Technical Specifications for Equipment

<To be modified by the Employer as per the works envisaged>

All materials required to complete the work as per given specifications & drawings etc. must be manufactured and supplied using fresh raw material. Re-moulded, re-circulated materials are not acceptable. The procurement of materials must be made by the contractor directly from manufacturer or through authorized dealer/distributors. Documentary evidence to this effect is to be made available to Employer for necessary checks/verification of source of supply of materials. Secondhand materials/ partial used materials/ used materials would not acceptable.

Climatic condition details are given with various materials specifications however, bidder shall note that materials covered under project specific RDSS works shall be utilized in that particular project only. Hence, the geographical location of that particular project site and its associated climatic condition shall be applicable for all the materials of that particular project.

<to be corrected as per finalized document>

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1. Power Transformers

1 SCOPE

1.1 This specification is provided for information for design, engineering, manufacture, assembly, stage inspection, final inspection and testing before dispatch, packing and delivery at destination stores by road transport, transit insurance of 3.15/5/6.3/8/10/12.5 MVA, 33/11 KV Power Transformer(s), complete with all fittings, accessories, associated equipment's, spares, 10% extra Transformer Oil, required for its satisfactory operation in any of the sub-stations of the purchaser.

1.2 The core shall be constructed either from high grade, non-aging Cold Rolled Grain Oriented (CRGO) silicon steel laminations conforming to HIB grade of BIS certified with lamination thickness not more than 0.23mm to 0.27mm or better (Quoted grade and type shall be used). The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall be such that it should under 10% overvoltage condition should not be more than 1.9 Tesla. The supplier shall provide saturation curve of the core material, proposed to be used. Laminations of different grade(s) and different thickness (s) are not allowed to be used in any manner or under any circumstances.

1.3 The scope of supply includes the provision of type test. The equipment offered should have been successfully type tested within five years from date of tender and the designs should have been in satisfactory operation for a period not less than three years as on the date of order. Compliance shall be demonstrated by submitting, (i) authenticated copies of the type test reports and (ii) performance certificates from the users, specifically from Central Govt./State Govt. or their undertakings.

1.4 The Power Transformer shall conform in all respects to highest standards of engineering, design, workmanship, this specification and the latest revisions of relevant standards at the time of offer and the employer shall have the power to reject any work or material, which, in his judgment, is not in full accordance therewith. The Transformer(s) offered, 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 supply, irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

The Employer reserves the right to reject the transformers if on testing the losses exceed the declared losses beyond tolerance limit as per IS or the temperature rise in oil and / or winding exceeds the value, specified in technical particular or impedance value differ from the

guaranteed value including tolerance as per this specification and if any of the test results do not match with the values, given in the guaranteed technical particulars and as per technical specification.

2 SPECIFIC TECHNICAL REQUIREMENTS

1	Rated MVA (ONAN rating)		3.15/5/6.3/8/10/12.5MVA
2	No. of phases		3
3	Type of installation		Outdoor
4	Frequency		50 Hz (± 5%)
5	Cooling medium		Insulating Oil (ONAN)
6	Type of mounting		On Wheels, Mounted on rails.
7	Rated voltage		
	a) High voltage winding		33KV
	b) Low voltage winding		11KV
8	Highest continuous system voltage		
	a) Maximum system voltage ratio (HV / LV)		36KV / 12 KV
	b) Rated voltage ratio (HV / LV)		33KV /11 KV
9	No. of windings		Two winding Transformers
10	Type of cooling		ONAN (Oil natural / Air natural)
11	MVA Rating corresponding to ONAN Cooling system		100%
	Method of connection:		
12	HV	:	Delta
	LV	:	Star
13	Connection symbol		Dyn 11
14	System earthing		Neutral of LV side to be solidly earthed.
15	Intended regular cyclic overloading of windings		As per IEC –76-1, Clause 4.2
16	a) Anticipated unbalanced loading		Around 10%
	b) Anticipated continuous loading of windings (HV / LV)		110 % of rated current

17	a) Type of tap changer	(For3.15, 5, 6.3, 8, 10 &12.5 MVA only) On or Off load tap changer as per BOQ	
	b) Range of taping	+ 5% to – 15% in 9 equal steps of 2.5% each for Off-load tap and in 17 equal steps of 1.25% each for On-load tap changer on HV winding	
18	Neutral terminals to be brought out	On LV side only	
19	Over Voltage operating capability and duration	112.5 % of rated voltage (Cont.)	
20	Maximum Flux Density in any part of the core and yoke at rated MVA with +12.5% combined voltage and frequency variation from rated voltage and frequency.	1.9 Tesla	
21	Insulation levels for windings: -	33kV	11kV
	a) 1.2 / 50 microsecond wave shape Impulse withstand (KVP)	170	75
	b) Power frequency voltage withstand (KVrms)	70	28
22	Type of winding insulation		
	a) HV winding	Uniform	
	b) LV winding	Uniform	
23	Withstand time for three phase short circuit	2 Seconds	
24	Noise level at rated voltage and frequency	As per NEMA Publication No. TR-1.	

Permissible Temperature rise over ambient temperature shall be as per IS-2026*

* Amendment issued vide letter No. REC/DDUGJY/SBD/TS/2017-18D. No.3091 Dated 25.08.2017.

25	Minimum clearances in air (mm) :-	Phase to Phase	Phase to ground
	a) HV	400	320
	b) LV	280	140
26	Terminals		

a. HV winding line end 36 KV oil filled communicating type porcelain bushings

(Anti-fog type)

b. LV winding 12 KV porcelain type of bushing (Anti-fog type) – for outdoor 11 KV breakers

(11KV Power cables shall be used for extending supply to 11KV breakers in case of indoor circuit breakers. The termination of 11 KV cables on LV bushing shall be through extended copper bus bars suitable to hold power cables termination. A metallic cable termination box, completely sealed, shall be installed on LV side of the transformer in which cables shall enter from bottom gland plates.)

27 Insulation level of bushing

	LV	HV
a) Lightning Impulse withstand (KVP)	170	75
b) 1 Minute Power Frequency withstand voltage (KV –rms)	70	28
c) Creepage distance (mm) (minimum)	900	300

28 Material of HV & LV Conductor — Electrolytic Copper

29 Maximum current density for HV and LV winding for rated current — As per best practice

30 Polarization index

(HV to LV, HV to Earth & LV to earth)

IR Test = 1 minute value/ 15 secs. value will not be less than 1.5

IR Test = 10 minutes value / 1 minute value will not be more than 5 and less than 1.5

31 Core Assembly — Boltless type

32 Temperature Indicator

a. Oil — One number

b. Winding — One number

35. **Losses**: - The losses shall not exceed the value given below

MVA Rating	No-load losses (Fixed loss) KW	Load losses at 75°C KW	Percentage impedance voltage on normal tap and MVA base at 75^{o} C
3.15	3	16	7.15
5	4	23	7.15
6.3	4.6	36	7.15
8	5.5	40	8.35
10	7	50	8.35
12.5	7.5	65	10

2.1 MARSHALLING BOX

A metal enclosed, weather, vermin and dust proof marshalling box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch etc. shall be provided with each

transformer to accommodate temperature indicators, terminal blocks etc. It shall have degree of protection of IP 55 or better as per IS: 2147 (Refer Clause 3.12 of IS).

2.2 CAPITALIZATION OF LOSSES AND LIQUIDATED DAMAGES

Capitalization of losses will be as per Annexure B which is attached herewith. No (+) ve tolerance shall be allowed at any point of time, on the quoted losses after the award. In case, the losses during type testing, routine testing etc. are found above the quoted losses, the award shall stand cancelled. In such a case, the CPG money shall also be forfeited.

