.

Power terminal shall be complete with lugs and control terminals shall be clamp type. Screw type terminals with screw directly impinging on conductor shall not be supplied. Connectors built from cells of moulded dielectric and brass stud inserts shall be provided for terminating the internal wiring and outgoing cables.

Each terminal for 25 Amps. Feeders shall be capable for connection of 2 Nos. 7/0.029ø copper wires at one end without any damage to the connector or any looseness of connection. The terminals shall be properly tagged and ferruled in compliance with approved drawings. The terminal blocks shall be readily accessible and those shall be rust proof and of best quality.

#### **7.15.9 WIRING**

The wiring shall be complete in all respect so as to ensure proper functioning of control, protection and interlocking scheme.

All wiring shall be complete up to the terminal blocks at the factory. The insulation grade of wire to be used for internal wiring if the switch board shall be 1100 volts grade. Wiring shall be carried out with flexible heat resistant, switchboard wires PVC insulated with 2.5 sq.mm. stranded copper conductors.

Earth wire shall be identified at both ends with ferrules showing wire designations in accordance with bidder's wiring diagram. Wires shall not be spliced or tapped between terminal points.

Each wire shall be continuous and there shall not be any joint within itself. Individual wire shall be connected only at the connection terminals, blocks, meters, relays, instruments and other devices used in the switchboards. Red ferrules with positive marking shall be used for positive terminals and white ferrule with negative marking shall be used for negative terminals for D.C. wiring.

Wires shall be neatly bunched and adequately supported so as to prevent sagging and strain on termination. All spare contacts of the equipment shall be wired up to the terminal block.

#### **7.15.10 SAFETY EARTHING**

Earthing of current free metallic parts of metallic bodies of the equipment on the switchboards shall be done with soft drawn bare copper bus. Tail connections shall have minimum area of 26 sq. mm. and the main earth connection for each switchboards shall be brought out to two terminals for connection with the station earthing system.

Earth terminals should be identified by means of the sign marked in a legible and indelible manner on or adjacent to the terminals. Earth lugs shall be provided and all earthing connections shall be carried out with green wires.

#### **7.15.11 SWITCH BOARD LIGHTING**

The interior of each panel switchboard shall be illuminated by CFL lamps connected to 230 volts. Single phase A.C. supply and shall be controlled by a door-operated switch. All A.C. wiring shall be carried out with black wires. The incoming A.C. supply to the D.C. boards shall be provided with H.R.C. fuse and link of proper rating.

#### **7.14.17 INDICATING INSTRUMENTS**

All instruments shall be of switchboard type, back-connected suitable for flush mounting. The construction shall conform to the appropriate Indian Standard Specifications. The instruments shall be capable of indicating freely without error when operated continuously at any ambient temperature from 0 deg. C to 50 deg. C. Those shall withstand the effects of shock, vibration and humidity. All circuits of instruments shall be capable of withstanding 20% overload for a period of at least 8 hours.

#### **7.15.13 COMPLETENESS OF SUPPLY**

The switchboards offered by the bidder shall be complete in all respects. Any materials necessary which may not have been specifically mentioned but which is usual or necessary for satisfactory and trouble-free operation and maintenance of the switchboards shall be supplied without any extra charge to the employer.

#### **7.15.14 SPARES**

The item wise price for the spares recommended for three years operation and maintenance of each switchboard shall be quoted.

#### **7.15.15 INTER CHANGEABILITY**

All similar materials and removable parts shall be interchangeable with each other.

All switches, contactors, etc. shall be easily removable as a complete unit from the switchboards and shall be capable of being put in similar position in other switchboards for performing identical functions.

The spares called for in respective sections shall be identical with like parts provided in the main equipments in all respects and shall be capable of replacing the main equipments wherever required to carry out identical functions.

#### **7.15.16 ACCEPTABILITY OF DIFFERENT EQUIPMENTS & AUXILIARIES**

All equipments, cables, wires and accessories offered shall be of best quality and of renowned make for successful and trouble free operation of the switchboards.

Equipments/accessories of substandard quality shall not be accepted by the Employer.

#### **7.15.17 TESTS**

The following tests are to be carried out.

- i) Checking continuity of the wiring.
- ii) Insulation resistance of all wiring circuit with all equipments mounted on the board, before and after application of H.V.
- iii) One minute power frequency voltage withstand test. All equipments and wiring shall withstand a power frequency voltage of 2 KV applied between any circuit and earth.
- iv) Routine test of all equipments, switches and devices according to relevant I.S.S.
- v) Type test reports shall be furnished.

#### **7.15.18 CLEARANCE**

The apparatus forming part of the panel shall have requisite clearances and these shall be maintained during normal service conditions. When arranging the apparatus within the panels, the clearances for them shall be complied with taking into account

the relevant service condition. In addition, abnormal conditions such as in short circuit shall not permanently reduce the distances between bus bars.

#### 7.15.19 NAME PLATE OF D.C. SWITCHBOARDS

Each panel shall be provided with name plates, marked in a durable manner and located in a place such that they are visible and legible when the panel is installed. The following information should be given on the name plate.

- a) The manufacturer's name and /or trade mark & identification number.
- b) Rated operational voltage.
- c) Purchase order number and date.
- d) Weight.

#### 7.15.20 D.C. SYSTEM

The 220 volts D.C. supply will be available from the lead acid station storage battery banks associated with battery charging equipment.

In the 220 KV system the D.C. supply will be available from two sources. So the system should be designed with provision for a bus coupler.

The battery shall normally float under trickle charge conditions with the charger which continuously supplies the D.C. load to the load bus in D.C. switchboard and trickle charging current to the battery. The charger will be connected to the bus through double pole switch fuse unit. These two double pole switch unit should be mechanically interlocked so that only one switch can be closed at a time. An emergency D.C. lighting system would be provided in each sub-station to operate a separate lighting system with D.C. power in case of total failure of A.C. supply. The D.C. lighting system would be completely independent from the normal A.C. lighting system. For this purpose, provision shall be made in the panel for main failure contactors with contacts rated for 32 Amps. And a switch on emergency lighting circuit across the D.C. but in the vent of main failure. The two switch fuse units required for D.C. lighting feeders shall be taken from the D.C. panel Board. D.C. fail alarm both audible and visual shall be provided in case of total failure of D.C. supply at the load bus as per drawing. 220 volts D.C. system single line diagram (No.SWG/570) is enclosed in Section-8 for guidance and understanding of D.C. system. As the entire D.C. system is to be designed by the contractor depending on the rating and type of equipment being supplied, the necessary modification in the schematic diagram has to be taken up by the contractor and got approved from the Engineer.

#### 8. BAY MARSHALLING KIOSK:

8.1: Same as ACDB but out door type. The purposes of these boards are to be installed in the switch yard at different locations. There shall be two inlets as source I and source II. There shall be adequate AC outlets both 3 phase with neutral and single phase, which will be taken to all the equipments and equipment marshalling boxes. At least 20% extra outlets are to be provided besides the requirement to meet during exigencies. All the inlet and outlets shall be provided with MCB's. The board shall have two doors one at front and the other at the rear end. Since these boards are to be installed outside in the switch yard sufficient care as per the relevant standards are to be taken care from weathering effect. At the front end all AC inlets and outlets are to be provided and at the rear end terminal blocks are to be provided in column wise for DC control /AC control purpose. The minimum quantity of terminal blocks of rating 20 Amps shall be 300 nos with duly marked the number of terminals. At the front side also adequate capacity (current rating) as per the rating of MCB terminal blocks to be provided for inlet and outlet points of AC supply.

8.2 Proper engineering to be made and to be submitted for approval to OPTCL before manufacturing and supply. The components and wirings to be used shall be of as per IS standard and of reputed make.

#### 9. AC CONSOLES:

**9.1:** Same as ACDB but out door type suitable for use in switchyard illumination control. Adequate nos of MCB,s for incoming and outlets are to be provided in the console to take care of the switch yard illumination system. No of such boards will be as per requirement. Care should be taken as these boards are of outdoor type. 20 % extra outlets should be provided to meet the exigencies.

**10. RECEPTACLE AC SUPPLY PANEL:**

**10.1:** Receptacle panels both indoor and out door types are to be provided to meet the emergency requirement of AC supply. For example welding purpose, testing purpose etc. Both three phase and single phase outlets should be provided. One no receptacle panels outdoor type shall be provided near the transformer for oil filtration purpose. The rating of the inlet and outlet MCCB, s shall be 250 Amp.

**DETAILS OF DISTRIBUTION BOARDS.**

**1) MAIN ACDB:**

a) Incomer - 1: 800 Amp/1600 Amp, 50KA, draw out type, Microprocessor Control, ACB. It shall contain 3 O/C & E/F relays with high setting provision, UV relay, Electrical Close/Open facility for ACB,ON/OFF lamp indication, Auto trip indication, TC healthy indication with P.B, Spring charge indication, R,Y,B healthy indication, Ammeter & voltmeter with selector switch, Annunciation facia with Acc, Reset and Test P.B.

b) One Bus-coupler: Same as Incomer 1 above.

c) Incomer ó 2: Same as Incomer ó 1 above.

d) Out going Feeders: (For Incomer ó 1) ,1)250 Amp MCCB: 4 Nos,  
2) 100 Amp MCCB: 4 Nos, 3) Spare compartment: 2 Nos.

e) Out going Feeders: (For Incomer ó 2) , 1)250 Amp MCCB: 4 Nos,  
2) 100 Amp MCCB: 4 Nos,3) Spare compartment:2 Nos

2) ACDB: R,Y,B Healthy Indication, Ammeter and voltmeter with selector switch.

a) Incomer -1: 250 Amp MCCB and 250 Amp MCCB for DG incomer.(with interlocking facility.

b) Out going feeder(for inc 1): 1) 63 Amp MCCB : 16 Nos 2) 32 A MCCB: 8 Nos

c) Bus coupler: 250 Amp MCCB

d) Incomer -2: 250 Amp MCCB and 250 Amp MCCB for DG incomer. (With interlocking facility.

e) Out going feeder (for Inc 2): 1) 63 Amp MCCB: 16 Nos 2) 32 A MCCB: 8 Nos

3) MAIN LIGHTING DB: R, Y, B Healthy Indication, Ammeter and voltmeter with selector switch.

a) Incomer -1: 250 Amp MCCB.

b) Out going feeder (for inc 1): 1) 63 Amp MCCB: 4 Nos 2) 32 A MCCB: 2 Nos

c) Bus coupler: 250 Amp MCCB

d) Incomer -2: 250 Amp MCCB

e) Out going feeder (for Inc 2): 1) 63 Amp MCCB: 4 Nos 2) 32 A MCCB: 2 Nos

4) INDOOR RECEPTACLE DB: R,Y,B Healthy indication.

a) Incomer: 63 Amp MCB

b) Out going: 32 Amp ,3 Phase,MCB: 2

c) Out going: 32 Amp ,1 Phase,MCB: 4

5) 220 V DC Indoor Ltg. DB:

a) Incomer : 32 Amp DC MCB from DCDB with auto changeover facility having delay timer with auto/manual selection switch.

b) Outgoing feeder: 16 Amp DC MCB: 5 Nos

6) 220 V DCDB (SET):

6.1) 220 V DC DB:1: Having Earth fault relay (Earth leakage), Under and over voltage, DC Ammeter and Voltmeter. Annunciation scheme.

a) Incomer: 100 Amp DC MCCB:

b) Out going: 100 Amp DC MCCB : To couple the other DCDB

c) Out going feeder: 32 Amp DC MCB: 20 Nos.

- 6.2) 220 V DC DB:2: Having Earth fault relay (Earth leakage), Under and over voltage, DC Ammeter and Voltmeter. Annunciation scheme.
- a) Incomer: 100 Amp DC MCCB:
  - b) Out going: 100 Amp DC MCCB : To couple the other DCDB
  - c) Out going feeder: 32 Amp DC MCB: 20 Nos.  
(\* 220 V DCDB-1 & 220 V DCDB-2 combined shall be treated as 220 V DCDB).
- 7) 48 V DCDB (SET):
- 7.1) 50 V DC DB:1: Having Earth fault relay (Earth leakage), Under and over voltage, DC Ammeter and Voltmeter. Annunciation scheme.
    - a) Incomer: 100 Amp/250 Amp DC MCCB:
    - b) Out going: 100 Amp/250 Amp DC MCCB: To couple the other DCDB
    - c) Out going feeder: 32 Amp DC MCB: 20 Nos.
  - 7.2) 50 V DC DB:2: Having Earth fault relay (Earth leakage), Under and over voltage, DC Ammeter and Voltmeter. Annunciation scheme.
    - a) Incomer: 100 Amp/250 Amp DC MCCB:
    - b) Out going: 100 Amp/ 250 Amp DC MCCB: To couple the other DCDB
    - c) Out going feeder: 32 Amp DC MCB: 20 Nos.  
(\* 50 V DCDB-1 & 50 V DCDB-2 combined shall be treated as 50 V DCDB)
- 9) BMK (Suitable for Outdoor type) (Provision of telephone jack points)
- a) Incomer : 63 Amp TP MCB : 1 for source - 1 and 1 for source -2 ( with timer,for auto changeover, contactors (two nos each rated 70 Amp) suitable to take care of changeover automatically.)
  - b) Out going feeder: 16 Amp TP MCB : 10 Nos , 10 Amp DP MCB: 8 Nos (at Front side)
  - c) 300 Nos of Terminal Block of Elmex/ any renowned make suitable for 35 Amp rated.
- 10) OUTDOOR RECEPTACLE DB:(Transformer filtration purpose)
- a) Near Transformer: Incomer 250 Amp MCCB: 1 No., Outgoing: 250 Amp MCCB : 1 No., Having provision of R,Y,B indication. (For transformer oil filtration)
  - b) Inside switch yard at Different location: Incomer: 63 Amp TPN MCB, Out going feeder: 2 Nos 32 Amp TP MCB and 2 Nos 16 Amp DP MCB.

All outdoor kiosk top cover shall be of Aluminum alloy having 3mm thickness & proper sloping shall be maintained for easy drainage of water.

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

**TECHNICAL SPECIFICATION**

**FOR**

**CONDUCTOR, AL TUBE G.I GROUND WIRE,  
INSULATORS, HARDWARE, CLAMPS & CONNECTORS**

**SECTION-I**

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## **CONDUCTORS**

### **SECTION - I**

#### TECHNICAL SPECIFICATION OF ACSR MOOSE, ZEBRA, AND PANTHER CONDUCTORS

##### 1. **SCOPE** :-

1.1. This specification provides for the manufacture, testing, supply and delivery at destination of the steel cored aluminum conductors as per Appendix-I attached.

##### 2. **STANDARDS** :-

2.1 The conductors shall comply in all respects to the clauses of this specification as indicated below & with the Indian Standard Specification, International standards with latest amendments. Some of the standards are :-

i) IS 398 - Specification for Aluminium Conductors for overhead transmission purposes,

IS 398, Part-II-Aluminium conductors for overhead Transmission purpose - Specification

ii) IS 1521, 1972 - Method of tensile testing of steel

iii) IS 1778 -1989 . Reel & drums for bare conductors.

iv) IEC - 1098

3. **MATERIALS :-**

3.1 The material offered shall be of best quality and workmanship. The steel Cored Aluminum conductor strands will consist of hard-drawn aluminum wire manufactured from 99.5% pure electrolytic aluminum rods of E.C. Grade. The steel wire shall be made from materials produced either by the acid or basic open hearth process or by electric process. No steel wire drawn from pressmen process shall be used. The steel wire shall not contain sulphur or phosphorus exceeding 0.05 percent, and the total of sulphur and phosphorus shall not exceed 0.085 percent.

3.2 The steel wires shall be evenly and uniformly coated with zinc complying with Indian Standard 4826-1979 specification for galvanized coatings on round steel wires. The uniformity of zinc coating and the weight of coating shall be in accordance with Appendix-II. The coating on the galvanized steel wires may be applied by the hot process or the electrolytic process.

4. **SIZES :-**

4.1 The size of steel-cored Aluminum Conductors shall be as given in Appendix-I. The resistance and weights shall be in accordance with the values given in the same appendix.

5. **TOLERANCES :-**

5.1 The following tolerances shall be permitted on standard diameter of aluminum wires.

Tolerance on standard diameter of aluminum wire  $\pm 1$  percent.  
wires.

Note : - The cross-section of any wire shall not depart from circularity by more than an amount corresponding to a tolerance of 2 percent on the standard diameter.

5.2 A tolerance of + 2 percent shall be permitted on the standard diameter of the galvanized steel wires. The variation from the approximate weights shall not be more than plus or minus 5 percent.

6. **MECHANICAL PROPERTIES : -**

6.1 The value of the final modules of elasticity for steel cored aluminum conductor in the average of values obtained from actual stress strain tests. The co-efficient of linear expansion for steel Cored Aluminum Conductors has been calculated on the basis of co-efficient of linear expansion of  $23.0 \times 10^{-6}$  per degree centigrade of aluminum and  $11.5 \times 10^{-6}$  per degree centigrade for steel and represent only the average values. These values shall however, be given by the bidder under the guaranteed technical particulars.

7. **SURFACE CONDITIONS :-**

7.1 The wires shall be smooth and free from inequalities, spills and splits. The surface conductor shall be free from points, sharp-edges, abrasions or other departures from smoothness or uniformity of surface contour that would increase radio interference and corona losses. When subjected to tension up to 50% of the ultimate strength of the conductor, the surface shall not depart from its cylindrical form nor any part of the component, parts or strands, move relative to each other in such a way as to get out of place and disturb the longitudinal smoothness of the conductor.

8. **JOINTS IN WIRES** : -

8.1 Aluminium wires : No joints shall be permitted in the aluminium wires in the outermost layer of the ACSR conductor. Joints in the inner layers are permitted, in addition to those made in the base rod or wire before final drawing, but no two such joints shall be less than 15 meter. apart in the complete stranded conductor. Such joints shall be made by cold pressure butt-welding.

Joints are not permitted in the outermost layer of the conductor in order to ensure a smooth conductor finish and reduce radio interference levels and corona losses on the extra high voltage lines.

8.2 Galvanized steel wires : - There shall be no joints except those in the base rod or wire before final drawing, in steel wires forming the core of the steel-reinforced aluminum conductor.

Joints have not been permitted in the steel wires after final drawing in order to avoid reduction in the breaking strength of the conductor that may occur as a result of failure of the joints.