2.3 PERFORMANCE

a. Transformer shall be capable of withstanding for two seconds without damage to any external short circuit, with the short circuit MVA available at the terminals.
b. The maximum flux density in any part of the core and yoke at rated Voltage and frequency shall be such that the flux density with +12.5% combined voltage and frequency variation from rated voltage and frequency shall not exceed 1.9 Tesla.
c. Transformer shall under exceptional circumstances due to sudden disconnection of the load, be capable of operating at the voltage approximately 25% above normal rated voltage for a period of not exceeding one minute and 40% above normal for a period of 5 seconds.
d. The transformer may be operated continuously without danger on any particular tapping at the rated MVA± 1.25% of the voltage corresponding to the tapping.
e. The thermal ability to withstand short circuit shall be demonstrated by calculation.
f. Transformer shall be capable of withstanding thermal and mechanical stress caused by any symmetrical and asymmetrical faults on any winding.

2.4 DRAWINGS/ DOCUMENTS INCORPORATING THE FOLLOWING PARTICULARS SHALL BE SUBMITTED WITH THE BID

a. General outline drawing showing shipping dimensions and overall dimensions, net weights and shipping weights, quality of insulating oil, spacing of wheels in either direction of motion, location of coolers, marshalling box and tap changers etc.
b. Assembly drawings of core, windings etc. and weights of main components / parts.
c. Height of center line on HV and LV connectors of transformers from the rail top level.
d. Dimensions of the largest part to be transported.
e. GA drawings / details of various types of bushing
f. Tap changing and Name Plate diagram
g. Type test certificates of similar transformers.
h. Illustrative & descriptive literature of the Transformer.

i. Maintenance and Operating Instructions.

2.5 MISCELLANEOUS

i) Padlocks along with duplicate keys as asked for various valves, marshalling box etc. shall be supplied by the contractor, wherever locking arrangement is provided.

ii) Foundation bolts for wheel locking devices of Transformer shall be supplied by the Contractor.

2.6 DELIVERY

The full quantity of the equipments shall be delivered as per the delivery schedule appended to this specification.

2.7 SCHEDULES

All Schedules annexed to the specification shall be duly filled by the bidder separately.

2.8 ALTITUDE FACTOR

If the equipment is to be installed in the hilly area, necessary correction factors as given in the Indian Standard for oil temperature rise, insulation level etc. shall be applied to the Standard Technical Parameters given above.

2.9 NAME PLATE

Transformer rating plate shall contain the information as given in clause 15 of IS-2026 (part-I). The details on rating plate shall be finalized during the detailed engineering. Further, each transformer shall have inscription of Employer's name. The name plate shall also include (i) The short circuit rating, (ii) Measured no load current and no load losses at rated voltage and rated frequency, (iii) measured load losses at 75° C (normal tap only), (iv) D.C resistance of each winding at 75° C.

3. SERVICE CONDITIONS

The service conditions shall be as follows: (To be confirmed by PIA as per locality of project)		
	Plain area	Hilly area
Maximum altitude above sea level	1000m	5000m
Maximum ambient air temperature	50° C	50° C

Maximum daily average ambient air temperature	35° C	40° C
Minimum ambient air temperature	-5° C	-30° C
Maximum temperature attainable by an object exposed to the sun	60 ° C	60 ° C
Maximum yearly weighted average ambient temperature	32° C	32° C
maximum relative humidity	100%	100%
average number of thunderstorm days per annum (isokeraunic level)	70	70
average number of rainy days per annum	120	120
average annual rainfall	1500 mm	1500 mm
maximum wind pressure	260Kg/m²	260Kg/m²

* HP, J&K, Uttrakhand, Sikkim, Assam, Meghalaya, Manipur, Nagaland, Tripura and Mizoram will be considered as Hilly Area.

Environmentally, the region where the equipment will be installed includes coastal areas, subject to high relative humidity, which can give rise to condensation. Onshore winds will frequently be salt laden. On occasions, the combination of salt and condensation may create pollution conditions for outdoor insulators. Therefore, outdoor material and equipment shall be designed and protected for use in exposed, heavily polluted, salty, corrosive, tropical and humid coastal atmosphere.

SYSTEM CONDITIONS

The equipment shall be suitable for installation in supply systems of the following characteristics.

Frequency		50 Hz± 5%
Nominal system voltages		33 KV 11 KV
Maximum system voltages	33KV System	36.3 KV
	11 KV System	12 KV
Nominal short circuit level (Basing on apparent power)	33KV System	31.5KA
	11 KV System	13.1KA

Insulation levels: 1.2/50 μ sec impulse withstand voltage	33KV System	170KV (peak)
	11 KV System	75 KV (peak)
Power frequency one minute withstand (wet and dry) voltage	33KV System	70KV (rms)
	11 KV System	28KV (rms)
Neutral earthing arrangements	11 KV System	Solidly earthed

CODES & STANDARDS

4.1 The design, material, fabrication, manufacture, inspection, testing before dispatch and performance of power transformers at site shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards and codes of practice. Nothing in this specification shall be construed to relieve the contractor of this responsibility.

4.2 The equipment and materials covered by this specification shall conform to the latest applicable provision of the following standards.

IS:5	Colour for ready mixed paints
IS:325	Three Phase Induction Motors
IS:335	New insulating oil for transformers, switch gears
IS:1271	Classification of insulating materials for electrical machinery and apparatus in relation to their stability in services
IS:2026(Part I to IV)	Power Transformer
IS:2071	Method of high voltage testing
IS:2099	High voltage porcelain bushings
IS:2147	Degree of protection
IS:2705	Current Transformers
IS:3202	Code of practice for climate proofing of electrical equipment
IS:3347	Dimensions for porcelain Transformer Bushings

IS:3637	Gas operated relays
IS:3639 Transformers	Fittings and accessories for power
IS:5561	Electric Power Connectors
IS:6600/BS: CP‟10:0 Transformers	Guide for loading of oil immersed
IS:10028	Code of practice for selection, installation and maintenance of transformers, Part I. II and III
C.B.I.P. Publication	Manual on Transformers

If the standard is not quoted for any item, it shall be presumed that the latest version of Indian Standard shall be applicable to that item.

The equipment complying other internationally accepted standards, may also be considered if they ensure performance superior to the Indian Standards.

4.3 DRAWINGS

a) The contractor shall furnish, within fifteen days after issuing of Letter of Award. Six copies each of the following drawings/documents incorporating the transformer rating for approval.

i) Detailed overall general arrangement drawing showing front and side elevations and plan of the transformer and all accessories including radiators and external features with details of dimensions, spacing of wheels in either direction of motion, net weights and shipping weights, crane lift for un-tanking, size of lugs and eyes, bushing lifting dimensions, clearances between HV and L.V terminals and ground, quantity of insulating oil etc.

ii) Assembly drawings of core and winging and weights of main components / parts

iii) Foundation plan showing loading on each wheel land jacking points with respect to centre line of transformer.

iv) GA drawings details of bushing and terminal connectors.

v) Name plate drawing with terminal marking and connection diagrams.

vi) Wheel locking arrangement drawing.

vii) Transportation dimensions drawings.

viii) Magnetization characteristic curves of PS class neutral and phase side current transformers, if applicable.

ix) Interconnection diagrams.

x) Over fluxing withstand time characteristic of transformer.

xi) GA drawing of marshalling box.

xii) Control scheme/wiring diagram of marshalling box.

xiii) Technical leaflets of major components and fittings.

xiv) As built drawings of schematics, wiring diagram etc.

xv) Setting of oil temperature indicator, winding temperature indicator.

xvi) Completed technical data sheets.

xvii) Details including write-up of tap changing gear.

xviii) HV & LV bushing.

xix) Bushing Assembly.

xx) Bi-metallic connector suitable for connection to 100 mm2 up to 232 mm2 AAAC Conductor.

xxi) GA of LV cable Box.

xxii) Radiator type assembly.

b) All drawings, documents, technical data sheets and test certificates, results calculations shall be furnished.

4.4 Any approval given to the detailed drawings by the Employer's shall not relieve the contractor of the responsibility for correctness of the drawing and in the manufacture of the equipment. The approval given by the employer shall be general with overall responsibility with contractor.

GENERAL CONSTRUCTIONAL FEATURES

6.1 All material used shall be of best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions without distortion or deterioration or the setting up of undue stresses which may impair suitability of the various parts for the work which they have to perform.

6.2 Similar parts particularly removable ones shall be interchangeable.

6.3 Pipes and pipe fittings, screws, studs, nuts and bolts used for external connections shall be as per the relevant standards. Steel bolts and nuts exposed to atmosphere shall be galvanized.

6.4 Nuts, bolts and pins used inside the transformers and tap changer compartments shall be provided with lock washer or locknuts.

6.5 Exposed parts shall not have pockets where water can collect.

6.6 Internal design of transformer shall ensure that air is not trapped in any location.

6.7 Material in contact with oil shall be such as not to contribute to the formation of acid in oil. Surface in contact with oil shall not be galvanized or cadmium plated

6.8 Labels, indelibly marked, shall be provided for all identifiable accessories like Relays, switches current transformers etc. All label plates shall be of in corrodible material.

6.9 All internal connections and fastenings shall be capable of operating under overloads and over- excitation, allowed as per specified stands without injury.

6.10 Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance and repairs.

6.11 No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.

6.12 Schematic Drawing of the wiring, including external cables shall be put under the pros pane sheet on the inside door of the transformer marshalling box.

6.13 Painting

6.13.1 All paints shall be applied in accordance with the paint manufacturer's recommendations.

Particular attention shall be paid to the following:

a. Proper storage to avoid exposure as well as extremes of temperature.
b. Surface preparation prior to painting.
c. Mixing and thinning
d. Application of paints and the recommended limit on time intervals between coats.
e. Shelf life for storage.

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

6.13.1.2 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 the manufacturer's recommendations. However, wherever airless spray is not possible, conventional spray be used with prior approval of Employer.

6.13.1.3 The supplier shall, prior to painting protect nameplates, lettering gauges, sight glasses, light fittings and similar such items.

6.13.2 Cleaning and Surface Preparation

6.13.2.1After 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.

6.13.2.2 Steel surfaces shall be prepared by Sand/Shot blast cleaning or Chemical cleaning by Seven tank process including Phosphate to the appropriate quality.

6.13.2.3 The pressure and Volume of the compressed air supply for the blast cleaning shall meet the work requirements and shall be sufficiently free from all water contamination prior to any painting. 6.13.2.4 Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale and shall only be used where blast cleaning is impractical.

6.13.3 Protective Coating As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anticorrosion protection.

6.13.4 Paint Material

Followings are the type of paints that may be suitably used for the items to be painted at shop and supply of matching paint to site:

a. Heat resistant paint (Hot oil proof) for inside surface.
b. For external surfaces one coat of Thermo Setting Paint or 2 coats of Zinc chromate followed by 2 coats of POLYURETHANE. The color of the finishing coats shall be dark admiral grey conforming to No.632 or IS 5:1961.

6.13.5 Painting Procedure

6.13.5.1 All painting shall be carried out in conformity with both specifications and with the paint manufacture's recommendations. All paints in any one particular system. Whether shop or site applied, shall

originate from one paint manufacturer.

6.13.5.2 Particular attention shall be paid to the manufacture's instructions on storage, mixing,
thinning and pot life. The paint shall only be applied in the manner detailed by the manufacturer e.g. brush, roller, conventional or airless spray and shall be applied under the manufacturer's recommended conditions. Minimum and maximum time intervals between coats shall be closely followed.

6.13.5.3 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 warm.

6.13.5.4 Where the quality of film is impaired by excess film thickness, (wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coatings and apply another. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25%. In all instances, where two or more coats of the same paints are specifies, such coatings may or may not be of contrasting colors.

6.13.5.5 Paint applied to items that are not be painted, shall be removed at supplier's expense, leaving the surface clean, un-stained and undamaged.

6.13.6 Damages to Paints Work

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

6.13.6.2 Any damaged paint work shall be made as follows:

a) The damaged area, together with an area extending 25mm around its boundary, shall be cleaned down to bare metal.
b) A priming coat shall immediately applied, followed by a full paint finish equal to that originally applied and extending 50mm around the perimeter of the originally damaged.

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

6.13.7 Dry Film Thickness

6.13.7.1 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 same color.

6.13.7.2 Each coat of paint shall allowed to hardened before the next is applied as per manufacture‟s recommendations.

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

6.13.7.4 The requirement for the dry film thickness (DFT) of paint and the material to be used shall be as given below:

Sl.No	Paint Type	Area to be painted	No of Coats	Total Dry film thickness(Min)
1	Liquid paint			
	a) Zinc Chromate(Primer)	Out side Out side	02 02	45 micron 35 micron
	b) POLYURETHANE Paint (Finish Coat)	inside	01	35 micron
	c) Hot Oil paint			

7.1 DETAILED DESCRIPTION

7.2 **Tank**

7.2.1 The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank and the shall be of welded construction.

7.2.2 Tank shall be designed to permit lifting by crane or jacks of the complete transformer assembly filed with oil. Suitable lugs and bossed shall be provided for this purpose.

7.2.3 All breams, flanges, lifting lugs, braces and permanent parts attached to the tank shall be welded and where practicable, they shall be double welded.

7.2.4 The main tank body of the transformer, excluding tap changing compartments and radiators, shall be capable of withstanding pressure of 760mm of Hg.

7.2.5 Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc.

7.2.6 Gaskets of nitrile rubber or equivalent shall be used to ensure perfect oil

tightness. All gaskets shall be closed design (without open ends) and shall be of one piece only. Rubber gaskets used for flange type connections of the various oil compartments, shall be laid in grooves or in groove- equivalent sections on bolt sides of the gasket, throughout their total length. Care shall be taken to secure uniformly distributed mechanical strength over the gaskets and retains throughout the total length. Gaskets of neoprene and / or any kind of impregnated / bonded core or cork only which can easily be damaged by over-pressing are not acceptable. Use of hemp as gasket material is also not acceptable.

7.2.7 Suitable guides shall be provided for positioning the various parts during assemble or dismantling. Adequate space shall be provided between the cores and windings and the bottom of the tank for collection of any sediment.

7.3 Tank Cover

The transformer top shall be provided with a detachable tank cover with bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. The surface of the cover shall be suitable sloped so that it does not retain rain water.

7.4 UNDER CARRIAGE

7.4.1 The transformer tank filled with oil shall be supported on steel structure with detachable plain rollers. Suitable channels for movement of roller with transformer shall be space accordingly, rollers wheels shall be provided with suitable rollers bearings, which will resist rust and corrosion and shall be equipped with fittings for lubrication.

7.5 CORE

7.5.1 Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.

7.5.2 The core shall be constructed either from high grade, non-aging Cold Rolled Grain Oriented (CRGO) silicon steel laminations conforming to HIB grade with lamination thickness not more than 0.23mm to 0.27mm or better(Quoted grade and type shall be used). The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall not be more than 1.69 Tesla. The Bidder shall provide saturation curve of the core material, proposed to be used. Laminations of different grade(s)_ and different thickness (s) are not allowed to be used in any manner or under any circumstances.

CRGO steel for core shall be purchased only from the approved vendors, list of which is available at

http://apps.powergridindia.com/ims/ComponentList/Power-former%20upto%20420%20kV-CM%20List.pdf

7.5.3 The bidder should offer the core for inspection starting from the destination port to enable Employer for deputing inspecting officers for detail verification as given below and approval by the Employer during the manufacturing stage. Bidder"s call notice for the purpose should be accompanied with the following documents as applicable as a proof towards use of prime core material: The core coils, if found suitable, are to be sealed with proper seals which shall be opened in presence of the inspecting officers during core- cutting at the manufacturer's or it's sub-vendor's premises as per approved design drawing.

a) Purchase Order No. & Date.
b) Invoice of the supplier
c) Mills test certificate
d) Packing list
e) Bill of lading
f) Bill of entry certificate to customs

Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute, but not through any agent.
Please refer to "**Check-list for Inspection of Prime quality CRGO for Transformers"** attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.

7.5.4 The laminations shall be free of all burrs and sharp projections. Each sheet shall have an insulting coating resistant to the action of hot oil.