9. **STRANDING** :-

9.1 The wires used in construction of a stranded conductor shall before stranding, satisfy all requirements of IS-398/ (part-II)1976 with latest amendments. For steel-cored aluminum conductors the lay ratio of the different layers shall be within the limits given under Appendix-I.

9.2 For all, constructions, each alternate layer shall be stranded in opposite directions. The wires in each layer shall be evenly and closely stranded round the under laying wire or wires. The final layer of wires shall have a right hand lay.

10. **PACKING AND MARKING** : -

10.1 The conductor shall be wound in non-returnable reels or drums conforming to Indian Standard 1978-1961 specification for Reels and Drums for Bare Wire, or any other authoritative standard and marked with the following : -

- |                         |  |
|-------------------------|--|
| a) Trade name, if any   | b) Contract/Award letter Number        |
| c) Name of manufacturer | d) Name & Address of Consignee         |
| e) Drum Number          | f) Length of conductor                 |
| g) Size of conductor    | h) Gross Weight of drum with conductor |
| i) Weight of empty drum | j) Net and gross of conductor.         |
- with lagging.**

k) Arrow marking of un-winding

**10.2** The reel shall be of such construction as to assure delivery of conductor in the field from displacement and damage and should be able to withstand all stresses due to handling and the stringing operations so that conductor surface is not dented, scratched or damaged in any way during manufacture, transport and erection. The conductor shall be properly lagged on the drums and the method of lagging to be employed may be clearly stated in the tender. It should be stocked to suit the reel and held in place by steel strapping. Lagging shall not be nailed or bolted in place.

**10.3** The conductor drum should be suitable for wheel mounting. Before reeling, the card-board or other suitable material shall be secured to the drum and inside flanges of the drums. After reeling the conductor, the exposed surfaces should be wrapped with suitable soft material to prevent the conductor from dirt and grit. Any space between the drum lagging and conductor should be suitably filled with soft filler material compactly packed. The conductor drum shall be made as per the relevant IS.

## **11. LENGTHS :-**

**11.1** The conductor shall be supplied in the standard lengths **as below** with a permitted variation of 5%. Not less than 90% of the total quantity of the conductor shall be supplied in the standard lengths. Thus the quantity of the conductor in lengths shorter than standard ones shall not exceed 10% of the total quantity to be supplied. Further no single conductor lengths in respect of such 10% (Maximum supply) in random lengths, shall be shorter than 50% of the standard lengths.

<u>Type of conductor</u>	<u>Length per drum.</u>
MOOSE ACSR	1.1 K.M
ZEBRA ACSR	1.1 K.M.
PANTHOR ACSR	2.2 K.M.

## **12. TESTS AND TEST CERTIFICATES :-**

The following type tests ,( & any other tests if purchaser decides to do), shall be conducted on the conductor at any Govt. approved laboratory or CPRI, in presence of the representatives of OPTCL, on the samples collected and sealed by the representative of OPTCL from the manufactured & offered drums of conductor at random at free of cost to OPTCL or firm may quote their test charges which will be taken in to account during bid price evaluation. If test charges will not be quoted by the firm, it will be treated as nil during bid price evaluation & firm have to do the type tests at free of cost to OPTCL. **Also the tenderer shall furnish valid type test reports, the tests are as per the IS 398 (part-2) conducted in any govt. approved laboratory or CPRI within last 5 years, from the date of opening of the bid (Techno-commercial) document, without which their bids will not be considered for evaluation.**

**12.1** Individual wire and finished steel cored Aluminum Conductor shall be subjected to before dispatch from the works, to the tests as per the provision

of the Indian standard Specification 398 (Part-II-1976) with the latest amendments & as per the tests indicated in this specification below.

12.2 Samples for individual wires for test shall be taken before stranding form not less than 10 percent of the spials in the case of aluminum wire and ten percent of the wire coils in the case of steel wires. If samples are taken after stranding, they shall be obtained by cutting 5 meters from the outer end of the finished conductor from not more than 10 percent of the finished reels.

12.3 The mechanical tests shall be carried out on single wires only.

12.4 The Tensile test shall apply to wires of all diameters forming part of steel cored aluminum conductors. If it is not possible to test the component wires before stranding the test may be made on wires taken from stranded conductors. The tensile strength of any of the wires shall not be less than the minimum values given in Appendix-II.

12.5 A suitable tensile testing machine shall be used the accuracy of which can easily be checked and the machine adjusted if necessary. The test sample before being placed in the machine, shall be straightened, if necessary in such a way as to cause the minimum alteration in its physical properties.

The load shall be applied gradually and rate of separation of the Jaws of the testing machine shall not be greater than 10cm/min. and less than 2.5cm/min.

## **TYPE TESTS**

### **12.6 Wrapping Test : -**

12.6.1 Samples of aluminium wires shall be wrapped round a wire of its own diameter to form a close helix of eight turns. Six turns shall then be unwrapped and again clearly wrapped in the same direction as before. The wire shall not break.

12.6.2 Samples of steel wires shall be closely wrapped eight times round a mandrel of diameter equal to four times the wire diameter. Six turns shall then be unwrapped and again closely wrapped in the same direction as before. The wire shall not break.

### **12.7 Galvanizing Test : -**

12.7.1 The uniformity of zinc coating and the weight of coating shall be as given in Appendix-II and shall be determined according to Indian Standard Specification 4826-1979. with latest amendments.

**12.7.2 This test shall be made whenever practicable, on wires before stranding and before the specimen has been bent, straightened or tested in any other way.**

### **12.8 Ductility Test : -**

This test shall be made on galvanized steel wires only by any of the proceedings given in 12.8.1 and 12.8.2.

**12.8.1 Torsion Test** : - One specimen cut from each of the sample shall be gripped at its ends in two vices, one of which shall be free to move longitudinally during the test. A small tensile bond not exceeding 2% of the breaking load of the wire, shall be applied to the sample during testing. The specimen shall be twisted by consisting one of the vices to revolve until fracture occurs and the number of twists shall be indicated by a counter or other suitable device. The rate of twisting shall not exceed 60 rev/min.

When tested before stranding, the number of complete twists before fracture occurs shall not be less than 18 on a length equal to 100 times the diameter of the wire. The fracture shall show a smooth surface at right angles, to the axis of the wire.

When tested after stranding, the number of complete twists before fracture occurs shall be not less than 16 on a length equal to 100 times the diameter of the wire. The fracture shall show a smooth surface at right angles to the axis of the wire.

**12.8.2 Elongation Test** : - The elongation of one specimen cut from each of the samples shall be determined. The specimen shall be straightened by hand and on original gauge length of 200 mm shall be marked on the wire. A tensile load shall be applied as described in 12.5 and the elongation shall be measured after the fractured ends fitted together. If the fracture occurs outside the gauge marks, or within 25mm of either mark and the required elongation is not obtained, the test shall be disregarded and another test made. When tested before stranding, the elongation shall be not less than 4 percent. When tested after stranding, the elongation shall be not less than 3.5 percent.

## **12.9 Surface Condition Test**

A sample of the finished conductor having a minimum recommended length of 5 meters with compression type dead end clamps compressed on both ends in such a manner as to permit the conductor to take its normal straight line shape, shall be subject to a tension of 50% of the UTS of the conductor. The surface shall not depart from its cylindrical shape nor shall the strands move relative to each other so as to get out of place or disturb the longitudinal smoothness of conductor. The measured diameter at any place shall be not less than the sum of the minimum specified diameters of the individual aluminum and steel strands.

## **12.10 Ultimate Strength (UTS) Test on Stranded Conductor**

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate up to specified 50% of UTS and held for one minute. The circles drawn shall not be distorted due to Relative movement of strands. Thereafter the load shall be increased at a steady rate to the minimum UTS specified in Appendix-I and held for one minute. The applied load shall then be increased until the failing load is reached and the value recorded.

### 12.11 Corona Extinction Voltage Test

One sample of conductor of 5m length shall be strung. In case of twin conductor, two samples shall be arranged with the actual sub-conductor spacing between them. This sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 320 KV (rms) for 400 KV and 176 KV (rms) for 220 KV system line to ground under dry condition. There shall be no evidence of corona on any part of sample when all possible sources of corona are photographed in a darkened room. The test shall be conducted without corona control rings. The voltage shall be corrected for standard atmospheric conditions.

### 12.12 Radio Interference Voltage Test

Under the conditions as specified in 12.11 above, the conductor samples shall have a radio interference voltage level below 1500 microvolts at one MHZ when subjected to 50HZ AC voltage of 1.1 times maximum line to ground voltage under dry condition. This test may be carried out with corona control rings and arcing horns.

### 12.13 D.C. Resistance Test on Stranded Conductor

On a conductor sample of minimum 5 m length two contact clamps shall be fixed with a pre-determined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20 degree centigrade as per clause No.12.8 of IS : 398 (part V). The resistance corrected at 20 degree centigrade shall conform to the requirements of this specification.

### 12.14 Stress-Strain Test

12.14 (i) This test is contemplated only to collect the creep data of the conductor from the supplier. A sample of conductor of minimum 10 metres length shall be suitably compressed with dead end clamps.

#### 12.14 (ii) Test Set-up

12.14 (ii) (a) The test sample shall be supported in a trough over its full length and the trough adjusted so that the conductor will not be lifted by more than 10 mm under tension. This shall be ascertained by actual measurement.

12.14 (ii) (b) The distance between the clamp and the sleeve mouth shall be monitored with callipers during the test to ensure that, after the test, it does not change by more than 1 mm +/-0.1mm from the value before the test.

12.14 (iii) (c) The conductor strain shall be evaluated from the measured displacements at the two ends of the gauge length of the sample. The gauge reference targets shall be attached to the clamps which lock the steel and aluminum wires together. Target plates may be used with dial gauges or displacement transducers and care shall be taken to position the plates perpendicular to the conductor. Twisting the conductor, lifting it and moving it from side-to-side by the maximum amounts expected during the test should introduce no more than 0.3mm error in the reading.

#### 12.14 (iii) Test Loads for Complete Conductor

The loading conditions for repeated stress-strain tests for complete conductor shall be as follows :

12.14 (iii) (a) 1 KN load shall be applied initially to straighten the conductor. The load shall be removed after straightening and then the strain gauges are to be set at zero at zero tension.

12.14 (iii) (b) For non-continuous stress-strain data, the strain reading at 1 KN intervals at lower tensions and 5KN intervals above 30% of UTS shall be recorded.

12.14 (iii) (c) The sample shall be reloaded to 50% of UTS and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes during the hold period. The load shall be released after the hold period.

12.14 (iii) (d) Reloading up to 70% of UTS shall be done and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45, and 60 minutes and then the load shall be released.

12.14 (iii) (e) Reloading up to 85% of UTS shall be done and hold for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes and then the load shall be released.

12.14 (iii) (f) Tension shall be applied again and shall be increased uniformly until the actual breaking strength is reached. Simultaneous readings of tension and elongation shall be recorded up to 90 % of UTS at the intervals described under Clause 12.14 (iii) (e).

#### 12.14 (iv) Test Loads for Steel core Only.

The loading conditions for repeated stress-strain tests for the steel core of ACSR shall be as follows :

12.14 (iv) (a) The test shall consist of successive application of load applied in a manner similar to that for the complete conductor at 30%, 50%, 70% and 85% of UTS.

12.14 (iv) (b) The steel core shall be loaded until the elongation at the beginning of each hold period corresponds to that obtained on the complete conductor at 30%, 50%, 70% and 85% of UTS respectively.

#### 12.14 (v) Stress Strain Curves

The design stress-strain curve shall be obtained by drawing a smooth curve through the 0.5 and 1 hour points at 30%, 50%, and 70% of UTS loadings. The presence of any aluminum slack that can be related to any observed extrusion entering the span from the compression dead ends shall be removed from the lower ends of the design curves. Both the laboratory and design stress-strain curves shall be submitted to the purchaser along with test results. The stress-strain data obtained during the test shall be corrected to the standard temperature i.e. 20 degree centigrade.

#### 12.15 Chemical Analysis of Zinc

Samples taken from the Zinc ingots shall be chemically/spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

#### **12.16 Chemical Analysis of Aluminum and Steel**

Samples taken from the Aluminum ingots/ coils/ strands shall be chemically/spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

#### **ROUTINE/ACCEPTANCE TESTS**

#### **12.17 Visual and Dimensional Check on Drums**

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this specification. Drum dimensions should confirm to **IS: 1778**. The flange diameter, traverse width, barrel diameter and flange thickness are to be as per relevant standard.

#### **12.18 Visual Check for Joints, Scratches etc.**

Conductor drums shall be rewound in the presence of the inspector. The inspector shall visually check for scratches, joints, etc. and that the conductor generally conforms to the requirements of this specification.

#### **12.19 Dimensional Check of Steel and Aluminum Strands**

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

#### **12.20 Check for Lay-ratios of various Layers**

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this specification.

#### **12.21 Breaking load test on welded Aluminum strand & Individual wires**

Two Aluminum wires shall be welded as per the approved quality plan and shall be subjected to tensile load. The welded point of the wire shall be able to withstand the minimum breaking load of the individual strand guaranteed by the supplier.

12.22 Ductility Test

12.23 wrapping test

12.24 Resistance test

12.25 Galvanising Test

#### **13. RETEST AND REJECTION : -**

13.1 Each coil or spool selected for testing shall be tested for compliance with the requirements of Indian Standard Specification 398 (part-II) 1976 with latest amendment if any selected coil or spool not fulfill any of the test requirements, that particular coil or spool shall be withdrawn. In respect of each failure, two test pieces shall be selected from two different coils in the lot and subjected to the test under which the failure occurred. If either of the two retest pieces fails to pass that test, the lot concerned shall be rejected.

If samples are taken for test after stranding and if any selected reel fails in the retest, the manufacturer may test each and every reel and submit them for further inspection. All rejected materials shall be suitably marked and segregated.

#### **14. GUARANTEED TECHNICAL PARTICULARS : -**

The bidder shall fill in the guaranteed technical particulars in the Performa at Appendix-IV and submit the same with his tender, without which bid will not be considered.

15. **SAG TENSION CHARTS AND SAG TEMPLATES** : -

The contractor shall supply each six copies of sag tension charts and sag templates in respect of each type of the steel core aluminum conductor. The Contractor shall also supply sag template in celluloid which shall be subject to the approval by the purchaser and without involving any extra charges. The design data of the lines on which these conductors will be used are given in **Appendix-III.**

**APPENDIX - I**

ACSR CONDUCTOR:	MOOSE	ZEBRA
1. Size of conductor: mm	54/7/3.53 mm	54/7/3.18
2. Stranding and wire diameter Aluminum	54/3.53 mm	54/3.18 mm
Steel	7/3.53 mm	7/3.18 mm
3. Sectional area of Aluminum (in mm <sup>2</sup> )	528.50	428.90
4. Approximate total mass (in Kgs/KM)	2004	1622
5. Calculated resistance at 20°C Max.: ( in Ohms/Km.)	0.05552	0.06868
6. Calculated breaking load of: composite conductor (in KN) (U.T.S.) (Min)	161.20 KN	130.32 KN.
7. <u>Lay Rating</u> :- Steel core	Max . 18 Min - 16	Max- 28 Min-13

Aluminium Layers

	12 Wire Layer	Max . 14	Max-17
	(Innermost Layer)	Min . 12	Min - 10
	18 Wire Layer	Max -13	Max - 16
	(Lay immediately beneath outside Layer)	Min . 11	Min - 10
	24 wire layer (outside layer)	Max -12	Max - 14
		Min -10	Min - 10
8.	Modulus of elasticity (in Kg / mm <sup>2</sup> ):	6860	8158
			0.7036 x 10 <sup>6</sup> Kg x CM <sup>2</sup> ( 69 GN per Sq. meter )
9.	Co-efficient of linear expansion of conductor per degree centigrade.	-----19.3 x 10 <sup>-6</sup> -----	
10.	Standard area of Cross Section in mm <sup>2</sup> Sq. mm of conductor.	597.0 mm <sup>2</sup>	484.5
11.	Diameter of complete conductor in	31.77 mm	28.62 mm

**A P P E N D I X - II**

**Solid Steel and Aluminum Wires used in Steel cored**

**Aluminum Conductors**

		<b><u>ZEBRA</u></b>		<b><u>MOOSE</u></b>	
		Steel	Aluminum	Steel	
1.	Diameter  Aluminium  Standard (in mm)  Maximum (in mm)  Minimum (in mm)				
		3.18	3.18	3.53	3.53
		3.24	3.21	3.60	3.55
		3.12	3.15	3.46	3.51
2.	Cross Sectional Area  of nominal Diameter  Wire (in mm <sup>2</sup> )				
		7.942	7.942	9.791	9.791
3.	Weight (in Kg/KM)				
		61.95	21.47		
4.	Minimum tensile strength:As per relevant ISS				
5.	Minimum breaking load  before stranding (in KN)				
		10.43	1.29	12.86	1.57
6.	Minimum breaking load:  after stranding (in KN)				
		9.91	1.23	12.22	1.49
7.	Zinc coating of steel  strands  Number and duration:  of dips  Minimum Weight of :  Coating (in gm/ m <sup>2</sup> )  (A s per IS-4826 . 1979)				
		3 (1 Min. dip)		3 dips of 1min	
			260	260	
8.	Maximum resistance at:  20°C of Aluminum strands  ( in Ohms / KM)				
		3.626	2.974	2.921	
9.	Minim Purity of aluminum rod:  ----				
				-----99.5 %-----	



## APPENDIX – III

	<b>ACSR CONDUCTOR:</b>	<b><u>ZEBRA</u></b>	<b><u>MOOSE</u></b>
1.	Conductor	-----Steel cored Aluminum-----	
	(a) Copper equivalent: mm <sup>2</sup>		
	(b) Stranding (in mm)	54/7/3.18	54/7/3.53
2.	Normal Span.	320 Meters	
	Wind Span.	320 Meters	
	<u>Weight Span.</u>		
	(a) Max.	500 Meters	
	(b) Min.	50 Meters	
3.	Wind Pressure on full project area.	52 Kgf per M <sup>2</sup>	
4.	Temperature		
	(a) Minimum	5 ° C	
	(b) Maximum	67 ° C	
	(c) Every day	32°C	
5.	Factors of safety : Minimum		
	(i) Every day temperature and no wind.	4.00	
	(ii) Minimum temperature and 2/3 maximum wind :	2.00	
	(iii) Every day Temperature and full wind	2.00	
	This is as per Indian Electricity Rules, 1956.		
6.	Relative Humidity.		
	Maximum.	100 Percent	
	Minimum.	60 Percent	
7.	Isoceramic level.	100/Years	
8.	Number of rainy days per year.	100 days	
9.	Average rainfall per year	1150 mm. approx.	
10.	Altitude.	Less than 350 Metres.	