7.5.5 The insulation structure for the core to bolts and core to clamp plates, shall be such as to withstand 2000 V DC voltage for one minute.

7.5.6 The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core assemble shall not deviate from the vertical plane by more than 25mm.

7.5.7 All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling and welding.

7.5.8 The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.

7.5.9 The core clamping structure shall be designed to minimize eddy current loss.

7.5.10 The framework and clamping arrangements shall be securely earthed.

7.5.11 The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.

7.5.12 Oil ducts shall be provided, where necessary, to ensure adequate cooling inside the core. The welding structure and major insulation shall not obstruct the free flow of oil through such ducts.

7.5.13 The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earth clamping structure and production of flux component at right angle to the plane of the lamination, which may cause local heating. The supporting framework of the cores shall be so designed as to avoid the presence of pockets, which would prevent complete emptying of the tank through the drain valve or cause trapping of air during filling.

7.5.14 The construction is to be of boltless core type. The core shall be provided with lugs suitable for lifting the complete core and coil assembly. The core and coil assemble shall be so fixed in the tank that shifting will not occur during transport or short circuits.

7.5.15 The temperature gradient between core & surrounding oil shall be maintained less than 20 deg. Centigrade. The manufacturer shall demonstrate this either through test (procurement to be mutually agreed) or by calculation.

7.6 INTERNAL EARTHING

7.6.1 All internal metal parts of the transformer, with the exception of individual laminations and their individual clamping plates shall be earthed.

7.6.2 The top clamping structure shall be connected to the tank by a copper strap. The bottom clamping structure shall be earthed by one or more the following methods:

a) By connection through vertical tie-rods to the top structure.
b) By direct metal to metal contact with the tank base.
c) By a connection to the structure on the same side of the core as the main earth connection to the tank.

7.6.3 The magnetic circuit shall be connected to the clamping structure at one point only and this shall be brought out of the top cover of the transformer tank through a suitably rated insulator. A disconnecting link shall be provided on transformer tank to facilitate disconnections from ground for IR measurement purpose.

7.6.4 Coil clamping rings of metal at earth potential shall be connected to the adjacent core clamping structure on the same side as the main earth

connections.

7.7 WINDING

7.7.1 Winding shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service. 7.6.2 All low voltage windings for use in the circular coil concentric winding shall be wound on a performed insulating cylinder for mechanical protection of the winding in handling and placing around the core.

7.7.2 Winding shall not contain sharp bends which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness.
The conductors shall be of electrolytic grade copper free from scales and burrs. The conductor insulation shall be made from high-density (at least 0.75 gm/cc) paper having high mechanical strength. The barrier insulation including spacers shall be made from high- density pre-compressed pressboard (1.1 gm/cc minimum for load bearing and 1 to 1.3 gm/cc minimum for non-load bearing) to minimize dimensional changes.

7.7.3 Materials used in the insulation and assembly of the windings shall be insoluble, non catalytic and chemically inactive in the hot transformer oil and shall not soften or the otherwise affected under the operating conditions.

7.7.4 Winding and connections shall be braced to withstand shocks during transport or short circuit.

7.7.5 Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in the oil steel bolts, if used, shall be suitably treated.

7.7.6 Terminals of all windings shall be brought out of the tank through bushings for external connections.

7.6.6.1 The completed core and coil assemble shall be dried in vacuum at not more than 0.5mm of mercury absolute pressure and shall be immediately impregnated with oil after the drying process to ensure the elimination of air and moisture within the insulation. Vacuum may be applied in either vacuum over or in the transformer tank.

7.6.6.2 The winding shall be so designed that all coil assembles of identical voltage ratings shall be interchangeable and field repairs to the winding

can be made readily without special equipment. The coils shall have high dielectric strength.

7.6.6.3 Coils shall be made of continuous smooth high grade electrolytic copper conductor, shaped and braced to provide for expansion and contraction due to temperature changes.

7.6.6.4 Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turn shall have additional protection against abnormal line disturbances.

7.6.6.5 The insulation of winding shall be designed to withstand voltage stress arising from surge in transmission lines due to atmospheric or transient conditions caused by switching etc.

7.6.6.6 Tapping shall not be brought out from inside the coil or from intermediate turns and shall be so arranged as to preserve as far as possible magnetic balance of transformer at all voltage ratios.

7.6.6.7 Magnitude of impulse surges transferred from HV to LV windings by electromagnetic induction and capacitance coupling shall be limited to BILL of LV winding.

7.7 INSULATING OIL

7.7.1 The insulating oil for the transformer shall be of EHV grade, generally conforming to IS: 335. No inhibitors shall be used in the oil.

7.7.2 The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. transformer shall supplied complete with all fittings, accessories and new transformer oil required for first filling plus 10% extra oil. The extra quantity of oil shall be supplied in non-returnable drums along with the oil required for the radiator banks.

7.7.3 The design and materials used in the construction of the transformer shall be such as to reduce the risk of the development of acidity in the oil.

7.7.4 The oil parameters shall be as per Table-1 of IS 335.

7.8 VALVES

i) Valves shall be of forged carbon steel upto 50mm size and of gun mental or of cast iron bodies with gun metal fittings for sizes above 50mm. They shall be of full way type with screwed ends and shall be opened by turning counter clockwise when facing the hand wheel. There

shall be no oil leakage when the valves are in closed position.

Each valve shall be provided with an indicator to show the open and closed positions and shall be provided with facility for padlocking in either open or closed position. All screwed valves shall be furnished with pipe plugs for protection. Padlocks with duplicate keys shall be supplied along with the valves.

ii) All valves except screwed valves shall be provided with flanges having machined faced drilled to suit the applicable requirements, Oil tight blanking plates shall be provided for each connection for use when any radiator is detached and for all valves opening to atmosphere. If any special radiator valve tools are required the contractor shall supply the same.

iii) Each transformer shall be provided with following valves on the tank:

a) Drain valve so located as to completely drain the tank & to be provided with locking arrangement.

b) Two filter valves on diagonally opposite corners of 50mm size & to be provided with locking arrangement.

c) Oil sampling valves not less than 8mm at top and bottom of main tank & to be provided with locking arrangement.

d) One 15mm air release plug.

e) Valves between radiators and tank. Drain and filter valves shall be suitable for applying vacuum as specified in the specifications.

7.9 ACCESSORIES

7.9.1 **Bushing**

i) All porcelain used in bushings shall be homogeneous, non-porous, uniformly glazed to brown colour and free from blisters, burns and other defects.

ii) Stress due to expansion and contraction in any part of the bushing shall not lead to deterioration.

iii) Bushing shall be designed and tested to comply with the applicable standards.

iv) Bushing rated for 400A and above shall have non-ferrous flanges and hardware.

v) Fittings made of steel or malleable iron shall be galvanized

vi) Bushing shall be so located on the transformers that full flashover strength will be utilized. Minimum clearances as required for the BIL shall be realized between live parts and live parts to earthed structures.

vii) All applicable routine and type tests certificates of the bushings shall be furnished for approval.

viii) Bushing shall be supplied with bi-metallic terminal connector/ clamp/ washers suitable for fixing to bushing terminal and the Employers specified conductors. The connector/clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of 550 Co ver an ambient of 500 C. The connector/clamp shall be designed to be corona free at the maximum rated line to ground voltage.

ix) Bushing of identical voltage rating shall be interchangeable.

x) The insulation class of high voltage neutral bushing shall be properly coordinated with the insulation class of the neutral of the low voltage winding.

xi) Each bushing shall be so coordinated with the transformer insulation that all flashover will occur outside the tank.

xii) The extended bushing bus bars shall be used for termination of 11 KV cables. LV busing shall be housed in completely sealed metallic enclosure.

xiii) Sheet steel, weather, vermin and dust proof cable box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch, water- tight hinged and padlocked door of a suitable construction shall be provided with each transformer to accommodate 11 KV cables etc. The box shall have slopping roof and the interior and exterior painting shall be in accordance with the specification. Padlock along with duplicate keys shall be supplied for marshaling box. The degree of protection shall be IP-55 or better. To prevent internal condensation, a metal clad heater with thermostat shall be provided. The heater shall be controlled by a MCB of suitable rating mounted in the box. The ventilation louvers, suitably padded with felt, shall also be provided. The louvers shall be provided with suitable felt pads to prevent ingress of dust. All incoming cables shall enter the kiosk from the bottom and the minimum 4mm thick, non-magnetic, gland plate shall not be less than 600 mm from the base of the box. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress of moisture from the cable trench – **for those transformers which are used in partly indoor**

substation, *If required as per BOQ, a cable box for LV bushings shall be provided.*

7.9.2 Protection & Measuring Devices

i) **Oil Conservator Tank**

a) The Conservator tank shall have adequate capacity between highest and lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment.

b) The conservator tank shall be bolted into position so that it can be remove for cleaning purposes.

c) The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact.

d) Plain conservator fitted with silica gel breather.