### Technical parameters

Sl. No.	Description	ACSR MOOSE
1	Stranding and wire diameter	54Al /3.53 mm+7 Steel/3.53 mm
2	Number of Strands	
	Steel centre	1
	1st Steel Layer	6
	1st Aluminium Layer	12
	2nd Aluminium Layer	18
	3rd Aluminium Layer	24
3	Sectional area of aluminium	528.5 mm <sup>2</sup>

4	Total sectional area	597.00 mm <sup>2</sup>	
5	Overall diameter	31.77 mm	
6	Approximate weight	2004 kg/km	
7	Calculated DC resistance at 20 °C	0.05596 Ω/km	
8	Minimum UTS	161.2 kN	
9	The details of aluminium strand are as follows:		
	Minimum breaking load of strand before stranding	1.57 kN	
	Minimum breaking load of strand after stranding	1.49 kN	
	Maximum DC resistance of strand at 20 °C	2.921Ω/km	
10	The details of steel strand are as follows		
	Minimum breaking load of strand before stranding	12.86 kN	
	Minimum breaking load of strand after stranding	12.22 kN	
11	Minimum number of twist to be with stood in torsion test when tested on a gauge length of 100 times diameter of wire	18 - before stranding 16 - after stranding	
12	Tolerances		
12a	Diameter of aluminium strands	3.53 mm	
	Standard		
	Maximum	3.55 mm	
	Minimum	3.51 mm	
	Diameter of steel strands	3.53 mm	
	Standard		
	Maximum	3.60 mm	
	Minimum	3.46 mm	
13	Lay ratio of Conductor		
13a	Steel - 6 wire layer	18	
	Maximum		
	Minimum	16	
13b	Aluminium - 12 wire layer	14	
	Maximum		
	Minimum	12	
13c	Aluminium - 18 wire layer	13	
	Maximum		
	Minimum	11	
13d	Aluminium - 24 wire layer	12	
	Maximum		
	Minimum	11	
14	Materials composition		
14a	Aluminium	99.5% with copper content less than 0.4%	
14b	Steel	0.50 to 0.85 %	
	Carbon		
	Manganese	0.50 to 1.10 %	
	Phosphorous	not more than 0.035 %	
	Sulphur	not more than 0.045 %	
	Silicon	0.10 to 0.35 %	
14c	Zinc for galvanising	electrolytic high grade zinc of 99.95% purity conforming to IS 209-1979.	

APPENDIX . **PANTHER**

1.	Size of conductor	30/7/3.00 mm
2.	Stranding and wire diameter Aluminum Steel	30/3.00 mm 7/3.00 mm
3.	Sectional Area of Aluminum	212.10 mm <sup>2</sup>
4.	Approximate total mass	974 Kgs/KM
5.	Calculated resistance at 20° C Max.	0.139 Ohm/KM
6.	Calculated breaking load of composite conductor (U.T.S) (Min)	89.67 KN
7.	<u>Lay Ratio</u> :- Steel Core	Max - 28 Min - 13
	<u>Aluminum Layers</u>	
	12 Wire layer (Layer below outside layer)	Max - 16 Min - 10
	18 Wire layer (Outside Layer)	Max - 14 Min - 10
8.	Modulus of elasticity	0.815 x 10 <sup>6</sup> Kg/CM <sup>2</sup> (80GN/M <sup>2</sup> )
9.	Co-efficient of Linear expansion of conductor.	17.8 x 10 <sup>-6</sup> / °C
10.	Standard area of cross Section in sq. mm of conductor	261.50 Sq. mm
11.	Diameter of complete conductor in mm	21 mm

**APPENDIX - II**

**PANTHER**

**Solid Steel and Aluminium Wires used in Steel cored**

**Aluminium Conductors**

1.	Diameter	Steel	Aluminum
	Standard	3.00 mm	3.00 mm
	Maximum	3.06 mm	3.03 mm
	Minimum	2.94 mm	2.97 mm
2.	Cross Sectional Area		
	of nominal Diameter Wire	7.069 mm <sup>2</sup>	7.069 mm <sup>2</sup>
3.	Weight	55.13 Kg/KM	19.11Kg/Km
4.	Minimum tensile strength	134Kg/mm <sup>2</sup>	16.87Kg/mm <sup>2</sup>
5.	Minimum breaking load	9.29 KN	1.17 KN
	before stranding		
6.	Minimum breaking load	8.83 KN	1.11 KN
	after stranding		
7.	Zinc coating of steel strands		
	No and duration of dips	3 (1 Min. dip)	
	Minimum Weight of	As per IS 4826-1979	
	coating		
8.	Maximum resistance at		4.079 Ohms/KM
	20°C of Aluminum strands		
9.	Purity of aluminum rod		99.5%

**APPENDIX - III**  
**PANTHER**

1.	Conductor	Steel cored Aluminum
	(a) Copper equivalent	130 mm <sup>2</sup>
	(b) Stranding	30/7/3.00 mm
2.	Normal Span.	320 Meters
	Wind Span.	320 Meters
	<u>Weight Span.</u>	
	(a) Max.	500 Meters
	(b) Min.	50 Meters
3.	Wind Pressure on full projected area.	52 Kgf per M <sup>2</sup>
4.	Temperature	
	(a) Minimum	5 °C
	(b) Maximum	67°C
	(c) Every day	32°C
5.	Factors of safety : Minimum	
	(i) Every day temperature and no wind.	4.00
	(ii) Minimum temperature and 2/3 maximum wind :	2.00
	(iii) Every day Temperature and full wind	2.00
	This is as per Indian Electricity Rules, 1956.	
6.	Relative Humidity.	
	Maximum.	100 Percent
	Minimum.	60 Percent
7.	Isoceramic level	100/years
8.	Number of rainy days per year.	100 days
9.	Average rainfall per year	1150 mm. approx.
10.	Altitude.	Less than 350 Meters



# G.I EARTH WIRE

## SECTION – II

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4.	SIZE AND CONSTRUCTION	22
5.	LENGTH OF JOINING	22
6.	TESTS AND TEST CERTIFICATES	22
7.	PACKING AND MARKING	23
8.	SAG AND TENSION CHARTS AND SAG TEMPLATE	23
9.	OVERHEAD EARTH CONDUCTORS	25

### TECHNICAL SPECIFICATION FOR G.I. GROUND WIRE.( 7/3.15 mm and 7/3.66mm )

#### 1. SCOPE :

1.1 This specification provides for the manufacture, testing before despatch, supply and delivery of Ground wire for the purpose of earthing and protection of power transmission line, as per the particulars given in Appendix-I attached. The ground wire shall consist of standard galvanized steel wire.

#### 2. STANDARDS :

2.1 The ground wire shall comply in all respect with the Indian Standard (IS) 2141-1979

#### 3. MATERIALS :

3.1 The material offered shall be of best quality and workmanship. The steel wires (Strands) shall be manufactured from steel produced by any suitable process. The steel wire shall not contain sulphur and phosphorous exceeding 0.040 percent each as per IS : 2141-1971.

3.2 The steel wires shall be evenly and uniformly coated with zinc complying with IS: 209-1965 specification for zinc (Retired). Only virgin zinc shall be used and reclaimed zinc is not permitted. The virgin zinc shall be of 99.95 percent quality.

3.3 The content of carbon shall not be more than 0.55 percent, manganese and silicon contents shall be 0.40 to 0.90 and 0.15 to 0.35 respectively.

#### 4. **SIZE AND CONSTRUCTION :**

4.1 The size of ground wire shall be as given in Appendix-I. The physical properties have been given in the same Appendix. The lay of the strands shall be of lengths as given in the Appendices. The wires shall be so stranded together that when any evenly distributed pulls applied at the end of the completed strands each wire will take an equal share of the pull.

#### 5. **LENGTH OF JOINING:**

5.1 The ground wire may be supplied in the standard length as per manufacturers standard practice and such length will be specifically indicated in the tender. However random length of ground wire upto a maximum of 10 (Ten) percent may be allowed.

5.2 The length of strand which may be supplied without joints in the individual wires comprising it depends on the length of wire which may be carried by the bobbin in a normal stranding machine. The normal lengths of strand which shall be supplied without joints in individual wires, excluding welds made in the rod before drawing shall be as given in Appendix 6 I.

5.3 Each coil shall be warranted to contain no weld joints or splice other than in the rod before it is drawn and those permitted in 5.3 above. The wire shall be circular and shall be free from scale or irregularities, imperfections, flaws and other defects. The zinc coating shall be smooth even and bright.

#### 6. **TESTS AND TEST CERTIFICATES:**

6.1 Ground wire shall be subjected to the tests as specified in the IS:2141-1979 before despatch.

6.2 All the coils of the galvanized strand shall be of the same grade, diameter and construction manufactured under similar conditions shall be grouped to constitute one lot.

6.3 Samples from each lot shall be tested for ascertaining the conformity to the requirements of the ground wire specified herein. The coils selected shall be tested for length of the lay and joints. The lot shall be declared conforming to the requirements of these characteristics if all the coils are found satisfactory. One test specimen from each wire of the strand shall be drawn, from every selected coil and subjected to tensile tests, ductility test and coating test. One specimen of the completed strand from each coil shall be subjected to tensile strength. The lot shall be declared conforming to the requirements of these characteristics if the entire best specimen satisfies the relevant requirements.

6.4 **Chemical Analysis :** One sample shall be drawn from the lot for chemical analysis. Unless otherwise agreed to between the purchaser and supplier the chemical analysis shall be carried out.

6.5 **Tensile Test :** The wire when tested in accordance with IS : 1521-1960 shall have minimum tensile strength specified in the Appendix 6 I. The tensile strength of the finished strand shall not be less than 95% of the aggregate of the single wires.

6.6 **Ductility test** : The wire shall be subjected to wrapping test in accordance with IS : 1755-1961. When wrapped eight times round its own diameter and on being subsequently straightened the wire shall not break or split.

6.7 **Coating test** : The uniformity of zinc coating shall be tested as per IS: 2633-1964. The wire shall withstand the number of dips specified in Appendix ó I.

6.8 Three copies of manufacturers test certificate shall be submitted by the contractor to the purchaser for approval immediately after such tests have been conducted on the strands and the wire.

6.9 The purchaser reserves the right to inspect the material at Manufacturer's works before despatch.

7. **PACKING AND MARKING :**

7.1 The ground wire shall be supplied in non-returnable reels or drums of non-perishable or treated wood conforming to IS: 1778-1991 specification for Reels and Drums for Bare wire. Each coil shall be provided with a level fixed firmly on the inner part of the coil, bearing the following information.

- (a) Trade name, if any.
- (b) Name of manufacturer
- (c) Type of wire, size and length of wire.
- (d) Net weight of the wire.
- (e) Total weight, and
- (f) Number of lengths on the reel or drum unless otherwise agreed to between the purchaser and the supplier, the stranded wire shall be supplied in 50 Kg. coil.

8. **SAG AND TENSION CHARTS AND SAG TEMPLATE :**

8.1 The successful tenderer shall be required to submit six copies of sag templates and strings charts for different temperatures and spans, One set of charts shall be ink on tracing cloth. The design data of the lines on which the ground wire will be used are given in Appendix ó II

## *A P P E N D I X – I*

### *TECHNICAL SPECIFICATION OF GROUND WIRE*

- |        |  |   |   |
|--------|--|---|---|
| (i)    | Material   | : | Steel   |
| (ii)   | Purity of material                               | : | Sulphur and phosphorous contents not exceeding 0.040 percent each. Carbon content not exceeding 0.55 percent. Total silicon contents shall be 0.15 to 0.35 and Manganese contents shall be 0.40 to 0.90 respectively. |
| (iii)  | Standing and wire diameter                       | : | 7/3.15 mm   |
| (iv)   | Weight   | : | 428 Kg / Km.  |
| (v)    | Single wire before stranding                     | : |   |
|        | Diameter of wire                                 | : | 3.15 mm   |
|        | Tolerance  | : | + 0.060 mm<br>- 0.030 mm  |
|        | Minimum elongation in 100 mm.                    | : | 4 mm.   |
|        | Minimum breaking strength                        | : | 857 kg.   |
|        | Minimum tensile strength                         | : | 85.7 kgf / mm <sup>2</sup>  |
| (vi)   | <b>Stranded wire length of lay</b>               | : |   |
|        | Maximum  | : | 175 mm  |
|        | Minimum  | : | 145 mm  |
|        | Minimum breaking load                            | : | 5810 kg   |
|        | Over all diameter                                | : | 9.45 mm   |
|        | Modulus of elasticity                            | : | 1.938 x 10 <sup>6</sup> Kg/Cm <sup>2</sup>  |
|        | Co-efficient of linear expansion                 | : | 11.50 x 10 <sup>6</sup> per deg. C.   |
|        | D.C. resistance at 20 <sup>0</sup> C             | : | 3.375 Ohms/Km.  |
| (vii)  | <b>Zinc coating :</b>                            | : |   |
|        | Number of one minute dips                        | : | Three   |
|        | Number of half-minute dips                       | : | One   |
|        | Quality of zinc                                  | : | Zn 98<br>IS:209/1966  |
|        | Weight of coating on wire process of galvanising | : | 275 g/m <sup>2</sup>  |
|        | Process of galvanising                           | : | Hot-dip.  |
| (viii) | Joints   | : | There shall be no joint in any of the wires constituting the ground wire.   |
| (ix)   | <b>Lengths -</b>                                 | : |   |
|        | Standard length                                  | : | 1500 metres.  |
|        | Tolerance on standard length                     | : | ± 5 percent   |
|        | Random lengths                                   | : | Not more than 5 percent of the lengths ordered.   |
| (x)    | <b>Tests : -</b>                                 | : | A sample of the finished ground wire when tested in tensile testing machine shall not fail at a stress  |
|        | Type tests Ultimate tensile strength test.       | : |   |

- less than 100% of UTS value of the ground wire. The length of the test sample shall be not less than 5 meters.
- Electrical Tests : As per BS : 182/1972 and BS : 3229/1960
- Routine Tests : As per clause No. 6 of IS: 2141 1968. In addition to these tests, the weight and adherence of Zinc coating tests shall be conducted as per clause 4 and 5 of IS : 4826/1968.
- (xi) Test Reports : Three copies of manufacturer test certificates shall be submitted by the Contracts to the purchaser for approve immediately after such test have been conducted on the galvanised steel strand and the wire.

## 9. Overhead earth conductors General(7/3.66mm)

Where earth conductors are erected to provide the specified degree of lightning protection, they shall consist of stranded galvanised steel and shall comply with IEC 888 and IEC 1089 in so far as it applies to steel wires.

Galvanising shall comply with the requirements of IS 2141.

The arrangement of earth conductors shall be such that failure of a single conductor cannot predictably result in a fall across both bus bars in a duplicate bus bar substation.

### Technical parameters

SI No.	Parameter	Value	
1	Stranding and wire diameter	7/3.66mm	
2	Number of strands	1/6	
3	Total sectional area	73.65 mm <sup>2</sup>	
4	Overall diameter	10.98mm	
5	Approximate weight	583 kg/km	
6	Calculated DC resistance at 20C	2.5 ohms/m	
7	Minimum ultimate tensile strength	68.4kN	
8	Direction of outer lay	Right hand	
9	Tolerances		
9a	Diameter	standard	3.66mm
		maximum	3.75mm
		minimum	3.57mm
9b	Lay length	standard	181mm
		maximum	198mm
		minimum	165mm
10	Steel composition	Carbon	≤ 0.55%
		Manganese	0.4 to 0.9%
		Phosphorous	≤ 0.04%
		Sulphur	≤ 0.04%
		Silicon	0.1 to 0.35%
11	Zinc for galvanising	Electrolytic high grade zinc of 99.95% purity to 209 1979	

Table for Technical parameters for earth wires

## INSULATORS SECTION-III

S.NO.      DESCRIPTION      PAGE NO.

1. SCOPE
2. STANDARDS
3. PRINCIPAL PARAMETERS
4. GENERAL TECHNICAL REQUIREMENTS
5. DETAILS OF SOLID CORE ROD INSULATORS
6. SPECIFICATION DRAWINGS
7. GENERAL TECHNICAL REQUIREMENTS
8. MATERIAL DESIGN AND WORKMANSHIP
9. TESTS (FOR DISC INSULATORS)
10. INSPECTION
11. QUALITY ASSURANCE PLAN
12. TEST DETAILS

# **INSULATORS**

## **TECHNICAL SPECIFICATION FOR DISC INSULATORS FOR SUBSTATION AND TRANSMISSION LINE WORK**

### **1.0 SCOPE.**

- 1.1 This specification provides for design, manufacture, engineering, inspection and testing before despatch packing and delivery FOR (destination) for Indian manufacturers of disc. Insulators as per technical requirements furnished in this specification.

These insulators are to be used in suspension and tension insulators strings for the suspension and anchoring of the conductors on EHV transmission line towers.

1.2 Following is the list of documents constituting this package.

- (i) Technical specification.
- (ii) Technical data sheet.
- (iii) Drawings of insulators
- (ii)

1.3 All the above volumes along with amendments there of shall be read and interpreted together. However, in case of a contradiction between the Technical Specification and any other volume, the provisions of this volume will prevail.

1.4 The insulators shall conform in all respects to high standards of engineering, design workmanship and latest revisions of relevant standards at the time of offer and purchaser shall have the power to reject any work or material which in his judgment, is not in full accordance therewith.

## 2.0 STANDARDS:

2.1 Except as modified in this specification, the disc insulators shall conform to the following Indian Standards, which shall mean latest revisions and amendments. Equivalent International and Internally recognized standards to which some of these standards generally correspond are also listed below.

Sl. No.	Indian Standard	Title.	International Standard.
1.	IS: 206	Method for Chemical Analysis of Slab Zinc.	
2.	IS: 209	Specification for Zinc.	BS: 3436
3.	IS: 731	Porcelain insulators for overhead power lines with a normal voltage greater than 1000V	BS: 137(I&II); IEC 274 IEC 383
4.	IS: 2071 Part-(I) Part-(II) Part-(III)	Method of High Voltage Testing.	
5.	IS: 2121  (Part-I)	Specification of Conductors and Earth wire Accessories for Overhead Power lines. Armour Rods, Binding wires and tapes for conductor.	
6.	IS: 2486	Specification for Insulator fittings for overhead power lines with a nominal voltage greater than 1000V.	
	Part . I	General Requirement and Tests.	BS: 3288
	Part . II	Dimensional Requirements.	IEC: 120
	Part . III	Locking devices.	IEC: 372
7.	IS: 2629	Recommended practice for Hot Dip Galvanisation for iron	

		and steel.	
8.	IS: 2633	Testing for Uniformity of Coating of Zinc coated articles.	
9.	IS: 3138	Hexagonal Bolts & Nuts.	ISO/R 947 & ISO/R 272
10.	IS: 3188	Dimensions for Disc Insulators.	IEC: 305
11.	IS: 4218	Metric Screw Threads	ISO/R 68-1969 R 26-1963, R 262-1969 & R965-1969
12.	IS: 6745	Determination of weight of zinc coating on zinc coated iron and steel articles.	
13.	IS: 8263	Methods of RIV Test of HV insulators.	IEC 437 NEMA Publication No.107/1964 CISPR
14.	IS: 8269	Methods for switching impulse test on HV insulators.	IEC: 506
15.		Thermal mechanical performance test and mechanical performance test on string insulator units.	IEC: 575
16	IEC	Long Rod Insulators	IEC-433

2.2 The standards mentioned above are available from:

Reference.	Abbreviation.	Name & Address:
BS		British Standards, British Standards Institution, 101, Pentonville Road, N-19 ND,U
IEC / CISPR		International Electro technical commission Electro Technique International. 1, Rue de verembe Geneva SWITZERLAND.
IS		Bureau of Indian Standards, Manak Bhavan, 9 Bahadurshah Zafar Marg, New Delhi-110001, ORISSA
ISO		International Organisation for Standardization. Danish Board of Standardization Dansk Standardizing Sraat Aurehoegvej-12 DK-2900 Helleprup DENMARK.
NEMA		National Electric Manufacturers Association 1`55, East 44 <sup>th</sup> . Street New York, NY 10017 USA

### 3.0 **PRINCIPAL PARAMETERS.**

#### 3.1 DETAILS OF DISC INSULATORS:

3.1.1 The Insulator strings shall consist of standard discs for use in three phases. 50 Hz effectively earthed 33/132/220 KV transmission system of OPTCL in a moderately polluted atmosphere. The discs shall be cap and pin, ball and socket type, radio interference and have characteristics as shown in Table-I and all ferrous parts shall be hot dip galvanized as per the latest edition of IS 2629. The zinc to be used for making sleeves shall be 99.95 % pure.

3.1.2 The size of disc insulator, minimum creepage distance the number to be used in different type of strings, their electromechanical strength and mechanical strength

3.1.3 of insulator string along with hardware shall be as follows:

**PRINCIPAL PARAMETERS OF THE DISC INSULATORS:-**

Sl. No.	Type of String.	Size of disc. Insulator (mm)	Minimum creepage distance of each disc (mm),	No. of standard discs 33 KV/132 KV /220KV/ 400 KV	Electro-mechanical strength of insulator string fittings (KN): 33 KV/132 KV /220/400 KV
1.	Single suspension	255 x 145/ 280x145	320	1X4/1x9 /1x14/1X25	90/90/90/120 KN Normal Disc Insulator
2.	Double suspension.	-do-	-do-	2X4/2x9 /2x14/2X25	90/90/90/120 KN Normal Disc Insulator
3	Single suspension	255 x 145/ 280x145	430	1X4/1x9 /1x14/1X25	90/90/90/120 KN Antifog Disc Insulator
4	Double suspension.	-do-	-do-	2X4/2x9 /2x14/2X25	90/90/90/120 KN Antifog Disc Insulator
5	Single Tension	280x145/ 305x170	430	1X4/1x10/1x1 5/1X25	120/160/160/160 KN Antifog Disc Insulator
6	Double Tension	-do-	-do-	2X4/2x10/2x1 5/2X25	120/160/160/160 KN Antifog Disc Insulator
7	Single Tension	305x170	475	1X4/1x10/1x1 5/1x25	160 KN Antifog Disc Insulator
8	Double Tension	-do-	-do-	2X4/2x10/2x1 5/2x25	160 KN Antifog Disc Insulator
5	Single Suspension	280x145	430	1X4/1x10/1x1 5/1X25	90/90/120 KN Antifog Disc Insulator
6	Double Suspension	-do-	-do-	2X4/2x10/2x1 5/2X25	90/90/120 KN Antifog Disc Insulator

**3.2 SPECIFICATION DRAWINGS:**

3.2.1 The specification in respect of the disc insulators are described. These specification for information and guidance of the Bidder only. The drawings to be furnished by the supplier shall be as per his own design and manufacture and in line with the specification.

**4.0 GENERAL TECHNICAL REQUIREMENTS:**

**4.1 Porcelain:**

The porcelain used in the manufacture of the shells shall be ivory white nonporous of high dielectric, mechanical and thermal strength, free from internal stresses blisters, lamination, voids, forgone matter imperfections or other defects which might render it in any way unusable for insulator shells. Porcelain shall remain unaffected by

climatic conditions ozone, acid, alkali, zinc or dust. The manufacturing shall be by the wet process and impervious character obtained by through verification.

The insulator shall be made of highest grade, dense, homogeneous, wet-process porcelain, completely and uniformly vitrified throughout to produce uniform mechanical and electrical strength and long life service. The porcelain shall be free from warping, roughness, cracks, blisters, lamination, projecting points foreign particles and other defects, except those within the limits of standard accepted practice. Surfaces and grooves shall be shaped for easy cleaning. Shells shall be substantially symmetrical.

#### 4.1.1 Porcelain glaze:

Surface to come in contact with cement shall be made rough by sand glazing. All other exposed surfaces shall be glazed with ceramic materials having the same temperature coefficient of expansion as that of the insulator shell. The thickness of the glaze shall be uniform throughout and the colour of the glaze shall be down. The Glaze shall have a visible luster and smooth on surface and be capable of satisfactory performance under extreme tropical climatic weather conditions and prevent ageing of the porcelain. The glaze shall remain under compression on the porcelain body through out the working temperature range.

## 4.2 **METAL PARTS:**

### 4.2.1 **Cap and Ball Pins:**

Ball pins shall be made with drop forged steel caps with malleable cast iron. They shall be in one single piece and duly hot dip galvanized. They shall not contain parts or pieces joined together welded, shrink fitted or by any other process from more than one piece of materials. The pins shall be of high tensile steel, drop forged and heat-treated. The caps shall be cast with good quality black heart malleable cast iron and annealed. Galvanizing shall be by the hot dip process with a heavy coating of zinc of very high purity. The bidder shall specify the grade composition and mechanical properties of steel used for caps and pins. The cap and pin shall be of such design that it will not yield or distort under the specified mechanical load in such a manner as to change the relative spacing of the insulators or add other stresses to the shells. The insulator caps shall be of the socket type provided with nonferrous metal or stainless steel cotter pins and shall provide positive locking of the coupling.

### 4.2.2 **Security Clips:**

The security clips shall be made of phosphor bronze or of stainless steel.

### 4.3 **FILTER MATERIAL:**

Cement to be used, as a filler material be quick setting, fast curing Portland cement. It shall not cause fracture by expansion or loosening by contraction. Cement shall not react chemically with metal parts in

contact with it and its thickness shall be as small and as uniform as possible.

#### **4.4 MATERIALS DESIGN AND WORKMANSHIP:**

##### **4.4.1 GENERAL:**

(II) All raw materials to be used in the manufacture of these insulators shall be subject to strict raw material quality control and to stage testing/ quality control during manufacturing stage to ensure the quality of the final end product. Manufacturing shall conform to the best engineering practices adopted in the field of extra high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance on Transmission lines.

(III) The design, manufacturing process and material control at various stages be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish elimination of sharp edges and corners to limit corona and radio interference voltages.

##### **4.4.2 INSULATOR SHELL:**

The design of the insulator shells shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. Shells with cracks shall be eliminated by temperature cycle test followed by mallet test. Shells shall be dried under controlled conditions of humidity and temperature.

##### **4.4.3 METAL PARTS:**

i) The pin and cap shall be designed to transmit the mechanical stress to the shell by compression and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric and of such design that it will not yield or distort under loaded conditions. The head portion of the pinball shall be suitably designed so that when the insulator is under tension the stresses are uniformly distributed over the pinhole portion of the shell. The pinball shall move freely in the cap socket either during assembly of a string or during erection of a string or when a string is placed in position.

ii) Metal caps shall be free from cracks, seams, shrinks, air holes, blowholes and rough edges. All metal surfaces shall be perfectly smooth with no projecting part or irregularities, which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stress uniformly. Pins shall not show any microscopically visible cracks, inclusions and voids.

##### **4.4.4 GALVANIZING:**

All ferrous parts, shall be hot dip galvanized in accordance with IS: 2629. The zinc to be used for galvanizing shall conform to grade Zn 99.5 as per IS: 209. The zinc coating shall be uniform, smoothly adherent, reasonably light, continuous and free from impurities such as flux, ash, rust stains, bulky white deposits and blisters. Before ball fittings are galvanized, all die flashing on the shank and on the bearing

surface of the ball shall be carefully removed without reducing the designed dimensional requirements.

**4.4.5 CEMENTING:**

The insulator design shall be such that the insulating medium shall not directly engage with hard metal. The surface of porcelain and coated with resilient paint to offset the effect of difference in thermal expansions of these materials. High quality Portland cement shall be used for cementing the porcelain to the cap & pin.

**4.4.6 SECURITY CLIPS (LOCKING DEVICES)**

The security clips to be used as locking device for ball and socket coupling shall be  $\nabla$  shaped hump type to provide for positive locking of the coupling as per IS: 2486 (Part-IV). The legs of the security clips shall allow for spreading after installation to prevent complete withdrawal from the socket. The locking device shall be resilient corrosion resistant and of sufficient mechanical strength. There shall be no possibility of the locking device to be displaced or be capable of rotation, which placed in position, and under no circumstances shall it allow separation of insulator units and fittings.  $\nabla$  type security clips are also acceptable. The hole for the security clip shall be counter sunk and the clip shall be of such design that the eye of the clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required for pulling the clip into its unlocked positions shall not be less than 50 N (5 kg.) or more than 500 N (50 kgs.).

**4.4.7 MARKING:**

Each insulator shall have the rated combined mechanical and electrical strength marked clearly on the porcelain surface. Each insulator shall also bear symbols identifying the manufacturer, month, and year of manufacture. Marking on porcelain shall be printed, not impressed, and shall be applied before firing.

**4.5 BALL AND SOCKET DESIGNATION:**

***The dimensions of the ball and sockets for 70 and 90 KN discs shall be of 16 mm and for 120 KN and 160 KN discs shall be of 20 mm designation in accordance with the standard dimensions stated in IS: 2486 (Part-II).***

**4.6 DIMENSIONAL TOLERANCE OF INSULATOR DISCS:**

It shall be ensured that the dimensions of the disc insulators are within the limits specified below:

**4.6 DIMENSIONAL TOLERANCE OF INSULATOR DISCS:**

It shall be ensured that the dimensions of the disc insulators are within the limits specified below:

**(a)**

Sl. No.	Diameter of Disc (mm)	Standard mm	in	Maximum	Minimum

1.	90 KN & 120 KN	255 & 280	As per IS	As per IS
2.	160 KN	305	As per IS	As per IS

**(b)**

Sl. No.	Ball to Ball spacing Between Discs (mm)	Standard mm	in	Maximum	Minimum
1.	90 KN/120 KN	145		As per IS	As per IS
2.	160 KN	170		As per IS	As per IS

**(C) GUARANTEED TECHNICAL PARTICULARS  
FOR ANTIFOG DISC INSULATORS**

Sl. No.	DESCRIPTION	70 KN	90 KN	120KN	160 KN
1.	Manufacturer's name & address				
2	Type of Insulator	Ball & socket	Ball & socket	Ball & socket	Ball & socket
3	Size of ball & socket	16B	16B	20	20
4	Dimensions				
(a)	Disc diameter	255	255	280	305
(b)	Unit spacing	145	145	145	170
(c)	Creepage distance of the single insulator-mm	430	430	430	475
5	Electro-mechanical strength of single insulator-kN	70	90	120	160
6	Materials of shell	Porcelain	Porcelain	Porcelain	Porcelain
	<b>Electrical value</b>				
7.					
7.1	Power frequency Withstand voltage disc				
	(a) Dry-kV (rms)	80	80	85	90
	(b) Wet-kV (rms)	45	45	50	50
7.2	Power frequency flash over voltage single-disc				
	(a) Dry-kV (rms)	85	85	90	95
	(b) Wet-kV (rms)	50	50	55	55
7.3	Impulse withstand voltage 1.2/50 micro second				
	1.Positive . kV(peak)	125	125	130	135
	2.Negative . kV (peak)	125	125	130	135
7.4	Impulse Flashover voltage 1.2/50 micro second				
	1.Positive . kV(peak)	135	135	140	145
	2.Negative . kV (peak)	130	130	135	140

\* Tolerance as per relevant IS (Latest edition).

**4.7 INTERCHANGEABILITY:**

The insulators inclusive of the ball and socket fittings shall be of standard design suitable for use with hardware fittings of any make conforming to relevant Indian Standards.

**4.8 CORONA AND RIV PERFORMANCE:**

All surfaces shall be even, smooth, without cuts, abrasions or projections. No part shall be subject to excessive localized pressure. The metal parts and porcelain shall not produce any noise-generating corona under all operating conditions.

**4.9 SUITABILITY FOR LIVE LINE MAINTENANCE:**

The insulator shall be compatible for use with hot line or live line maintenance techniques so that usual hot line operation can be carried out with easy speed and safety.

**4.10 FREEDOM FROM DEFECTS:**

Insulators shall have none of the following defects:

- 1) Ball pin shake.
- 2) Cementing defects near the pin like small blow holes, small hair cracks lumps etc.
- 3) Sand fall defects on the surface of the insulator.

**4.11 INSULATOR STRINGS:**

**4.11.1 TYPE AND RATING:**

The insulator strings shall be formed with standard discs described in this specification for use on 3 phases 132/22 KV 50 Hz effectively earthed systems in an atmosphere with pollution level as indicated in project synopsis. Suspension insulator strings for use with suspension/tangent towers are to be fitted with discs 70/90 KN EMS rating while tension insulator strings for use with Anchor/ Tension towers are to be fitted with discs of 120 KN / 160 KN EMS level rating.

**4.11.2 STRING SIZE:**

The sizes of the disc insulator, the number to be used in different types of strings, their electro-mechanical strength and minimum nominal creep age distance shall be as given in clause 3.12

**4.12 STRING CHARACTERISTICS:**

4.12.1 The characteristics of the complete string shall be as follows:

Sl. No.	Description.	Suspension.		Tension.	
		132K V	220kV	132KV	220KV
I	Switching surge withstand voltage (dry & wet) KV peak.	-	-	-	-
ii	Lighting impulse withstand voltage (dry) KV Peak.	650	1050	650	1050
iii	Power frequency without voltage (wet) KV r.m.s.	275	460	275	460
iv.	Corona extinction voltage level	-	176	-	176

	KV rms				
v.	Max. RIV for comp. Etc. strong including corona rings at 156 KV (rms). ̄ hours clamps etc. at 1.1. times maximum knee to ground voltage (micro volts).	-	500	-	500
vi.	Mechanical failing load for each sting (kgf)	6500	11500	11500	15500
Vii.	No deformation load for each string (kgf)	-	7705	-	10385
Viii.	Max. voltage across any disc.	13%	13%	13%	13%

4.12.2 Insulator units after assembly shall be concentric and coaxial within limits as permitted by Indian Standards.

4.12.3 The strings design shall be such that when units are coupled together there shall be contact between the shell of one unit and metal of the adjacent unit.

5.0 DETAILS OF SOLID CORE LONG ROD INSULATORS:

5.1 The insulator shall consist of standard-discs for a three-phase 50 Hz effectively earthed 132 KV transmission system heavily polluted atmosphere. The insulator shall be ball and socket type.

5.2 The size of long rod insulator, minimum creepage distance, the number to be used in different type of strings, their electromechanical strength and mechanical strength of insulator string along with hardware shall be as follows:

Sl. No.	Type of string.	Size of long rod insulator (mm)/(Unit) 132/220 KV	Minimum creepage distance (mm) 132/220 KV	No. of unit 132/220 KV)	Electromechanical strength of insulator (KN) 132/220 KV)
1.	Single suspension	200X 1305 /210X2030	4000 / 6125	'1/2	90 KN
2.	Double suspension	-do-	-do-	'2/4	90 KN
3.	Single tension.	205 X 1450 / 215X2550	4300/7130	'1/2	120 KN/160 KN
4.	Double Tension.	-do-	-do-	'2/4	120 KN/160 KN

6.0 **SPECIFICATION DRAWINGS:**

6.1 The specification in respect of the long rod insulators indicated above is given at Annexure-II. These specification is for information and guidance of the bidder only. The drawings to be furnished by the

supplier shall be as per his own design and manufacture and shall be in line with the specification.

7.0 **GENERAL TECHNICAL REQUIREMENT:**

7.1 **PORCELAIN:**

The porcelain used in the manufacture of the shell shall be ivory white, nonporous of high dielectric, mechanical and thermal strength free from internal stress blisters and thermal strength from internal stresses blisters, laminations, voids, foreign matter. Imperfections or other defects, which might render it in any way unsuitable for insulator shells. Porcelain shall remain unaffected by climatic conditions, ozone, acid alkalis, and zinc of dust. The manufacturing shall be by the wet process and impervious character obtained by through vetrification.

7.2 **PORCELAIN GLAZE:**

Surfaces to come in contact with cement shall be made rough by stand glazing. All other exposed surfaces shall be glazed with ceramic materials having the same temperature coefficient of expansion as that of the insulator shell. The thickness of the glaze shall be uniform throughout and the colour of the glaze shall be brown. The glaze shall have a visible luster and smooth on surface and be capable of satisfactory performance under extreme tropical climatic weather conditions and prevent ageing of the porcelain. The glaze shall remain under compression on the porcelain body throughout the working temperature range.