Pressure Relief Device.

The pressure relief device provided shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage of the equipment. The device shall operate at a static pressure of less than the hydraulic test pressure of transformer tank. It shall be mounted direct on the tank. A pair of electrically insulated contract shall be provided for alarm and tripping.

Buchholz Relay

A double float type Buchholz relay shall be provided. Any gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation. A copper tube shall be connected from the gas collector to a valve located about 1200 mm above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent potential free contracts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

Temperature Indicator

a) **Oil Temperature Indicator (OTI)**

The transformers shall be provided with a micro switch contact type thermometer with 150 mm dial for top oil temperature indication. The thermometer shall have adjustable, electrically independent potential free alarm and trip contacts. Maximum reading pointer and resetting device shall be mounted in the local control panel. A temperature sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to the OTI by means of capillary tubing. Accuracy class of OTI shall be ± 1% or better. One No electrical contact capable of operating at 5 A ac at 230 volt supply.

Winding Temperature indicator (WTI)

A device for measuring the hot spot temperature of the winding shall be provided. It shall comprise the following.

i) Temperature sensing element.

ii) Image Coil.

iii) Micro switch contacts.

iv) Auxiliary CTS, If required to match the image coil, shall be furnished and mounted in the local control panel.

v) 150mm dial local indicating instrument with maximum reading pointer mounted in local panel and with adjustable electrically independent ungrounded contacts, besides that required for control of cooling equipment, one for high winding temperature alarm and on for trip.

vi) Two number electrical contact each capable of operating at 5 A ac at 230 Volt supply.

7.9.3 Oil Preservation Equipment

7.9.3.1 **Oil Sealing**

The oil preservation shall be diaphragm type oil sealing in conservator to prevent oxidation and contamination of oil due to contact with atmospheric moisture.

The conservator shall be fitted with a dehydrating filter breather. It shall be so designed that.

i) Passage of air is through a dust filter & Silica gel.

ii) Silica gel is isolate from atmosphere by an oil seal.

iii) Moisture absorption indicated by a change in colour of the crystals of the silica gel can be easily observed from a distance.

iv) Breather is mounted not more than 1400 mm above rail top level.

7.10 MARSHALLING BOX

i) Sheet steel, weather, vermin and dust proof marshaling box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch, water- tight hinged and padlocked door of a suitable construction shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. The box shall have slopping roof and the interior and exterior painting shall be in accordance with the specification. Padlock along with duplicate keys shall be supplied for marshaling box. The degree of protection shall be IP-55 or better.

ii) The schematic diagram of the circuitry inside the marshaling box be prepared and fixed inside the door under a propone sheet.

iii) The marshaling box shall accommodate the following equipment:

a) Temperature indicators.

b) Space for accommodating Control & Protection equipment in future for the cooling fan (for ONAF type cooling, may be provided in future).

c) Terminal blocks and gland plates for incoming and outgoing cables.

All the above equipment except c) shall be mounted on panels and back of panel wiring shall be used for inter-connection. The temperature indicators shall be so mounted that the dials are not more than 1600 mm from the ground level and the door (s) of the compartment(s) shall be provided with glazed window of adequate size. The transformer shall be erected on a plinth which shall be 2.5 feet above ground level.

iv) To prevent internal condensation, a metal clad heater with thermostat shall be provided. The heater shall be controlled by a MCB of suitable rating mounted in the box. The ventilation louvers, suitably padded with felt, shall also be provided. The louvers shall be provided with suitable felt pads to prevent ingress of dust.

v) All incoming cables shall enter the kiosk from the bottom and the gland plate shall not be less than 450 mm from the base of the box. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress of moisture from the cable trench.

7.11 TAPCHANGER

7.11.1 **ON-LOAD TAP-CHANGERS**

i) The3.15/5/6.3/8/10/12.5 MVA transformers shall be provided with On-load Taps. Specification of OLTC is attached herewith as Annexure.

ii) The Transformer with off-load tap changing gear shall have taps ranging from +5% to -15% in 9 equal steps of 2.5% each for Off Load Tap.

iii) The tap changing switch shall be located in a convenient position so that it can be operated from ground level. The switch handle shall be provided with locking arrangement along with tap position indication, thus enabling the switch to be locked in position

7.12 FITTINGS AND ACCESSORIES

The following fittings and accessories shall be provided on the transformers:

i) Conservator with isolating valves, oil filling hole with cap and drain valve. The conservator vessel shall be filled with constant oil pressure diaphragm oil sealing system.

ii) Magnetic type oil level gauge (150 mm dia) with low oil level alarm contacts.

iii) Prismatic/ toughened glass oil level gauge.

iv) Silica gel breather with oil seal and connecting pipe complete with first fill of activated silica gel or Alumina mounted at a level of 1300 mm above ground level.

v) A double float type Buchholz relay with isolating valve. Bleeding pipe and a testing cock, the test cock shall be suitable for a flexible (pipe connection for checking its operation). A 5mm dia. Copper pipe shall be connected from the relay test cock to a valve located at a suitable height above ground level to facilitate sampling of gas with the transformer in service. Interconnection between gas collection box and relay shall also be provided. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden oil surge. These

contacts shall be wired upto transformer marshaling box. The relay shall be provided with shut off valve on the conservator side as well as on the tank side.

vi) Pressure relief devices (including pressure relief valve) and necessary air equalizer connection between this and the conservator with necessary alarm and trip contacts.

vii) Air release plugs in the top cover.

viii) Inspection cover, access holes with bolted covers for access to inner ends of bushing etc.

ix) Winding temperature (hot spot) indicating device for local mounting complete in all respects. Winding temperature indicator shall have two set of contacts to operate at different settings :

a) To provide winding temperature high alarm

b) To provide temperature too high trip

x) Dial thermometer with pocket for oil temperature indicator with one set of alarm and one set of trip contacts and maximum reading pointer.

xi) Lifting eyes or lugs for the top cover, core and coils and for the complete transformer.

xii) Jacking pads

xiii) Haulage lugs.

xiv) Protected type mercury / alcohol in glass thermometer and a pocket to house the same.

xv) Top and bottom filter valves on diagonally opposite ends with pad locking arrangement on both valves.

xvi) Top and bottom sampling valves.

xvii) Drain valve with pad locking arrangement

xviii) Rating and connection diagram plate.

xix) Two numbers tank earthing terminals with associated nuts and bolts for connections to Employer's grounding strip.

xx) Marshaling Box (MB)

xxi) Shut off valve on both sides of flexible pipe connections between radiator bank and transformer tank.

xxii) Cooling Accessories :

a) Requisite number of radiators provided with :-

- One shut off valve on top
- One shut off valve at bottom
- Air release device on top
- Drain and sampling device at bottom
- Lifting lugs.

b) Air release device and oil drain plug on oil pipe connectors:

xxiii) Terminal marking plates for Current Transformer and Main Transformer

xxiv) On/Off Load Tap changer as per BOQ

xxv) Oil Preservation Equipment

xxvi) Oil Temperature indicator

xxvii) Transformer shall be supplied with all control cable, WTI & OTI, sensing cable, glands, lugs etc (complete control).