7.3 **METAL PARTS:**

7.3.1 **Cap and Ball pins:**

Twin Ball pins shall be made with drop forged steel and caps with malleable cast iron. They shall be in one single piece and duly hot dip galvanized. They shall not contain parts or pieces joined together, welded, shrink fitted or by any other process from more than one piece of material. The pins shall be of high tensile steel, drop forged and heat malleable cast iron and annealed. Galvanizing shall be by the hot dip process with a heavy coating of zinc of very high purity with minimum of 6 dips. The bidder shall specify the grade, composition and mechanical properties of steel used for caps and pins.

7.3.2 **SECURITY CLIPS:**

The security clips shall be made of phosphor bronze or of stainless steel.

7.4 **FILLER MATERIAL:**

Cement to be used as a filler material shall be quick setting, for curing Portland cement. It shall not cause fracture by expansion or loosening by contraction. Cement shall not react chemically with metal parts in contract with it and its thickness shall be as small and as uniform as possible.

## 8.0 **MATERIAL DESIGN AND WORKMANSHIP:**

### 8.1 **GENERAL:**

i) All raw materials to be used in the manufacture of these insulators shall be subject to strict raw materials quality control and to stage testing quality control during manufacturing stage to ensure the quality of the final end product. Manufacturing shall conform to the best engineering practices adopted in the field of extra high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance on Transmission lines.

ii) The design, manufacturing process and material control at various stages be such as to give maximum working load, highest mobility, best resistance to corrosion good finish, elimination of sharp edges and corners to limit corona and radio interference voltage

### 8.2 **INSULATOR SHELL:**

The design of the insulator shell shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. Shells with cracks shall be eliminated by temperature cycle test followed by temperature cycle test followed by mallet test. Shells shall be dried under controlled conditions of humidity and temperature.

### 8.3 **METAL PARTS:**

i) The twin ball pin and cap shall be designed to transmit the mechanical stresses to the shell by compression and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric and of such design that it will not yield or distort under loaded conditions. The head portion of the insulator or is under tension the stresses are uniformly distributed over the pinhole portion of the shell. The pinball shall move freely in the cap socket either during assembly of a string or during erection of a string or when a string is placed in position.

ii) Metal caps shall be free from cracks, seams, shrinks, air holes, blowholes and rough edges. All metal surfaces shall be perfectly smooth with no projecting parts or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly. Pins shall not show any macroscopically visible cracks, insulations and voids.

### 8.4 **GALVANIZING:**

All ferrous parts shall be hot dip galvanized six times in accordance with IS: 2629. The zinc to be used for galvanizing shall conform to grade Zn 99.5 as per IS: 209. The zinc coating shall be uniform, smoothly adherent, reasonably light, continuous and free from impurities such as flux ash, rust stains, bulky white deposits and blisters. Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the designed dimensional requirements.

#### 8.4.1 **CEMENTING:**

The insulator design shall be such that the insulating medium shall not directly engage with hard metal. The surfaces of porcelain and coated with resilient paint to offset the effect of difference in thermal expansions of these materials.

**8.5 SECURITY CLIPS (LOCKING DEVICES)**

The security clips to be used as locking device for ball and socket coupling shall be  $\nabla$  shaped hump type to provide for positive locking of the coupling as per IS: 2486 (Part-IV). The legs of the security clips shall allow for some adding after installation to prevent complete withdrawal from the socket. The locking device shall be resilient corrosion resistant and of sufficient mechanical strength. There shall be no possibility of the locking device to be displaced or be capable of rotation when placed in position and under no circumstances shall it allow separation of insulator units and fitting  $\nabla$  type security clips are also acceptable. The hole for the security clip shall be countersunk and the clip shall be of such design that the eye of the clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required for pulling the clip into its unlocked position shall not be less than 50 N (5 Kgs.) or more than 500N (50 Kgs.)

**8.6 BALL AND SOCKET DESIGNATION:**

The dimensions of the balls and sockets for 80 KN long rod insulators shall be of 16mm and for 120 KN shall be of 20mm designation in accordance with the standard dimensions stated in IS: 2486 (Part-III).

**8.7 DIMENSIONAL TOLERANCE OF INSULATORS DISCS**

It shall be ensured that the dimensions of the long rod insulators are within the limits as per relevant IEC/ISS.

**9.0 TESTS (FOR DISC INSULATORS) :**

9.1 The following tests shall be carried out on the insulator string and disc insulators.

**9.2 TYPE TEST:**

This shall mean those tests, which are to be carried out to prove the design, process of manufacture and general conformity of the material and product with the intents of this specification. These tests shall be conducted on a representative number of samples prior to commencement of commercial production. The Bidder shall indicate his schedule for carrying out these tests.

**9.3 ACCEPTANCE:**

This shall mean these tests, which are to be carried out on samples taken from each lot offered for pre-despatch inspection for the purpose of acceptance of the lot.

**9.4 ROUTINE TESTS:**

This shall mean those tests, which are to be carried out on each insulator to check the requirements, which are likely to vary during production.

9.5 **TESTS DURING MANUFACTURE:**

Stage tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture to ensure quality control such that the end product is of the designed quality conforming to the intent of this specification.

9.6 **TEST VALUE:**

For all type and acceptance tests the acceptance values shall be the value guaranteed by the bidder in the guaranteed technical particulars of the acceptance value specified in this specification of the relevant standard whichever is more stringent for that particular test.

9.7 **TEST PROCEDURE AND SAMPLING NORMS:**

The norms and procedure of sampling for the above tests shall be as per the relevant Indian Standard or the Internationally accepted standards. This will be discussed and mutually agreed to between the supplier and purchaser before placement of order. The standards and normal according to which these tests are to be carried out are listed against each test. Where a particular test is a specific requirement of this specification, the norms and procedure for the same shall be as specified in Annexure-IV attached hereto as mutually agreed to between the supplier and the purchaser in the quality assurance programme.

9.8 **TYPE TESTS:**

The following type test shall be conducted on a suitable number of individual unit components, materials or complete strings.

9.8.1 On the complete insulator string with hardware fittings.

- a) Power frequency voltage withstand test with corona control rings and under wet condition. : BS:137(Part-I)
- b) Switching surge voltage withstand test under wet condition (400 only) :
- c) Impulse voltage withstand test under dry condition. : IEC: 383
- d) Impulse voltage flashover test under dry condition. :
- e) Voltage distribution test. :
- f) Corona & RIV test under dry condition. : As per this specification.
- g) Mechanical strength test. : As per this specification.
- h) Vibration. :

9.8.2 On Insulators:

- a) Verification of dimensions. : IS: 731
- b) Thermal mechanical performance test: : IEC:575
- c) Power frequency voltage withstand and : BS: 173

- flashover  
(l) dry (ii) wet.
- d) Impulse voltage withstand flashover test (dry) : IEC: 383  
e) Visible discharge test (dry) : IS:731  
f) RIV test (dry) : IS:8263
- 9.8.3 All the type tests given under clause No.6.8.1 above shall be conducted on single suspension and Double Tension insulator string alongwith hardware fittings.
- 9.9 **ACCEPTANCE TESTS:**
- 9.9.1 **For insulator:**
- a) Visual examination : IS:731  
b) Verification of dimensions. : IS:731  
c) Temperature cycle test. : IS:731  
d) Galvanizing test. : IS:731  
e) Mechanical performance test. : IEC:575  
f) Test on locking device for ball and socket coupling. : IEC:372  
g) Eccentricity test. : As per this specification.  
h) Electro-mechanical strength test. :  
i) Puncture test. : IS:731  
j) Porosity test. : IS:731
- 9.10 **ROUTINE TESTS:**
- 9.10.1 **For insulators:**
- a) Visual inspection. : IS:731  
b) Mechanical routine test. :  
c) Electrical routine test. : IEC:383
- 9.11 **TEST DURING MANUFACTURE:**  
On all components as applicable.
- a) Chemical analysis of zinc used for galvanizing. :  
b) Chemical analysis, mechanical and metallographic test and magnetic particle inspection for malleable castings. :  
c) Chemical analysis, hardness test and magnetic particle inspection for forgings. : As per this specification.  
d) Hydraulic Internal Pressure tests on shell. :  
e) Crack detection test for metal parts. :
- 9.12 **ADDITIONAL TEST:**  
The purchaser reserves the right for carrying out any other tests of a reasonable nature at the works of the supplier/ laboratory or at any other recognized laboratory/ research institute in addition to the above mentioned type, acceptance and routine tests at the cost of the purchaser to satisfy that the material complies with the intent of this specification.

9.13 **CO-ORDINATION FOR TESTING:**

For insulator strings, the supplier shall arrange to conduct testing of their disc insulators with the hardware fittings to be supplied to the purchaser by other suppliers. The supplier is also required to guarantee overall satisfactory performance of the disc insulator with the hardware fittings.

**NOTE:**

In respect of electrical tests on a complete string consisting of insulators and hardware guarantee of values of responsibility of testing shall be with hardware manufacturer of RIV corona and voltage distribution test and with insulator manufacturer for all other tests.

9.14 **TEST CHARGES AND TEST SCHEDULE:**

9.14.1 **TYPE TEST:**

The insulator offered shall be fully type tested as per this specification. In case the equipment of the type and design offered, has already been type tested in an independent test laboratory. The bidder shall furnish four sets of type test reports alongwith the offer. These tests must not have been conducted earlier than five years. The purchaser reserves the right to demand repetition of some or all type tests in the presence of purchaser's carrying representative. For this purpose the bidder may quote unit rates for carrying out each type test. These prices shall be taken into consideration for bid evaluation. For any change in the design/type already type tested and the design/type offered against this specification, purchaser reserves the right to demand repetition of tests without any extra cost.

9.14.2 **ACCEPTANCE AND ROUTINE TEST:**

All acceptance and routine tests as stipulated herein shall be carried out by the supplier in the presence of purchaser's representative.

9.14.3 Immediately after finalisation of the programme of type/ acceptance/ routine testing, the supplier shall give sufficient advance intimation to the purchaser to enable him to depute his representative for witnessing the tests.

9.14.4 For type tests involving tests on a complete insulator string with hardware fittings, the purchaser will advice the supplier of the hardware fittings to provide the necessary fittings to the place of the test.

9.14.5 In case of failure of the complete string in any type tests, the supplier whose product has failed in the tests, shall get the tests repeated at his cost. In case of any dispute, assessment of the purchaser as to the items that has caused the failure in any of the type tests shall be final and binding.

10. **INSPECTION:**

10.1 i. Purchaser and its representative shall at all times be entitled to have access to the works and to all places of manufacturer where insulators are manufactured and the supplier shall afford

all facilities to them for unrestricted inspection of the works, inspection of materials, inspection of manufacturing process of insulators and for conducting necessary tests as specified herein.

- ii. The supplier shall keep the purchaser informed in advance of the time of starting and of progress of manufacture of insulators in its various stages so that arrangements could be made for inspection.
- iii. No material shall be dispatched from its point of manufacture unless the materials has been satisfactorily inspected and tested.
- iv. The acceptance of any quantity of insulators shall in no way relieve the supplier of his responsibility for meeting all the requirement of this specification and shall not prevent subsequent rejection, if such insulators are later found to be defective.

## 10.2 **IDENTIFICATION MARKING:**

10.2.1 Each unit of insulator shall be legibly and indelibly marked with the trade mark of the supplier, the year of manufacture, the guaranteed combined mechanical and electrical strength in kilo-newtons abbreviated by  $\text{kNq}$  to facilitate easy identification and proper use.

10.2.2 The marking shall be on porcelain for porcelain insulators. The marking shall be printed and not impressed and the same shall be applied before firing.

## 11. **QUALITY ASSURANCE PLAN:**

11.1 The bidder hereunder shall invariably furnish following information alongwith his offer, failing which the offer shall be liable for rejection.

- i. Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw material are tested, list of tests normally carried out on raw materials in presence of bidder's representative, copies of test certificates.
- ii. Informations and copies of test certificates as in (i) above in respect of bought out materials.
- iii. List of manufacturing facilities available.
- iv. Level of automation achieved and lists of area where manual processing exists.
- v. List of areas in manufacturing process, where stage inspections are normally carried out in quality control and details of such tests and inspection.
- vi. Special features provided in the equipment to make it maintenance free.
- vii. List of testing equipping available with the bidder for final testing of equipment specified and test plant limitation, if any, vis-à-vis the type, special, acceptance and routine tests specified in the relevant standards. These

limitations shall be very clearly brought out in schedule of deviations from specified test requirements.

11.2 The supplier shall within 30 days of placement of order submit the following information to the owner.

i) List of raw material and the names of sub-suppliers selected from those furnished alongwith the offer.

#### POST INSULATORS.

Post insulator shall conform in general to IS 2544, IEC 168 and IEC 815.

##### 3.1 constructional features

Post type insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright and be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators will be acceptable.

Porcelain used shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

Glazing of the porcelain shall be of uniform brown in colour, free from blisters, burrs and other similar defects.

The insulator shall have alternate long and short sheds with aerodynamic profile. The shed profile shall also meet the requirements of IEC 815 for the specified pollution level.

When operated at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or insulators by the formation of substance produced by chemical action.

The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

All ferrous parts shall be hot dip galvanized in accordance with the latest edition of IS 2633, and IS 4579. The zinc used for galvanizing shall be grade Zn 99.95 as per IS 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux ash, rust stains, bulky white deposits and blisters. The metal parts shall not produce any noise generating corona under the operating conditions. Flat washer shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the beveled surfaces they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.

Bidder shall make available data on all the essential features of design including the method of assembly of shells and metal parts, number of

shells per insulator, the manner in which mechanical stresses are transmitted through shells to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

## **12. TEST DETAILS.**

### **1. VOLTAGE DISTRIBUTION TEST:**

The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage and proportionate correction be applied as to give a total of 100% distribution. The voltage across any disc. Not exceed the values given in clause 4-12.1

### **2. CORONA EXTINCTION VOLTAGE TEST (DRY):**

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than the value specified at clause 4.12.1 (iv) under dry condition. There shall be no evidence of corona on any part of the sample when all possible sources of corona are photographed in a darkened room.

### **3. RIV TEST (DRY):**

Under the conditions as specified in (2) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 500 micro volts at one MHz when subjected to 50 Hz AC voltage of 1.1 times maximum time to ground voltage under dry condition. The test procedure shall be in accordance with IS: 8263.

4. The complete insulator string along with its hardware fitting excluding arcing horn corona controlling/grading ring and suspension assembly/dead end assembly shall be subject to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased already rate to 68% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to disassemble them by hand,. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing loads reached and the value recorded.

### **5. VIBRATION TEST:**

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 meters. In the case of suspensions string a load equal to 600 Kg. shall be applied along with the axis of the suspensions string by means of turn buckle. The insulators string along with hardware fittings and two sub

conductors throughout the duration of the test vibration dampers shall not be used on the test span. Both the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulator string (more than 10Hz) by means of vibration inducing equipment. The amplitude of vibration at the antipode point nearest to the string shall be measured and the same shall not be less than 120.4 being the frequency of vibration. The insulator strings shall be vibrated for five million cycles then rotated by 90 deg and again vibrated for 5 million cycles without any failure, after the test, the disc insulators shall be examined for looseness of pins and cap or any crack in the cement. The hardware fittings shall be examined to fatigue fatter and mechanical strength test. There shall be no deterioration of properties of hardware components and disc insulators after the vibration test. The disc insulators shall be subjected to the following tests as per relevant standards.

Test.	Percentage of disc To be tested.
a) Temperature cycle test followed by Mechanical performance test.	60 40
b) Puncture test (for porcelain insulator only)	

6. **CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING.**

Samples taken from the zinc ingot shall be chemically analysed as per IS: 209. The purity of zinc shall not be less than 99.95%.

7. **TEST FOR FORGINGS:**

The chemical analysis hardness tests and magnetic particle inspection for forgings will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the supplier and purchaser in quality assurance programme.

1. **TEST ON CASTING:**

The chemical analysis mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally recognized procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the supplier and purchaser in quality assurance programme.

2. **HYDRAULIC INTERNAL PRESSURE TEST ON SHELLS:**

The test shall be earned out on 100% shells before assembly. The details regarding test will be as discussed and mutually agreed to by the suppliers and purchaser in Quality Assurance Programme.

3. **THERMAL MECHANICAL PERFORMANCE TEST:**

The thermal mechanical performance test shall be carried out on minimum 15 number of disc insulators units as per the procedure given in IEC 575. The performance of the insulator unit shall be determined by the same standard.

4. **ECCENTRICITY TEST:**

The insulator shall be vertically mounted on a fixture using dummy pin and socket. A vertical scale with horizontal slider shall be used for the axial run out. The pointer shall be positioned in contact with the bottom of the outermost petticoat of the disc. The disc insulators shall be rotated with reference to the fixture and the slider shall be allowed to move up and down on the scale but always maintaining contact with the bottom of the outer most petticoats. After one full rotation of the disc the maximum and minimum position the slider has reached on the scale can be found out. Difference between the above two readings shall satisfy the guaranteed value for axial run out.

Similarly using a horizontal scale with vertical slider the radial run out shall be measured. The slider shall be positioned on the scale to establish contact with the circumference of the disc insulator and disc insulator rotated on its fixture always maintaining the contact. After one full rotation of the disc the maximum and minimum position the slider has reached on the scale can be found out. Difference between the above two readings shall satisfy the guaranteed value for axial run out.

5. **CRACK DETECTION TEST:**

Crack detection test shall be carried out on each ball and pin before assembly of disc unit. The supplier shall maintain complete record of having conducted such tests on each and every piece of ball pin. The bidder shall furnish full details of the equipment available with him for crack test and also indicate the test procedure in detail.

## 6. Tubular bus conductors:

### General

Aluminium used shall be grade 63401 WP conforming to IS 5082. The tube shall be seamless and shall be manufactured by either of the following processes:

- Hot extrusion process through die and mandrel (Hollow billet process). Heat treatment shall be carried out after hot extrusion of tube.
- Bridge extrusion process and then cold drawn. Heat treatment shall be carried out after cold drawing of tube.

### Constructional features

For outside diameter (OD) and thickness of the tube there shall be no minus tolerance, other requirements being as per IS 2678 and IS 2673.

The aluminium tube shall be supplied in suitable cut length to minimise wastage.