Note :

1. The fittings listed above are indicative and any other fittings which are generally required for satisfactory operation of the transformer are deemed to be included in the quoted price of the transformer.
2. The contacts of various devices required for alarm and trip shall be potential free and shall be adequately rated for continuous, making and breaking current duties as specified.

7.13 CONTROL CONNECTIONS AND INSTRUMENT AND WIRING TERMINAL BOARD AND FUSES

i) Normally no fuses shall be used anywhere instead of fuses MCB"s (both

in AC & DC circuits) shall be used. Only in cases where a MCB cannot replace a fuse due to system requirements, a HRC fuse can be accepted.

ii) All wiring connections, terminal boards, fuses MCB"s and links shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resisting insulation and the bare ends of stranded wire shall be sweated together to prevent seepage of oil along the wire.

iii) Panel connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC or non-rusting metal cleats of the compression type. All wiring to a panel shall be taken from suitable terminal boards.

iv) Where conduits are used, the runs shall be laid with suitable falls, and the lowest parts of the run shall be external to the boxes. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.

v) When 400 volt connections are taken through junction boxes or marshaling boxes, they shall be adequately screened and 400 volts Danger Notice must be affixed to the outside of the junction boxes or marshaling box. Proper colour code for Red, Yellow, Blue wires shall be followed.

vi) All box wiring shall be in accordance with relevant ISS. All wiring shall be of stranded copper (48 strands) of 1100 Volt grade and size not less than 2.5 sq.mm

vii) All wires on panels and all multi-core cables shall have ferrules, for easy identifications, which bear the same number at both ends, as indicated in the relevant drawing.

viii) At those points of interconnection between the wiring carried out by separate contractors, where a change of number cannot be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the equipment.

ix) The same ferrule number shall not be used on wires in different circuits on the same panels.

x) Ferrules shall be of white insulating material and shall be provided with glossy finish to prevent the adhesion of dirt. They shall be clearly and durably marked in black and shall not be affected by dampness or oil.

xi) Stranded wires shall be terminated with tinned Ross Courtney terminals,

claw washers or crimped tubular lugs. Separate washers shall be suited to the size of the wire terminated. Wiring shall, in general, be accommodated on the sides of the box and the wires for each circuit shall be separately grouped. Back of panel wiring shall be arranged so that access to the connecting items of relays and other apparatus is not impeded.

xii) All circuits in which the voltage exceeds 125 volts, shall be kept physically separated from the remaining wiring. The function of each circuit shall be marked on the associated terminal boards.

xiii) Where apparatus is mounted on panels, all metal cases shall be separately earthed by means of stranded (48 No.) copper wire of strip having a cross section of not less than 2 sq. mm where strip is used, the joints shall be sweated. The copper wire shall have green coloured insulation for earth connections.

xiv) All wiring diagram for control and relay panel shall preferably be drawn as viewed from the back and shall show the terminal boards arranged as in services.

xv) Terminal block rows should be spaced adequately not less than 100 mm apart to permit convenient access to external cables and terminations.

xvi) Terminal blocks shall be placed with respect to the cable gland (at a minimum distance of 200 mm) as to permit satisfactory arrangement of multicore cable tails .

xvii) Terminal blocks shall have pairs of terminals for incoming and outgoing wires. Insulating barriers shall be provided between adjacent connections. The height of the barriers and the spacing between terminals shall be such as to give adequate protection while allowing easy access to terminals. The terminals shall be adequately protected with insulating dust proof covers. No live metal shall be exposed at the back of the terminal boards. CT terminals shall have shorting facilities. The terminals for CTs should have provision to insert banana plugs and with isolating links.

xviii) All interconnecting wiring, as per the final approved scheme between accessories of transformer and marshaling box is included in the scope of this specification and shall be done by the Transformer supplier.

xix) The schematic diagram shall be drawn and fixed under a transparent prospane sheet on the inner side of the marshaling box cover.

xx) To avoid condensation in the Marshaling Box, a space heater shall be

provided with an MCB and thermostat.

xxi) Suitable MV, CFL light shall be provided in the Marshaling Box for lightning purpose.

7.14 RADIO INTERFERENCE AND NOISE LEVEL

Transformers shall be designed with particular care to suppress at least the third and fifth harmonic voltages so as to minimize interference with communication circuits. Transformer noise level when energized at normal voltage and frequency shall be as per NEMA stipulations.

8 INSPECTION AND TESTING

(i) The Contractor shall carry out a comprehensive inspection and testing programme during manufacture of the transformer. This is, however, not intended to form a comprehensive programme as it is contractor's responsibility to draw up and carry out such a programme duly approved by the Employer.

(ii) Transformer of each rating will be as per pre-type tested design.

(iii) The pre-shipment checks shall also be carried out by the contractor.

(iv) The requirements on site tests are as listed in the specifications.

(v) Certified test report and oscillograms shall be furnished to the Employer Consultants for evaluation as per the schedule of distribution of documents. The Contractor shall also evaluate the test results and rectify the defects in the equipment based on his and the Employers evaluations of the tests without any extra charges to the Employer. Manufacturer's Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.

(vi) The bidder shall state in his proposal the testing facilities available at his works. In case full testing facilities are not available, the bidder shall state the method proposed to be adopted so as to ascertain the transformer characteristics corresponding to full capacity.

8.1 INSPECTION

Transformers not manufactured as per Type- Tested design shall be rejected.

i) **Tank and Conservator**

a) Inspection of major weld.

b) Crack detection of major strength weld seams by dye penetration test.

c) Check correct dimensions between wheels, demonstrate turning of wheels, through 900
and further dimensional check.

d) Leakage test of the conservator.

ii) Core

a) Sample testing of core materials for checking specific loss, properties, magnetization characteristics and thickness.

b) Check on the quality of varnish if used on the stampings.

c) Check on the amount of burrs.

d) Visual and dimensional check during assembly stage.

e) Check on completed core for measurement of iron loss, determination of maximum flux density,

f) Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.

g) High voltage DC test (2 KV for one minute) between core and clamps.

Please refer to "**Check-list for Inspection of Prime quality CRGO for Transformers"** attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.

iii) Insulating Material

a) Sample check for physical properties of materials.
b) Check for dielectric strength
c) Check for the reaction of hot oil on insulating materials.

iv) Winding

a) Sample check on winding conductor for mechanical and electrical conductivity.
b) Visual and dimensional checks on conductor for scratches, dent mark etc.
c) Sample check on insulating paper for PH value, electric strength.
d) Check for the bonding of the insulating paper with conductor.
e) Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.

f) Check for absence of short circuit between parallel strands.

v) **Checks Before Drying Process**

a) Check condition of insulation on the conductor and between the windings.
b) Check insulation distance between high voltage connections, between high voltage connection cables and earth and other live parts.
c) Check insulating distances between low voltage connections and earth and other parts.
d) Insulating test for core earthing.

vi) **Check During Drying Process**

a) Measurement and recording of temperature and drying time during vacuum treatment.
b) Check for completeness of drying

vii) **Assembled Transformer**

a) Check completed transformer against approved outline drawing, provision for all fittings, finish level etc.

b) Jacking test on the assembled Transformer.

viii) Oil All standard tests in accordance with IS: 335 shall be carried out on Transformer oil sample before filling in the transformer.

ix) Test Report for bought out items The contractor shall submit the test reports for all bought out / sub contracted items for approval.

a) Buchholz relay
b) Sudden pressure rise relay on Main Tank
c) Winding temperature indicators (for TX capacity 5 MVA)
d) Oil temperature indicators
e) Bushings
f) Bushing current transformers in neutral (If Provided)
g) Marshaling box
h) On/Off Load Tap changer as per BOQ
i) Any other item required to complete the works.
j) Porcelain, bushings, bushing current transformers, wherever provided, winding coolers, control devices, insulating oil and other associated equipment shall be tested by the contractor in accordance with relevant IS . If such requirement is purchased by the contractor on a sub-contract, he shall have them tested

to comply with these requirements.