### Technical parameters

Sl No.	Size	4" IPS	3"IPS	4.5"IPS
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		(EH type)	(EH type)	(EH type)
1	Outer diameter (mm)	114.20	88.9	120.0
2	Thickness (mm) :	8.51	7.62	12.0
3	Cross-sectional area (sq.mm) :	2825.61	2373.63	4071.5
4	Weight (kg/m) :	7.7	6.44	10.993
5	Chemical composition			
	i) Cu	0.05 max	0.05 max	0.05 max
	ii) Mg	0.4 to 0.9	0.4 to 0.9	0.4 to 0.9
	iii) Si	0.3 to 0.7	0.3 to 0.7	0.3 to 0.7
	iv) Fe	0.5 max	0.5 max	0.5 max
	v) Mn	0.03 max	0.03 max	0.03 max
	vi) Al	Remainder	Remainder	Remainder
6	Minimum ultimate Tensile strength Kg/Sq mm	20.5	20.5	20.5
7	Temp co-eff of resistance		0.00364 per Deg C	
8	Minimum electrical conductivity at 20 deg C		55% of IACS	
9	Modulus of Elasticity		6700 Kg/sq mm	

## 7. Post insulators:

Post insulators shall conform in general to IS 2544, IEC 168 and IEC 815.

### Constructional features

Post type insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright and be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators will be acceptable.

Porcelain used shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

Glazing of the porcelain shall be of uniform brown in colour, free from blisters, burrs and other similar defects.

The insulator shall have alternate long and short sheds with aerodynamic profile. The shed profile shall also meet the requirements of IEC 815 for the specified pollution level.

When operating at normal rated voltage there shall be no electric discharge between conductor and insulators, which would cause corrosion or injury to conductors, or insulators by the formation of substance produced by chemical action.

The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

All ferrous parts shall be hot dip galvanised in accordance with the latest edition of IS 2633, and IS 4579. The zinc used for galvanising shall be grade Zn 99.95 as per IS 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux ash, rust stains, bulky white deposits and blisters. The metal parts shall not produce any noise generating corona under the operating conditions.

Flat washer shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the bevelled surfaces they shall be

provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.

Bidder shall make available data on all the essential features of design including the method of assembly of shells and metals parts, number of shells per insulator, the manner in which mechanical stresses are transmitted through shells to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

### **Services to be performed by the equipment being furnished**

The equipment shall be able to withstand forces due to wind load on the equipment and approach conductor and due to short circuit, all forces considered together.

The Contractor shall submit detailed calculations proving the satisfactory performance of the equipment under short circuit conditions to meet the layout requirements.

### **Technical Parameters**

SI No.	Parameter	400kV	245kV	132kV	33kV
1	Type	Confirming to IEC 273 (solid core )			
2	Voltage class (kV)	420	245	145	36
3	Dry and wet one minute withstand voltage (kVrms)	630	460	235	70
4	Dry lightning impulse withstand voltage (kVp)	± 1550	± 1050	± 650	± 250
5	Wet switching surge withstand voltage (kVp)	± 1175	NA	NA	NA
6	Max. RIV at corona extinction voltage (microvolts)	500	500	500	NA
7	Corona extinction voltage (kVrms)	320 (min)	156 (min)	105	
9	Total minimum cantilever strength (kg)	not< 800	not< 800	not< 600	not< 600
10	Minimum torsional moment	As per IEC 273			
11	Total height of insulator (mm)	3650	2300	1100	325
12	PCD (mm) top/bottom	127/300	127/254	127/254	76/76
13	No. of bolts top/bottom	4/8	4/8	4/8	4/8
14	Diameter of bolt holes (mm) top/bottom	M16/18	M16/18	M16/18	M16/18
15	Pollution level as per IEC 815	Heavy	Heavy	Heavy	Heavy
16	Minimum total creepage distance (mm)	10500	6125	3625	900

If corona extinction voltage is to be achieved with the help of corona ring or any other similar device, the same shall be deemed to be included in the scope of the Supplier.

## 8. Spacers

### General

Spacers shall conform to IS 10162. Spacers are to be located at a suitable spacing to limit the short circuit forces and also to avoid snapping of sub conductors during short circuit conditions.

### Constructional features

No magnetic material shall be used in the fabrication of spacers except for GI bolts and nuts.

Spacer design shall be made to take care of fixing and removing during installation and maintenance.

The design of the spacers shall be such that the conductor does not come in contact with any sharp edge.

## SECTION-IV HARDWARES

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## TECHNICAL SPECIFICATION FOR HARDWARE FITTINGS.

SUITABLE FOR GALVANISED STEEL STRANDED GROUNDWIRE (7/3.15mm and 7/3.66 mm) ACCESSORIES AND POWER CONDUCTOR ACSR PANTHER ,ACSR ZEBRA AND MOOSE.

### **1.0 SCOPE**

This Specification covers design (if required), manufacture, testing at manufacturer's Works, supply and delivery of GSS), power conductor and ground wire accessories, insulator and hardware fittings for string insulators suitable for use in 220 and 132 KV Over-head transmission lines and substations of OPTCL. The hard wares to be supplied shall be as per approved drawings of OPTCL. Any change there of shall be with due permission of Sr. G.M (CPC).The firm shall submit his drawings for approval of OPTCL and only after which the manufacturing shall be started.

The materials/equipment offered, shall be complete with all components, which are necessary or usual for the efficient performance and satisfactory maintenance. Such part shall be deemed to be within the scope of contract.

## **2.0 STANDARDS**

The materials covered under this Specification shall comply with the requirement of the latest version of the following standards as amended upto date, except where specified otherwise.

- i) IS:2486 Part-II & III : Insulator fitting for overhead power lines with a nominal voltage greater than 1,000 volts.
- ii) IS:2121 Part I & II Conductor & earth wire accessories for overhead power lines.
- iii) IS:9708 Stock Bridge Vibration Dampers on overhead power lines.
- iv) IS:2633 Method of testing of uniformity of coating on zinc coated articles
- v) IS:209 Specification for Zinc.
- vi) BS:916 Specification for Hexagonal bolts and nuts.

## **3.0 MATERIALS AND DESIGN**

Aluminium and aluminium alloys, malleable iron and forged steel, having required mechanical strength, corrosion resistance and machinability depending on the types of application for which accessories / fittings are needed, shall be employed.

In manufacturer of the accessories / fittings, the composition of the aluminium alloys used shall be made available to Employer if required for verification.

The materials offered shall be of first class quality, workmanship, well finished and approved design. All castings shall be free from blow-holes, flaws, cracks of other defects and shall be smooth, close grained and true forms and dimensions. All machined surfaces should be free, smooth and well finished.

Metal fittings of specified material for conductor and earth wire accessories and string insulator fittings are required to have excellent mechanical properties such as strength, toughness and high resistance against corrosion. All current carrying parts shall be so designed and manufactured that contact resistance is reduced to the minimum.

All bolts, nuts, bolt-heads shall be the white wrought standard thread. Bolt heads and nuts shall be hexagonal. Nuts shall be locked in an approved manner. The treads in nuts and tapped holes shall be cut after galvanising and shall be well fabricated and greased. All other treads shall be cut before galvanising. The bolt treads shall be undercut to take care of increase in diameter due to galvanising.

All nuts shall be made of materials to Clause 4.8 of IS:1367 (latest edition) with regard to its mechanical properties.

The general design conductor and earthe wire accessories and insulator fittings shall be such as to ensure uniformity, high strength, free from corona formation and high resistance against corrosion even in case of high level of atmosphere pollution.

All hooks, eyes, pins, bolts, suspension clamps and other fittings for attaching to the tower or to the line conductor or to the earthwire shall be so designed that the effects of vibration, both on the conductor and the fittings itself, are minimized.

Special attention must be given to ensure smooth finished surface throughout. Adequate bearing area between fittings shall be provided and point or line contacts shall be avoided.

All accessories and hardwares shall be free from cracks, shrinks, slender air holes, burrs or rough edges.

The design of he accessories and hardwares shall be such as to avoid local corona formation or discharge likely to cause interference to tele-transmission signals of any kind.

#### **4.0 GALVANISING :**

All ferrous parts of conductor and ground wire accessories and insulator hardwares shall be galvanised in accordance with IS:2629-Recommended Practice for hot dip galvanising of iron and steel or any other equivalent authoritative standards. The weight of zinc coating shall be determined as per method stipulated in IS:2633 for testing weights, thickness and uniformity of coating of hot dip galvanised articles or as per any other equivalent authoritative standards. The zinc used or galvanisation shall conform to grade zn 98 of IS:209. The galvanised parts shall withstand four (4) dips of 1 minute each time while testing uniformity of zinc coating as per IS:2633.

**Spring washers shall be elctro galvanised.**

#### **5.0 ACCESSORIES FOR CONDUCTOR AND GROUND WIRE, MID SPAN COMPRESSION JOINTS:FOR ACSR- PANTHER ,ZEBRA, MOOSE AND GROUNDWIRE OF 7/3.15 and 7/3.66 mm.**

The Mid-Span Joints for conductor and earthwire shall be of compression type. The conductor mid-span joints shall comprise of outer aluminium sleeve of extruded aluminium (99.5% purity) and inner sleeve HDG Steel. All filler plug shall also be provided. The ground wire mid-span joints shall be of HDG steel. The sleeves shall be of circular shape suitable for compression into hexagonal shape.

The compression type mid-span straight joints shall be suitable for making joints in the ACSR öPANTHER,ZEBRA & MOOSEö conductor or in the galvanised steel stranded ground wire.

The joints shall be so designed that when installed no air space is left within the finished joints. The joints shall have the conductivity as specified in relevant Clause.

The joints shall conform to IS:2121 (latest edition) unless specified otherwise. The details of the joints both suitable for ACSR- Panther,Zebra & Moose and ground wire are given in the technical particulars.

The inner and outer diameters and lengths of the offered joints before and after compression shall be clearly shown in the drawings.

## **6.0 VIBRATION DAMPER FOR ACSR PANTHER,ZEBRA MOOSE AND GROUND WIRE(7/3.15 and 7/3.66 mm)**

Vibration Damper having 4 resonance frequency characteristic commonly called 4R Damper shall be offered. The Damper shall eliminate fatigue on the conductor due to vibration and damp out the vibration effectively so that no damage due to vibration is caused to conductor / ground wire / string.

The dampers are proposed to be used at all tension locations and also at suspension locations. One or more dampers are proposed to be used on tension/suspension locations depending upon the span.

Bidder shall also recommend the number of damper required to effectively damp out conductor or ground wire vibration for different values of span lengths and the distance of fixation.

Vibration dampers shall be of approved design. The clamps of the vibration dampers shall be made of aluminium alloy, so designed as to prevent any damage while fixing on the conductor during erection or in continued operation. The fastening bolts should be approved by the Employer. The spring washers should be electro galvanised and of minimum 2 mm thickness.

The messenger cable shall be made from high tensile strength steel strands in order to prevent subsequent drop of weight in service.

Clamping bolts shall be provided with self locking nuts as designed to prevent corrosion of the threads. All ferrous parts including the messenger cable shall be hot dip galvanised. The end of the messenger cable shall be effectively sealed to prevent corrosion.

The vibration dampers and its attachment shall have smooth surface so that no corona occurs on them.

The clamps of the stock bridge vibration dampers shall be so designed that in case of loosening of the bolt or changing free parts of the clamp, it does not allow the damper to disengage from the conductor.

## **7.0 REPAIR SLEEVE FOR ACSR PANTHER,ZEBRA,MOOSE AND GROUNDWIRE :**

Compression type repair sleeves shall be offered to provide reinforcement for conductor with broken or damaged aluminium strands/galvanised steel ground wire broken in damaged steel strands. The repair sleeve shall be designed to make good a conductor of which not more than one-sixth (1/6<sup>th</sup>) of the strands in the outermost layer and damaged or severed. The repair sleeves after compression should present a smooth surface.

## **8.0 SUSPENSION CLAMPS : FOR GROUND WIRE**

Suspension clamps of suitable size are required for holding the galvanised steel stranded ground wire at suspension points. The suspension clamps shall be suspended from the lower hanger or  $\pm\text{D}\phi$  belt of 16 mm. dia. And should, therefore, be supplied with a suitable attached that would allow the clamps to swing freely both in the transverse and longitudinal direction. The clamps shall be so designed that the effect of vibration both on the groundwire and the fittings itself is minimum.

The clamps shall be manufactured and finished so as to avoid sharp radii of curvature, ridges which might lead to localized pressure and damage the ground wire in service.

The clamps shall be made of heat treated malleable iron one Eye hook made of forced steel. The entire assembly shall be hot dip galvanized.

The clamping surface shall be smooth and formed to support the groundwire on long easy curves to take care of required steel vertical and horizontal angles.

The clamps shall permit the groundwire to slip before the failure of the latter occurs. The leg of U-bolt holding the keeper piece of the clamps shall be kept sufficiently long and shall be provided with threads, nuts and locking nuts for fixing the flexible earthing bond between the suspension clamps and tower structures.

## **9.0 TENSION CLAMPS (DEAD END ASSEMBLY) FOR GROUND WIRE.**

Compression type dead end assembly of G.S.S. ground wire shall be required for use on the tension towers. The dead end assembly shall be supplied with complete jumper terminals, nuts and bolts suitable link pieces between the steel clevis and tower strain plates so as to provide sufficient flexibility not less than that of G.S.S. ground wire and the tensile strength not less than 90% that of the G.S.S. ground wire.

The assemblies shall comprise of compression type dead end clamps and one anchor shackle made of forged steel. The entire assembly shall be hot dip galvanized.

One of bolt holding joint per terminal of dead end assemblies shall be kept sufficiently long and threaded and shall be provided with nuts, washers and locking nuts for fixing the flexible earthing bond between the dead-end clamp and tower structures.

## **10.0 BONDING PIECES (FLEXIBLE COPPER EARTHING BOND FOR EARTH WIRE 7/3.15 and 7/3.66 mm)**

The tenderer shall offer flexible copper earthing bonding pieces for connecting the ground wire suspension and tension clamps and tower legs suitable for earthing. Each bond piece shall have suitable compression type galvanized steel lug or thimble on either end for making connections to clamp and tower legs. The size, strength, etc. of the bonding piece is given in this Specification.

## **11.0 INSULATOR HARDWARES**

The insulator disc hardware and string assemblies to be offered by the tenderer shall be suitable to meet the requirement given in the specific technical particulars as detailed hereinafter.

Hardware for suspension and tension insulator shall be suitable for insulator with normal pin shank diameter of 20 mm. in case of tension string unit and 16mm. for suspension string unit.

Each insulator string shall generally include the following hardware components.

Single Suspension Set.

Double Suspension Set.

- a) Ball Hook
- b) tower side arcing horn

- c) Socket Eye with R-Type security clip.
- d) Line side arcing horn.

- e) Armour grip suspension clamps

Single Tension Set :

- a) Anchor Shackle.
- b) Ball Eye.
- c) Tower side arcing horn.
- d) Socket Clevis with R-Type security clip.
- e) Line side arcing horn
- f) Compression type dead end clamp.

- a) Ball Hook.
- b) Socket clevis with R-Type security clip-3 Nos.

- c) Yoke Plate-2 Nos.
- d) Tower side arcing horns-2Nos.

- e) Ball clevis – 2 Nos.
- f) Line side arcing horns-2 Nos.
- g) Clevis Eye.
- h) Armour Grip Suspension Clamp.

Double Tension Set :

- a) Anchor Shackle.
- b) Chain Link
- c) Yoke Plate – 2 Nos.
- d) Tower side arching horn.
- e) Ball Clevis – 2 Nos.
- f) Socket Clevis with R-Type security clip – 2 Nos.
- g) Line side arcing horns.
- h) Compression type dead end clamps.

## **12.0 CLAMP**

### **12.1 ARMOUR GRIP SUSPENSION CLAMPS**

Armour Grip Suspension Clamp shall consist of 2 neoprene insert, one set of armour rods made of aluminium alloy, two aluminium housing having inner profile matching with the profile of the armour rods and supporting strap made of aluminium alloy. The A.G. type suspension clamp shall be designed, manufactured and finished as to have a suitable shape without sharp edges at the end and to hold the respective conductor properly. It should, however, have sufficient contact surface to minimise damage due to fault current. The clamp shall be of Armour Grip Type.

The A.G. type suspension clamp shall permit the conductor to slip before the occurrence of failure of the conductor and shall have sufficient slip strength to resist the conductor tension under broken wire conditions. The clamp shall have slip strength of not less than 15 % of respective conductors.

### **12.2 TENSION CLAMPS**

The Tension Clamps shall be made out of aluminium alloy and of compression type suitable for PANTHER, ZEBRA & MOOSE conductor. The tension clamps shall not permit slipping or damage to failure of the complete conductor or any part thereof at a load less than 90% of the ultimate strength of conductor. The mechanical efficiency of tension / clamps shall not be affected by method of erection involving come / along or similar clamps or tension stringing operation during or after assembly and erection of tension clamp itself. The tension clamp shall be of a design that will ensure unrestricted flow of current without use of parallel groove clamps. The clamps shall be as light as possible.

### 12.3 ARCING HORNS

Each hardware assembly shall have provision for attaching arcing horns of both adjustable and non/adjustable type across the suspension and tension strings or tower side. However each hardware assembly shall be provided with arching horn of fixed type on line side only.

### 12.4 UNIVERSAL JOINTING COMPOUND

**BENDEX-HV' Universal jointing compound which is a chemically inert compound to be used as filler for the compression joints and dead end clamps to be supplied.**

## 13.0 TESTS, TEST CERTIFICATE AND PERFORMANCE REPORTS

The fittings and accessories for the power conductor and G.S.S. ground wire, insulator and hardwares shall be tested in accordance with IS:2121, IS:2486, IS:9708 (For V Dampers), BS:916 for hexagonal bolts and nuts or any other authoritative equivalent standards. Six sets of type and routine test certificates and performance reports are to be submitted by the bidder.

The Employer however, reserves the right to get all the tests performed in accordance with the relevant I.S. Specification as Acceptance Test in presence of Employer-s representatives.

The tenderer shall clearly state the testing facilities available in the laboratory at his Works and his ability to carry out the tests in accordance with this Specification. All the specified tests shall be carried out without any extra cost.

Acceptance Test for power conductor and G.S.S. ground wire accessories.

- a) Visual examination
- b) Dimensional verification
- c) Failing load test
- d) Slip strength test (for clamps)
- e) Electrical resistance test
- f) Resonance frequency test (for vibration dampers)
- g) Fatigue test (for vibration dampers)
- h) Mass pull off test (for vibration dampers)
- i) Galvanising test.

### 13.1 ACCEPTANCE TEST FOR HARDWARES

- a) Dimensional verification.
- b) Ultimate tensile test.
- c) Slip strength test.
- d) Electrical resistance test.
- e) Heating cycle test
- f) Breaking strength of full string assembly.
- g) Galvanising test.