8.2 FACTORY TESTS

i) All standards routine tests in accordance IS: 2026 with dielectric tests corresponding as per latest amendments to IS: 2026 shall be carried out.

ii) All auxiliary equipment shall be tested as per the relevant IS. Test certificates shall be submitted for bought out items.

iii) High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.

iv) Following additional routine tests shall also be carried out on each transformer:

a) Magnetic Circuit Test Each core shall be tested for 1 minute at 2000 Volt AC

b) Oil leakage test on transformer

8.2.1 Type Test

8.2.1.1 The measurements and tests should be carried out in accordance with the standard specified in each case as indicated in the following table if the same tests were not conducted earlier at CPRI or any NABL accredited Laboratory on the transformers of the offered design without any cost implication on employer.

Table 6: Transformer type tests

Type Test Standard	
Temperature Rise Test	IEC 76/IS 2026/IS6600
Impulse Volt age Withstand Test, including Full	IEC 76/IS 2026
Noise Level Measurement	IEC 551

In accordance with IEC 76-3 the following sequence of impulses should have been/ should be applied;

- One full wave at 50% BIL;
- One full wave at 100% BIL;
- One chopped wave at 50% BIL
- Two chopped waves at 100% BIL and
- Two full waves at 100% BIL.

8.2.1.2 If the type test report(s) submitted by the bidder do not fulfill the criteria, as stipulated in this technical specification/ Bidder's offer, the relevant type test(s) has/ have to be conducted by the Bidder at his own cost in CPRI/ NABL accredited laboratory in the presence of employers representative(s) without any

financial liability to employer in the event of order placed on him.

8.2.1.3 The offered transformer must be manufactured as per type tested design. A copy of type test certificate must be submitted by manufacturer to Engineer/Employer. Transformers offered without type tested however design shall not be accepted. In case manufacturer agrees for type testing of transformers, testing shall be conducted on manufacturer's cost. No claim shall be acceptable towards type testing. The transformers shall be accepted only on acceptance of type testing results by employer.

8.2.1.4 The supplier shall furnish calculations in accordance with IS: 2026 to demonstrate the Thermal ability of the transformers to withstand Short Circuit forces.

8.2.1(A) Special Test

The short circuit test shall be a mandatory test for each design shall be supplied by the manufacturer and no exception shall be allowed. The test shall be conducted as per latest standard tabled below:

Short Circuit Test	IEC 76 / IS 2026

8.2.2 STAGE INSPECTION

The supplier shall offer the core, windings and tank of each transformer for inspection by the Employers representative(s). During stage Inspection, all the measurements like diameter, window height, leg Centre, stack width, stack thickness, thickness of laminations etc. for core assembly, conductor size, Insulation thickness, I.D., O.D, winding height, major and minor insulations for both H.V and L.V windings, length, breadth, height and thickness of plates of Transformer tank, the quality of fittings and accessories will be taken / determined. The supplier can offer for final inspection of the transformers subject to clearance of the stage Inspection report by the Employer.

8.2.3 Routine Tests

Transformer routine tests shall include tests stated in latest issue of IS: 2026 (Part –1). These tests shall also include but shall not be limited to the following :

(i) Measurement of winding DC resistance.

(ii) Voltage ratio on each tapping and check of voltage vector relationship.

(iii) Impedance voltage at all tappings.

(iv) Magnetic circuit test as per relevant ISS or CBIP manual or latest standard being followed.

(v) Measurement of Load losses at normal tap and extreme taps.

(vi) No load losses and no load current at rated voltage and rated frequency, also at 25% to 120 % of rated voltage in steps.

(vii) Absorption index i.e insulation resistance for 15 seconds and 60 seconds (R 60/ R 15) and polarization index i.e Insulation Resistance for 10 minutes and one minute (R 10 mt / R 1 mt).

(viii) Induced over voltage withstand test.

(ix) Separate source voltage withstand test.

(x) Tan delta measurement and capacitance of each winding to earth (with all other windings earthed) & between all windings connected together to earth.

(xi) Measurement of zero sequence impedance

(xii) Tests on On/Off Load Tap changer as per BOQ (fully assembled on transformer) as per IS 2026

(xiii) Auxiliary circuit tests

(xiv) Oil BDV tests

(xv) Measurement of neutral unbalance current which shall not exceed 2% of the full rated current of the transformer.

(xvi) Magnetic balance test

(xvii) Leakage test.

Six (6) set of certified test reports and oscillographs shall be submitted for evaluation prior to dispatch of the equipment. The contractor shall also evaluate the test results and shall correct any defect indicated by his and Employers evaluation of the tests without charge to the Employer.

8.4 TANK TESTS

a) **Oil leakage Test :**

The tank and oil filled compartments shall be tested for oil tightness completely filled with air or oil of viscosity not greater than that of insulating oil conforming to IS : 335 at the ambient temperature and applying a pressure equal to the normal pressure plus 35 KN/ m2 measured at the base of the tank. The pressure shall be maintained for a period of not less than 12 hours of oil and one hour for air and during that time no leak shall occur.

b) Pressure Test

Where required by the Employer, one transformer tank of each size together with its radiator, conservator vessel and other fittings shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN / m2 whichever is lower, measured at the base of the tank and maintained for one hour.

c) Vacuum Test

One transformer tank of each size shall be subjected to the vacuum pressure of 60 mm of mercury. The tanks designed for full vacuum shall be tested at an internal pressure of 3.33 KN/m2 (25 mm of mercury) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the value specified in C.B.I.P. Manual on Transformers (Revised 1999) without affecting the performance of the transformer.

8.5 PRE-SHIPMENT CHECK AT MANUFACTURERS WORKS

i) Check for proper packing and preservation of accessories like radiators, bushings, explosions vent, dehydrating breather, rollers, buchholz relay, control cubicle connecting pipes and conservator etc.

ii) Check for proper provision of bracing to arrest the movement of core and winding assembly inside the tank.

iii) Gas tightness test to conform tightness.

8.6 INSPECTION AND TESTING AT SITE

On receipt of transformer at site, shall be performed detailed inspection covering areas right from the receipt of material up to commissioning stage. An indicative program of inspection as envisaged by the Engineer is given below.

8.6.1 Receipt and Storage Checks

i) Check and record conditions of each package visible parts of the transformers etc for any damage.

ii) Check and record the gas pressure in the transformer tank as well as in the gas cylinder.

iii) Visual check of core and coils before filling up with oil and also check condition of core and winding in general.

8.6.2 Installation Checks

i) Inspection and performance testing of accessories like tap changers etc.

ii) Check choking of the tubes of radiators

iii) Test on oil samples taken from main tank top and bottom and cooling system. Samples should be taken only after the oil has been allowed to settle for 24 hours.

iv) Check the whole assembly for tightness, general appearance etc.

v) Oil leakage tests.

8.6.3 Pre-Commissioning Tests

After the transformer is installed, the following pre-commissioning tests and checks shall be done before putting the transformer in service.

i) Megger Test

ii) Phase relationship test (Vector group test)

iii) Buchholz relay alarm & surge operation test (Physical)

iv) Ratio test on all taps

v) Low oil level (in conservator) alarm

vi) Temperature Indicators (Physical)

vii) Marshaling kiosk (Physical)

8.6.4 The following additional checks shall be made :

i) All oil valves are incorrect position closed or opened as required

ii) All air pocket are cleared.

iii) Thermometer pockets are filled with oil

iv) Oil is at correct level in the bushing, conservator, diverter switch & tank etc.

v) Earthing connections are made.

vi) Bushing arcing horn is set correctly and gap distance is recorded.

vii) C T polarity and ratio is correct.

8.7 PERFORMANCE

The performance of the transformer shall be measured on the following aspects.

i) The transformer shall be capable of being operated without danger on any tapping at the rated KVA with voltage variations and ± 10% corresponding to the voltage of the tapping

ii) Radio interference and Noise Level

iii) The transformer shall be designed with particular attention to the suppression of third and fifth harmonics so as to minimize interference with communication circuits.