## 13.2 SPECIFIC TECHNICAL REQUIREMENTS FOR CONDUCTOR ACCESSORIES AND INSULATOR HARDWARES

Conductor	Panther/zebra/Moose	GSS ground wire
a) Type	ACSR Panther/zebra/Moose	Ground wire.
b) Material	Aluminium conductor steel reinforced.	Galvanised stranded steel wire.
c) Strand & Wire diameter.	Panther/Zebra/Moose Aluminium 30/3mm Steel 7/3mm,/all.54/3.18mm steel-7/3.18mm,/ all.54/3.53mm steel-7/3.53mm resp.	7/3.15 mm. and 7/3.66 mm
d) Weight per Km.	974/1622 /2004Kg/Km. 21/28.62/31.7 mm	426 Kg/Km.and 583Kg/Km 9.4mm. and 10.98 mm
e) Overall diameter	0.13750/0.06915/0.05552 Ohms/KM.	3.375 Ohms/KM
f) D.C. Resistance at 20 deg. C when corrected to standard weight.	144/13289/16120 Kg	5710 Kg.and 10580 Kg
g) Minimum Breaking load/Ultimate tensile strength.	3806/4325 Kg.	1393 Kg.
h) Maximum working tension at minimum temperature & 2/3 full wind.	6120/9240 mm.	5150mm.
i) Maximum Sag at maximum temperature & no wind.		

**DISC Insulator (for suspension & tension Insulator strings) (132 ,220 and 400 KV)**

	Disc Insulators	Suspension	Tension
a) Type		<b>Ball &amp; Socket</b>	<b>Ball &amp; Socket.</b>
b) Ball size		<b>16mm. Alt. B</b>	<b>20mm. Alt.</b>

c) Diameter	(IS:2486 Pt.II)	B/20mm
d) Spacing	254/255 mm.	(IS:2486 Pt.II)
e) E.M.	146/145 mm.	255/280 mm
strength	90/120 KN,.	145/170mm. 120/160 KN.

	Single Suspension	Single Tension	Double Suspension	Double Tension
132 KV / 220 KV /400 KV				
<b>String Arrangements :</b>				
a) No. of insulator discs.	10/14/25	10/14/25	2x10/2X14 /2X25	2x10/2 X14/
b) Length of string assembly (mm)	1672/2340	1851/3003	1837/2243	2X25 2132/30 82

## GENERAL REQUIREMENT FOR POWER CONDUCTOR & GROUND WIRE:

### I) ACCESSORIES.

#### GENERAL REQUIREMENTS POWER CONDUCTOR AND GROUND WIRE ACCESSORIES

#### A) MID-SPAN COMPRESSION JOINTS

	Suitable for ACSR Panther/zebra/Moose	Suitable for G.S.S. groundwire 7/3.15 and 7/3.66 mm.
i) Type	Compression	Compression
ii) Material	Extruded Aluminium	Extruded aluminium.
a) Outer sleeve		
b) Inner sleeve	Steel (galvanised)	Steel (Galvanised)
	Before Compression	After Compression
		Before Compression
		After Compression
iii) Dimension of Compression joint for Aluminium part.	Outer dia:38mm Inner Dia:23mm. Minimum length	Adjacent Size 32 mm. Diagonal Size : 37mm.

610mm.  
 Minimum  
 weight  
 1.2 kg.  
 (approx)

iv) Dimension of compression joint for Steel Part	Outer dia:18mm Inner dia. 9.3 mm Adjacent Size : 15.1mm Minimum Length : 203mm. Minimum weight : 0.28Kg (app.)	Adjacent size : 15.1mm. 10mm. Minimum m	Outer dia.18mm. Inner dia : 17.4mm Length 203mm.	Adjace nt Size : Diagon al
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v) Minimum failing load. 95% of ultimate tensile strength of conductor 95% of ultimate tensile strength of groundwire

vi) Electrical resistance 20 Deg. C 75% of measured resistance of the equivalent length of conductor.

vii) Galvanising :

a) Ferrous Parts. Hot-dip galvanised (HDG) Hot dip galvanised .

b) No.of dips 4 dips for 1 minute withstand. 4 dips 4 dips

viii) **110% of maximum  
Minimum line to ground  
Corona voltage  
formation  
voltage**

**B) VIBRATION DAMPERS:**

(SUITABLE FOR ACSR CONDUCTOR: PANTHER/ZEBRA /MOOSE AND G.S.S. GROUND WIRE 7/3.15 and 7/3.66 mm.

- i) Type : 4R Stock Bridge Type
- ii) Distance between conductor : 74.5 mm. & axis of the Vibration Damper.
- iii) Messenger Cable : 130 Kg/mm sq. quality (19 strands)
- iv) Bolt size : 16 mm. (dia.)
- v) Slip strength of messenger Cable : 500 Kgs.
- vi) Mass pull-of : As per I.S.S.

**C) REPAIR SLEEVES:**

**SUITABLE FOR ACSR PANTHER/ZEBRA/MOOSE CONDUCTOR AND G.S.S. GROUND WIRE.**

	Suitable for ACSR panther/Zebra/Moose.	Suitable for G.S.S. Ground wire.
i) Type	Compression	Compression.
ii) Material	Extruded aluminium.	Steel
iii) Min. failing load	95% of UTS of conductor.	95% of UTS of ground wire.
iv) Length	241/279 mm.	200 mm (150 mm. min.)
v) Dimension :		
a) After compression	21mm	11.5 mm
(i) Adjacent side		

(b) Before Compression  
: 21mm.  
(i) Outer diameter 11.5mm.  
38/48mm.  
(ii) Inner diameter  
23/40mm

vii) Electrical Resistance at 20 deg. C Not more than 75% of the resistance of equivalent length of conductor.

vii) Galvanising : Hot – dip galvanized  
a) Ferrous parts  
b) No. of dips for one-minute stand. 4 dips

#### **D) SUSPENSION CLAMP: FOR GROUND WIRE 7/3.15 and 7/3.66 mm**

- i) Type : Envelop type  
ii) Material : Forged Steel / NCL.
- iii) Minimum slip strength : 25% of UTS of ground wire.
- iv) Dimension :
- (a) Overall length : 230mm  
(b) Inner dia. (before compression). : 10mm.  
(c) Outer diameter (before compression). : 18mm.  
(d) After Compression :  
Adjacent : 15.1 mm.  
Diagonal side : 17.4mm.  
(e) Galvanising :  
(i) Ferrous parts. : Hot-dip galvanized.

(ii) No. of dips for one-minute withstand. : 4 dips

### E) BONDING PIECES:

- a) material : flexible copper bond (37/7/0.417 mm. tinned copper flexible stranded cable).
- b) Length : Not less than 750 mm.
- c) Bolt size : 16mm x 40 mm.
- d) Copper area. : 34 sq.mm.
- e) Thickness of long : 6 mm.
- f) Material for connecting socket. : Tinned Brass

### F) INSULATOR HARDWARES

#### A) String hardware :

##### Material and strength

	Description of item.	Material	UTS
i)	Bolt hook	Forged Steel	11,500 Kgs (90 KN)
ii)	Anchor Shackle	-do-	15,500 Kgs (120 KN)
iii)	Socket Eye Horn Holder.	- do-	11,500 Kgs (90 KN)
iv)	Socket Clevis.-do-		15,500 Kgs.
v)	Ball Clevis	-do-	15,500 Kgs.
vi)	Clevis Eye	-do-	15,500 Kgs.
vii)	Socket Eye.	-do-	15,500 Kgs.
vii)	Bottom / Top Yoke plate :		
	Double suspension	Mild Steel	11,500 Kgs.

	<b>Double Tension</b>	<b>-do-</b>	<b>15,500 Kgs.</b>
<b>ix)</b>	<b>Arcing Horn</b>	<b>-do-</b>	<b>—</b>
<b>x)</b>	<b>Suspension Clamp.</b>	<b>Aluminium Alloy and Neoprene.</b>	<b>—</b>
<b>xi)</b>	<b>Tension Clamp.</b>	<b>All.Alloy &amp; Steel.</b>	<b>11,500 Kgs.</b>
<b>xii)</b>	<b>Ball Pin</b>	<b>High tensile forged steel (hot-dip galvanised)</b>	<b>90% of UTS of conductor.</b>
<b>xiii)</b>	<b>Security Clip</b>	<b>Brass (R-Type)</b>	
	<b>Minimum failing load String (KN)</b>	<b>Single Suspension</b>	<b>: 11,500</b>
		<b>Single Tension</b>	<b>: 11,500/15,500</b>
		<b>Double Suspension</b>	<b>: 11,500</b>
		<b>Double Tension</b>	<b>: 11,500/15,500</b>

## II) CLAMPS.

	<b>Single suspension string</b>	<b>Single tension string</b>	<b>Double suspension string</b>	<b>Double tension string.</b>
i) Type	AGS Type	Compression Type	AGS Type	Compression Type
ii) Material	<b><u>Aluminium Alloy and neoprene</u></b>	Aluminium Alloy and Steel	Aluminium Alloy and Neoprene	Aluminium Alloy and Steel
ii) Minimum slip strength	Not less than 15%	90% of UTS of conductor	Not less than 15% of UTS of conductor	90% of UTS of conductor
iv) Minimum failing load (kg)	11,500	90% of UTS of conductor	11,500 90%	Of UTS of conductor

### III). Suspension assembly: armour grip clamp.

1. The armour grip suspension clamp shall comprise of retaining strap, support housing, elastomer inserts with aluminum reinforcements and AGS preformed rod set.
2. Elastomer insert shall be resistant to the effects of temperature up to 85 deg. C, ozone, Ultraviolet radiation and other atmospheric contaminants likely to be encountered in service. The physical properties of the elastomer shall be of approved standard. It shall be electrically shielded by a cage of AGS preformed rod set. The elastomer insert shall be so designed that the curvature of the AGS rod shall follow the contour of the neoprene insert.
3. The AGS preformed rod set shall be as detailed above in general except that the length of the AGS preformed rods shall be such that it shall ensure sufficient slipping strength and shall not introduce unfavourable stress on the conductor under all operating conditions.

### IV) Fasteners: bolts, nuts & washers.

1. All bolts and nuts shall conform to IS-6639 ó 1972. All bolts and nuts shall be galvanized. All bolts and nuts shall have hexagonal heads, the heads being truly concentric, and square with the shank, which must be perfectly straight.
2. Bolts upto M16 and having length upto ten times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 Mpa minimum as per IS-12427. Bolts should be provided with washer face in accordance with IS-1363 Part-I to ensure proper bearing.
3. Fully threaded bolts shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts.
4. All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit the firm gripping of the component parts but not further. It shall be ensured that the threaded portion of the bolt protrudes not less than 3 mm and not more than 8 mm when fully tightened. All nuts shall fit and be tight to the point where shank of the bolt connects to the head.
5. Flat washers and spring washers shall be provided wherever necessary and shall be of positive lock type. Spring washers shall be electro-galvanized. The thickness of washers shall conform to IS-2016-1967.

6. The bidder shall furnish bolt schedules giving thickness of components connected, the nut and the washer and the length of shank and the threaded portion of the bolts and size of holes and any other special details of this nature.
7. To obviate bending stress in bolt, it shall not connect aggregate thickness more than three time its diameter.
8. Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.
9. Fasteners of grade higher than 8.8 are not to be used and minimum grade for bolts shall be 5.6.

### **GENERAL:**

1. All ferrous parts including fasteners shall be hot dip galvanized, after all machining has been completed. Nuts may however be tapped (threaded) after galvanizing and the threads oiled. Spring washers shall be electro-galvanized. The bolt threads shall be undercut to take care of the increase in diameter due to galvanizing. Galvanizing shall be done in accordance with IS-2629-1985 and shall satisfy the tests mentioned in IS 2633-1986. Fasteners shall withstand four dips while spring washers shall withstand three dips of one-minute duration in the standard Preece test. Other galvanized materials shall be guaranteed to withstand at least six successive dips each lasting one minute under the Standard Preece test for galvanizing.
2. The zinc coating shall be perfectly adherent of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters. The zinc used for galvanizing shall be of grade Zn 99.95 as per IS 209-1979.
3. Pin balls shall be checked with the applicable  $\delta G$  gauges in at least two directions, one of which shall be across the line of die flashing and the other 90 deg. to this line. NO GO gauges shall not pass in any direction.
4. Socket ends, before galvanizing shall be of uniform contour. The bearing surface of socket ends shall be uniform about the entire circumference without depressions or high spots. The internal contours of socket ends shall be concentric with the axis of the fittings as per IS 2486/IEC-120. The axis of the bearing surfaces of socket ends shall be coaxial with the axis of the fittings. There shall be no noticeable tilting of the bearing surfaces with the axis of the fittings.
5. All current carrying parts shall be so designed end manufactured that contact resistance is reduced to minimum.
6. Welding of aluminum shall be by inert gas shielded tungsten arc or inert gas, shielded metal arc process. Welds shall be clean, sound, smooth, and

uniform without overlaps, properly fused and completely sealed. There shall be no cracks, voids incomplete penetration, incomplete fusion, under-cutting or inclusions Porosity shall be minimized so that mechanical properties of the aluminum alloys are not affected. All welds shall be properly finished as per good engineering practices.

### **Electrical Design:**

The normal duty and heavy duty suspension, light duty, normal duty and heavy duty tension insulator sets shall all comply with the technical requirements of schedule C and satisfy the test requirements stated in Section-7.

### **Mechanical design:**

The mechanical strength of the insulators and insulator fittings shall be as stated in Schedule-C

The design shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to the development of defects.

Insulating material shall not engage directly with hard metal. All fixing materials shall be of approved quality, shall be applied in an approved manner and shall not enter into chemical action with the metal parts or cause fracture by expansion in service. Where cement is used as a fixing medium, cement thickness shall be as small and even as possible and proper care shall be taken to correctly centre and locate the individual parts during cementing.

### **Technical Specification for Design, Supply and Testing of Hard ware fittings.**

Type tests:

The following type tests shall be conducted on hardware fittings.

#### **A. On suspension hardware fittings only.**

- (a) Magnetic power loss test.
- (b) Clamp slip strength Vs torque
- (c) Mechanical strength test.
- (d) On one test on elastomer.

#### **B. On Tension hard ware fittings only.**

Electrical resistance test for IS 2486 (Part-I) 1971  
Dead end assembly.

- (a) Heating cycle test for dead end assembly. -do-
- (b) Slip strength test for dead end assembly. IS 2486 (Part-I)

(c) Mechanical strength test.

C. **On both suspension and tension hardware fittings.**

- (a) Visual examination. IS-2486 (Part-I) 1971
- (b) Verification of dimension. -do-
- (c) Galvanizing / electroplating test. -do-
- (d) Mechanical strength test of each component  
(including corona control ring/grading ring and arcing horn)
- (e) Mechanical strength test of welded joint.
- (f) Mechanical strength test for corona control ring/  
grading ring and arcing horn. BS-3288 (Part-I)
- (g) Test on locking device for ball and socket coupling. IEC 6 3721984
- (h) Chemical analysis, hardness tests, grain size,  
inclusion rating and magnetic particle inspection for forging/casting.

D. **On suspension hardware fittings only.**

- (a) Clamp slip strength ver as torque test for suspension clamp.
- (b) Shore hardness test of elastomer cushion for AG suspension clamp.
- (c) Bend test for armour rod set. IS-2121 (Part-I)
- (d) Resilience test for armour rod set. -do-
- (e) Conductivity test for armour rod set. -do-

E. **On tension hardware fittings only**

	Unit.	37/4.00 mm <sup>2</sup>
<b>MID SPAN COMPRESSION JOINTS FOR CONDUCTORS.</b>		
Weight of the joint.	Kg.	1.27
Slipping strength.	KN	129.6
Resistance of the completed joint.	Ohms.	0.000027
Materials of the joints specify alloy type and its aluminum contents.		6201
Before compression dia of sleeve.	mm	
(a) Inner diameter.		31+/-0,5
(b) Outer diameter.		48+/-1.0

Dimensions after compression.	mm	
(a) Corner to corner.		46+/-0.5
(b) Surface to surface.		40+/-0.5
Length of the sleeve.	mm	
(a) Before compression.		500+/-5.0
(b) After compression.		540+/-5.0
Compression pressure.	Tone	100
Whether designed for intermittent or continuous compression.		Continuous compression.
Minimum corona extinction voltage under dry condition.	Kv	154
Radio interference voltage under conditions.	Micro volt.	Below 1000
<b>REPAIR SLEEVE FOR CONDUCTOR</b>		
Weight of the sleeve.	Kgs.	0.63
Before compression dia of sleeve.		
(a) Inner diameter.	mm	31.05
(b) Outer diameter.	mm	48.10
Dimensions after compression.		
(a) Corner to corner.	mm	48.05
(b) Surface to surface.	mm	40.05
Length of sleeve.		
(a) Before compression.	mm	279.50
(b) After compression.	mm	300.50
Compression pressure.	Tone.	100
Minimum corona extinction voltage under dry condition.	Kv.	154
Radio interference voltage under condition.	Micro volt.	Below 1000

(a) Slip strength test for dead end assembly. IS-2121 (Part-I)

All the acceptance tests stated at clause shall also be carried out on composite insulator unit, except the eccentricity test at clause. In addition to these, all the acceptance tests indicated in IEC 1109 shall also be carried out without any extra cost to the employer.

**F. For hardware fittings.**

(a) Visual examination. IS-2121 (Part-I)

(b) Proof & test.

**G. Tests on conductor accessories.**

H. Type tests.

I. Mid span compression joint for conductor and earthwire.

(a) Chemical analysis of materials.

(b) Electrical resistance tests.  
clause 6.5 & 6.6

IS-2121 (Part-II) 1981

(c) Heating cycle test.

-do-

(d) Slip strength test.

-do-

(e) Corona extinction voltage test (dry)

(f) Radio interference voltage test (dry)

J. Repair sleeve for conductor.

(a) Chemical analysis of materials.

### VIBRATION DAMPER FOR CONDUCTOR.

Vibration Damper for AAC 37/4.00 mm	Unit.		
Total weight of the damper.	Kgs.	4.5	
Weight of each damper mass.	Kgs.	Left.	Right.
Resonance frequencies.		1.6	2.2
1. First frequency.	Hz	12+/- 1	18+/- 2
2. Second frequency.	Hz	28+/- 2	36+/- 2
Dimension of each damper mass.	Mm	55 Ox165	60 Ox195
Material of:		Cast iron hot dip galvanized.	
1. Damper mass.		High tensile galvanized steel wire.	
2. Messenger cable.			
No. of strands in messenger cable strands.		19	
Lay ratio of messenger cable strands.		9-11	
Min tensile strength of messenger cable.	Kg./ Sq.mm	135	
Miss pull-off strength.	KN	5	
Clamping force.	Kg.m	7	
Slipping strength of the damper clamp.	KN		
1. Before fatigue test.		2.5	
2. After fatigue test.		2.0	
Magnetic power loss per vibration damper.	Watts.	1 watt at 500 amps.	
Min. corona extinction voltage under dry conditions.	Kv.	154	
Radio interference voltage under dry condition 1MHz, at 154 KV.	Microv olt.	Below 1000	

Percentage variation in reactance after fatigue test in comparison with that before the fatigue test.	%	20
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# SECTION – V

## CLAMPS AND CONNECTORS

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# TECHNICAL SPECIFICATION CLAMPS AND CONNECTORS

## (A) TECHNICAL SPECIFICATION FOR CLAMPS & CONNECTORS

### 1. SCOPE

This specification covers design, manufacture, assembly, testing at manufacturer's works, supply and delivery at site of all terminal connectors of 220,132 & 33KV equipments (mainly breaker, isolator, CT,PT,CVT,BPI and LA) and all other clamps and dropper connectors required for the switch yard as per approved lay out and system design.

### 2. STANDARDS

The terminal connectors under this specification shall conform strictly to the requirements of the latest version of the following standards as amended up-to-date, except where specified otherwise.

- |      |          |  |
|------|----------|--|
| i)   | IS: 5561 | Power Connectors.  |
| ii)  | IS:617   | Aluminium & Aluminium Alloy                                      |
| iii) | IS: 2629 | Recommended Practice for hot dip galvanizing of iron and steel.  |
| iv)  | IS: 2633 | Method of testing uniformity of coating of zinc coated articles. |

The materials conforming to any other authoritative standards which ensure equal or better performance shall also be acceptable. The salient points of these specifications and points of difference between these and the above specifications, shall be clearly brought out in the bid.

### 3. MATERIAL & WORKMANSHIP

The terminal connectors shall be manufactured from Aluminium Silicon Alloy and conform to designation A6 of IS: 617 (latest edition)

The connectors shall be of best quality and workmanship, well finished and of approved design. Specific materials for clamps and connectors should have high current carrying capacity, high corrosion resistance and be free from corona formation.

All connectors or its components to be connected with ACSR conductor shall be of compression type having aluminium purity not less than 99.5%.

All bus bar clamps shall be made preferably from forged aluminium of purity not less than 99.5%. The thickness and contact surface should be maintained in such a way that the clamp should conform to IS:5561/1970 or any latest revision thereof.

#### 4. RATING

The connector rating shall match with the rating of the respective equipments for the terminal connectors and the connectors for bus bar and dropper should be of the following rating. Minimum thickness at any part of connector shall be 10(ten)mm. Indicative ratings are given below:

Rating	400/220 / 132 KV
1. Main bus bar connectors high level and low level (Amps)	3600/2000/2000
2. High level bus sectionalisation isolator(Amps)	3600/2000/2000
3. Connectors along the bay (Amps)	3600/2000/2000
4. Terminal connectors for CB(Amp.)	as per rating of CB
5. -do- for Isolator(Amps)	as per rating of ISO
6. -do- for CT	As per CT rating
7. -do- for PI	As per PI rating
8. -do- for LA	As per LA rating
9. -do- for PT	As per PT rating
10. -do- for CVT	As per CVT rating
11. -do- for WT	As per WT rating.

#### 5. EQUIPMENT CONNECTORS

Bimetallic connectors shall be used to connect conductors of dissimilar metal. The following bimetallic arrangement shall be preferred.

- i) copper cladding of minimum 4 mm. thickness on the aluminium portion of connector coming in contact with the copper palm or stud of the equipment.
- ii) alternatively, to provide cold rolled aluminium copper strip between the aluminium portion of the connection, the sheet thickness shall not be less than 2 mm.

Sufficient contact pressure should be maintained at the joint by the provision of the required number of bolts or other fixing arrangements, but the contact pressure should not be so great as to cause relaxation of the joint by cold flow, the joint should be such that the pressure is maintained within this range under all conditions of service, to avoid excessive local pressure, the contact pressure should be evenly distributed by use of pressure plates, washers or suitable saddles of adequate area of thickness should be less than that of an

equal length of conductor where measured individually test results showing the milli drop test and resistance should be enclosed with the bid.

All connectors shall be so designed and manufactured as to offer ease of installation as these are to be used in overhead installations, design shall be such that full tightening of nuts and bolts should be possible with the use of double wrench.

The connectors shall be such as to avoid local corona, sound or visible discharge.

## **6. TEMPRATURE RISE**

The temperature rise of connectors when carrying rated current shall not exceed 45• C above reference design temperature of 50• C.

- i) Acceptance Tests
  - (a) Tensile Test
  - (b) Temperature rise test
  - © Temperature rise test
- ii) Routine Test
  - (a) Visual Inspection
  - (b) Dimensional Check

Type test reports from a recognized laboratory shall have to be submitted.

## **7. WEIGHTS**

Weights of different materials uses in manufacture, such as aluminium, silicon, copper etc. should be clearly indicated in the bid.

## **8. INTERCHANGE ABILITY**

Corresponding parts of similar clamps and connectors shall be made to gauge or jig and shall be interchangeable in every respect.

## **(B) TECHNICAL SPECIFICATION FOR ACSR BUS-BAR**

### **1. SCOPE**

The specification covers design, engineering, manufacture, testing at manufacturer's works, supply and delivery of heavy duty ACSR bus-bar for use in 220 KV and 132 kV sub-station.

### **2. MATERIALS**

The ACSR bus bar shall be drawn by using MOOSE/ZEBRA as per system requirement.

The strung ACSR bus-bar shall be of heavy duty type and design to operate within set temperature limits and to withstand thermal and electromechanical forces developed due to short circuits.

### **3. MECHANICAL CHARACTERISTICS**

- The mechanical strength of the strung ACSR bus-bar shall be limited to be maximum allowable tension for specific size of conductor as per ISS.
4. **DIMENSIONAL TOLERANCE**  
Dimensional tolerances shall be as per relevant ISS.
5. **CHEMICAL COMPOSITION**  
The chemical composition for ACSR conductors (MOOSE/ZEBRA) shall be holding good under all operating condition.
6. **ELECTRICAL & MECHANICAL CHARACTERISTICS AND CURRENT RATINGS**  
Electrical and mechanical characteristics and current ratings for ACSR bus-bar shall be same as stipulated for MOOSE/ZEBRA ACSR conductors, the details of which has been specified.

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

LINE HARDWARE AND ACCESSORIES FOR 132/220 KV & GROUND WIRE 7/3.15mm

A	HARDWARES	Suspension	Tension
i	Maker's name and Address	ERI-TECH LIMITED	
ii	Size and designation of ball and socket with standard specification to which conforming	16mmB as per IS 2486	20mm as per IS 2486
iii	Material		
a	Anchor shackle	NA	Forged steel Galvanised
b	Chain Link	NA	Forged Steel galvanised
c	Ball hook / Ball Link (HH)	Forged Steel galvanized	Forged Steel galvanised
d	Socket Eye (HH)	Forged Steel galvanized	NA
e	Ball Clevis	Forged Steel galvanized	Forged Steel galvanised
f	Socket Clevis	Forged Steel galvanized	Forged Steel galvanised
g	Yoke Plate	Mild Steel Galvanised	Mild Steel Galvanised
h	Arcing Horn	Mild Steel Galvanised	Mild Steel Galvanised
i	Clamp Suspension	A.G.S. Clamp	NA
j	Dead End/Cross arm strap	NA	NA
k	Dead end clamp(Compression)	NA	Ext. Al. Alloy
iv	Standard specification to which the Hardwares conform	IS 2486, IS: 2004,IS:617, IS-2633, & IS-733	
v	Standard specification to which conforming	IS: 2486	
vi	Galvanising		

a	Ferrous parts	Hot Dip Galvanised		
b	Spring washers	Electro Galvanised		
c	Quality of zinc used	99.5%		
d	Number of dips which the clamp can withstand	4/ 1 minute dips		
vii	Standard to which conforming	IS 2633		
viii	Reference to drawing No.	Drg. Attached		
ix	Minimum failing load in kg	For AAAC & ACSR Panther (132 kv)	For AAAC & ACSR Zebra (220 kv)	For AAAC & ACSR Moose (220 kv/400 KV)
a	For Single Tension Hardwire Fittings	120 kN	160 kN	160 kN
b	For Double Tension Hardwire Fittings	120 kN	160 kN	160 kN
c	For Single Suspension Hardwire Fittings	70 kN	70 kN	90/120 kN
d	For Double Suspension Hardwire Fittings	70 kN	70 kN	120 kN
B.	TENSION CLAMPS	Suitable for Panther, Zebra & Moose (AAAC/ACSR)		
i	Type	Compression type tension clamp		
ii	Material	Ext. Al. Alloy/ Ext. Al.		
iii	Breaking Strength	95% of UTS of Conductor		
iv	Slipping strength	95% of UTS of Conductor		
v	Galvanising			
a	Ferrous parts	Hot Dip Galvanised		
b	Spring washers	Electro Galvanised		
c	Quality of zinc used	99.5%		
d	Number of dips which the clamp can withstand	4/ 1 minute dips		
vi	Standard to which conforming	IS 2633		
vii	Electrical Conductivity			
	a. Results of heating cycle test carried out	T.C. Attached		
	b. Electrical resistance	Not more than 75% of equivalent length of conductor		
viii	Reference to type tests and other tests reports attached	T.C. Attached		
ix	Make of bolts and nuts used	Local Make		
C	SUSPENSION CLAMPS	Panther (AAAC/ACSR)	Zebra (AAAC/ACSR)	Moose (AAAC/ACSR)
i	Type	AGS Type		
ii	Type of material used for retaining rod for AGS assembly giving reference of ISS	Aluminium Alloy 6061/ Equivalent	Aluminium Alloy 6061/ Equivalent	Aluminium Alloy 6061/ Equivalent
iii	minimum tensile strength of	35 kg/mm <sup>2</sup>	35 kg/mm <sup>2</sup>	35 kg/mm <sup>2</sup>

	retaining rod material				
iv	Chemical composition of retaining rod material	As per IS:733	As per IS:733	As per IS:733	As per IS:733
v	Electrical conductivity of Armour Rod material (in percentage of the conductivity of IACS i.e. International Annealed Copper Standard	Not less than 40% of IACS	Not less than 40% of IACS	Not less than 40% of IACS	Not less than 40% of IACS
vi	Slipping strength of cushioned suspension assembly	8% to 15% of UTS of Conductor	20 to 29 KN of UTS of Conductor	20 to 29 KN of UTS of Conductor	20 to 29 KN of UTS of Conductor
vii	Breaking strength of suspension Clamp	7000kgf	7000kgf	7000kgf	9000kgf
viii	Physical properties of neoprene cushion				
a	Minimum Tensile Strength	2000 psi	2000 psi	2000 psi	2000 psi
b	Minimum ultimate Elongation	300%	300%	300%	300%
ix	Ageing (guaranteed life of the assembly)	40 years	40 years	40 years	40 years
x	Hardness	65 to 80 A	65 to 80 A	65 to 80 A	65 to 80 A
D	Midspan compressions joints for	Panther		Zebra	
		AAAC	ACSR	AAAC	ACSR
i	Type	Compression Type			
ii	Suitable for	AAAC Panther	ACSR Panther	AAAC Zebra	ACSR Zebra
iii	Materials				
a	Outer Sleeve	Ex. Al. Alloy	Ex. Al.	Ex. Al. Alloy	Ex. Al.
b	Inner Sleeve	N.A.	Galvanised Steel	N.A.	Galvanised Steel
iv	Outer Sleeve				
a	Outer Dia. Before compression (mm)	Ø 38	Ø 38	Ø 48	Ø 48
b	Flat to Flat After compression (mm)	32	32	40	40
v	Length of Outer Sleeve				
a	Before compression (mm)	610	610	711	711
b	After compression (mm)	655	660	760	768
vi	Inner Sleeve				
a	Outer Dia. Before compression (mm)	N.A.	Ø 18	N.A.	Ø 19.2
b	Flat to Flat After compression (mm)	N.A.	15.1	N.A.	16.1
vii	Length of Inner Sleeve				
a	Before compression (mm)	N.A.	203	N.A.	241
b	After compression (mm)	N.A.	230	N.A.	273
viii	Weight of Sleeve				
a	Aluminium (kg)	1.2	1.2	2.032	2.032
b	Galvanised Steel (kg)	N.A.	0.295	N.A.	0.410
ix	Galvanising				
a	Ferrous parts	Hot Dip Galvanised			

b	Spring washers	Electro Galvanized			
c	Quality of zinc used	99.5%			
d	Number of dips which the clamp can withstand	4/ 1 minute dips			
x	Standard to which conforming	IS 2633			
xi	Slipping strength of mid span joint expressed as percentage of UTS of conductor	95%			
xii	Breaking strength of mid span joint expressed as percentage of UTS of conduct	95%			
xiii	Conductivity of Compression joint expressed as percentage of conductivity of cable	100% of equivalent length of conductor			
xiv	Resistance as percentage of measured resistance of equivalent length of conductor	Not more than 75% of equivalent length of conductor			
E	Repair Sleeve	AAAC & ACSR Panther		AAAC & ACSR Zebra	
i	Type	Compression type			
ii	Suitable for	AAAC Panther	ACSR Panther	AAA C Zebra	ACSR Zebra
iii	Outside diameter or length of sleeve				
a	Before compression (mm)	Ø 38	Ø 38	Ø 48	Ø 48
b	After compression Flat to Flat (mm)	32	32	40	40
iv	Length of Sleeve				
a	Before compression (mm)	241	241	279	279
b	After compression (mm)	270	270	310	310
v	Material	Ex. Al.Alloy	Ex. Al.	Ex. Al.Alloy	Ex. Al.
vi	Weight of sleeve in (kg)	0.450	0.453	0.810	0.810
vii	Breaking strength as percentage of UTS of conductor	95%			
viii	Conductivity as percentage of conductivity of conductor	100% of equivalent length of conductor			
ix	Resistance as percentage of measured resistance of equivalent length of conductor	Not more than 75% of equivalent length of conductors			
F	Vibration Damper	For AAAC & ACSR ZEBRA			
i	Total weight of the damper (Kg)	4.5 Approx			
		Left		Right	
ii	Weigh of each damper mass (kgs.)	1.6		2.2	
iii	Resonance frequencies				
	1. First frequency (Hz)	12+ 1		18+ 2	

	2. Second frequency (Hz)	28+ 2	36+2
iv	Dimensions of each damper mass	60 Φ x 195	55 Φ x 165
v	Material of :		
	1. Damper mass	Cast iron hot dip galvanised.	
	2. Messenger cable.	High tensile galvanised steel wire.	
vi	Galvanising		
a	Ferrous parts	Hot Dip Galvanised	
b	Spring washers	Electro Galvanised	
c	Quality of zinc used	99.5%	
d	Number of dips which the clamp can withstand	4/ 1 minute dips	
vii	Standard to which conforming	IS 2486 and IS 2633	
viii	No of strands in messenger cable strands	19	
ix	Lay ratio of messenger cable strands	9 11	
x	Min tensile strength of messenger cable ( kg /sq. mm)	135	
xi	Mass pull - off strength (KN)	5	
xii	Clamping torque (Kg.m)	7	
xiii	Slipping strength of the damper clamp		
	1.Before fatigue test (KN)	2.5	
	2. After fatigue test (KN)	2	
xiv	Magnetic power loss per vibration damper (Watts)	1 watt at 500 amps	
xv	Min. corona extinction voltage under dry conditions (KV)	154	
xvi	Radio interference voltage under conditions 1 MHZ, AT 154 KV (Microvolt)	Below 1000	
xvii	Percentage variation in reactance after fatigue test in comparison with that before the fatigue test (%)	20	
G	Midspan compression joint For 7/3.15mm Galvanised Stranded Steel Wire		
i	Material	Galvanized Steel	
ii	Size	OD 20.2 x Length 230	
iii	Suitable for groundwire	Yes (7/3.15)	
iv	Weight in kg	0.85	
v	Minimum failing load	50 KN	
vi	Galvanization		
a	Ferrous parts	Hot Dip Galvanised	
b	Spring washers	Electro Galvanised	
c	Quality of zinc used	99.5%	
d	Number of dips which the clamp can withstand	4 / 1 minute dip	
vii	Standard to which conforming	IS 2633	

H	Suspension Clamps For 7/3.15mm Galvanised Stranded Steel Wire	
i	Materials	Malleable Cast Iron / Galvanised Steel
ii	Size	As per Drawing
iii	Suitable for groundwire	Yes (7/3.15)
iv	Weight in kg	
v	Slip strength	12-17 KN
vi	Minimum failing load	70 KN
vii	Galvanising	
a	Ferrous parts	Hot Dip Galvanised
b	Spring washers	Electro Galvanised
c	Quality of Zinc used	99.5%
d	Number of dips which the clamp can withstand	4/1 minute dips
viii	Standard to which conforming	IS 2486 and IS 2633
I	Compression type dead end assemblies For 7/3.15mm Galvanised Stranded Steel Wire	
i	Materials	Forged steel
ii	Size	As per drawing
iii	Suitable for ground wire	Yes (7/3.15)
iv	Weight in kg	3.69
v	Minimum failing load	70 KN
vi	Galvanising	
a	Ferrous parts	Hot Dip Galvanised
b	Spring washers	Electro Galvanized
c	Quality of zinc used	99.5%
d	Number of dips which the clamp can withstand	4/ 1 minute dips
vii	Standard to which conforming	IS 2486 and IS 2633
J	Flexible copper bond	
i	Drawings enclosed	Yes
ii	Stranding	37/7/0.417
iii	Cross sectional area (Sq.mm)	75.6
iv	Minimum copper equivalent area (Sq.mm)	34 (each individual wire)
vi	Length of copper cable (mm)	500
vii	Material lugs	Tinned Copper
viii	Bolt Size	
	(i) Diameter (mm)	16
	(ii) Length (mm)	40
ix	Resistance (Ohm)	0.0004 ( as per IS:2121)
x	Total weight of flexible copper bond (kg)	0.45 (approx)