8.8 FAULT CONDITIONS

a) The transformer shall be capable of withstanding for two(2) seconds without damages any external short circuit to earth

b) Transformer shall be capable of withstanding thermal and mechanical stresses conveyed by symmetrical or asymmetrical faults on any winding. This shall be demonstrated through calculation as per IS : 2026.

c) Transformer shall accept, without injurious heating, combined voltage and frequency fluctuation which produce the 125% over fluxing condition for one minute and 140% for 5 seconds.

8.9 WITNESSING OF TESTS AND EXCESSIVE LOSSES

i) The Employer reserves the right to reject the Transformer if losses exceed the maximum specified as per Clause No 2. SPECIFIC

TECHNICAL REQUIREMENTS (STANDARD CONDITIONS), item-35of this specification or if temperature rise of oil and winding exceed the values specified at item -26 of the above clause.

9 LIQUIDATED DAMAGES FOR EXCESSIVE LOSSES

There is no positive tolerance on the guaranteed losses offered by the bidder. However, the transformer(s) shall be rejected out rightly, if any of the losses i.e. no load loss or load loss or both exceed (s) the guaranteed maximum permissible loss figures quoted by the bidder in the Technical Data Schedule with the bid.

10 **SPARE PARTS**

In case the manufacturer goes out of production of spare parts, then he shall make available the drawings of spare parts and specification of materials at no extra cost to the Employer to fabricate or procure spare parts from other sources.

Mandatory Spare Parts

The suppliers shall provide the following mandatory spare s for each of Transformer supplied

1. H.V. & L.V. Bushing & Studs –Each 2 Nos
2. Bimetallic connector for H.V & L.V. Bushings – Each 2 sets

10.1 INSTRUCTION MANUAL

Eight sets of the instruction manuals shall be supplied at least four (4) weeks before the actual dispatch of equipment. The manuals shall be in bound volumes and shall contain all the drawings and information required for erection, operation and maintenance of the transformer. The manuals shall include amongst other, the following particular:

a) Marked erection prints identifying the components, parts of the transformer as dispatched with assembly drawings.

b) Detailed dimensions, assembly and description of all auxiliaries.

c) Detailed views of the core and winding assembly, winding connections and tapings tap changer construction etc. These drawings are required for carrying out overhauling operation at site.

d) Salient technical particulars of the transformer.

e) Copies of all final approved drawings.

f) Detailed O&M instructions with periodical check lists and Performa etc.

10.2 COMPLETENESS OF EQUIPMENT

All fittings and accessories, which may not be specifically mentioned in the specification but which are necessary for the satisfactory operation of the transformer, shall be deemed to be included in the specification and shall be furnished by the supplier without extra charges. The equipment shall be complete in all details whether such details are mentioned in the specification or not, without any financial liability to the Employer under any circumstances.

11.0 **COMMISSIONING**

The utility will give a 10 days' notice to the supplier of transformer before commissioning. The manufacturer will depute his representative to supervise the commissioning. In case, the manufacturer fails to depute his representative, the utility will go ahead with the commissioning and under these circumstances, it would be deemed that commissioning is done as per recommendations of manufacturer.

12.0 **GUARANTEE**

The manufacturers of the transformer shall provide a guarantee of 60 months from the date of commissioning. In case the transformer fails within the guarantee period, the supplier will depute his representative within 15 days from date of intimation by the utility for joint inspection. In case, the failure is due to the reasons attributed to supplier, the transformer will be replaced/repaired by the supplier within 2 months from the date of joint inspection.

Annexure-B

Methodology for computing total owning cost for

Power Transformer

TOC = IC + (A xWi) + (B xWc) ; Losses in KW		
Where,		
TOC	=	Total Owning Cost
IC	=	Initial cost taxes including manufacturer of transformer as quoted by the
A factor	=	Cost of no load losses in Rs/KW (A = 334447)
B factor	=	Cost of load losses in Rs/KW (B = 151616)
Wi	=	No load losses quoted by the manufacturer in KW
Wc	=	Load losses quoted by the manufacturer in KW

ON LOAD TAP CHANGER FOR 33/11KV POWER TRANSFORMER

The tapping range of On Load Tap Changer shall be +5% to -15% in steps of 1.25% each. The no of taps shall be 17.The On Load Tap Changer shall be supplied with RTCC panel and AVR (Automatic Voltage Regulating Relay)

The Continuous current rating of the tap changer shall be based on connected winding rating and shall have liberal and ample margin. Lower rated tap changers connected in parallel are not acceptable.

The on-load tap changing equipment shall have the provision for mechanical and electrical control from a local position and electrical control from a remote position. For local mechanical operation, the operating handle shall be brought outside the tank for operation from floor level with provision to lock the handle in each tap position. Remote electrical operation shall have an AUTO-MANUAL selection at the remote location. When selected AUTO, the tap changing gear shall maintain steady voltage within practical limit on the transformers secondary bus from which the reference shall not respond to transient variation of voltage due to grid disturbance and system fault.

The required voltage relay shall not be sensitive to frequency variation and shall be suitable for sensing voltage from the secondary of potential transformers mounted on the 66KV, 33KV, or 11KV bus.

The tap changer shall be provided with over-current protection in order to prevent the tap-change operation during a short circuit, which would to greatly stress the contacts of the diverter switch. The function of protection shall be arranged as follows;

(i) Whenever over current occurs, the control circuit for commanding OLTC motor operation shall be blocked by the normally close contracts of the over current relays.

(ii) If during tap change over current occurs, the OLTC motor circuit shall be blocked through the mechanical cam switch, which is close from the very beginning to the very end of every tap change operation and to the normally open contacts of the over current relays. The stop action of the motor shall be made through the motor brake contactor.

The design of the tap changing equipment shall be such that the mechanism will not stop in any intermediate position; however, if the mechanism through faulty operation does stop in an intermediate position, the full load must be carried by the transformer without injury to the equipment. The mechanical position indicator shall be equipped in the motor drive cubicle. The motor shall be designed to be of step control. In any case the operation shall be of step by step.

The **voltage regulating relay** shall be supplied together with the timer

and under voltage relay. The signal order from the voltage regulating relay to execute the tap changer operation, when the regulating voltage is out of the voltage regulating level shall be designed to be delayed by the adjustable timer. If the control voltage abnormally falls, the movement of the tap changer shall be locked by the contact of the under voltage relay, even if the contacts of the voltage regulating relay are working.

The control circuit of the transformer shall be completely designed and provisions shall be made for parallel operation with another transformer.

The following accessories, control and selector switches and other necessary accessories shall be furnished.

Remote tap changer control board

(Placed in the control room)

- Voltmeter
- "AUTO-MANUAL" control switch
- "RAISE-LOWER" control switch
- Tap position indicator
- Tap changer operation program indicator.

Transformer Tap Changer driving mechanism control cubicle

- "REMOTE-LOCAL-TEST" selector switch
- "AUTOMATIC-MANUAL" control switch
- "RAISE-LOWER" control switch
- Tap position indicator
- Tap changer operation program indicator
- Voltmeter
- Tap change operation counter
- Means for manual operation when power supply is lost

Check-list for Inspection of Prime quality CRGO for Transformers

During inspection of PRIME CRGO, the following points needs to be checked by the Transformer manufacturer. Utilitity's inspector shall verify all these points during inspection:-

i) **In case PRIME CRGO cutting is at works of Transformer Manufacturer:**

Review of documents:

Purchase Order (unpriced) to PRIME CRGO supplier/Authorised Agency
Manufacturer's test certificate

Invoice of the Supplier

Packing List

Bill of Lading

Bill of Entry Certificate by Customs Deptt.

Reconciliation Statement as per format below
Certificate of Origin
BIS Certification

Format for Reconciliation/Traceability records

Packing List No./date /Quantity of PRIME CRGO received
Name of Manufacturer
Manufacturer test certificate No./date

Serial No.	Deatails of Package/Job	Drawing Reference	Quantity Invoved	Commulative Quantity Consumed	Balance Stock

(i) .1 Inspection of PRIME CRGO Coils:

PRIME CRGO-Manufacturer's Identification Slip on PRIME CRGO Coils
Visual Inspection of PRIME CRGO Coils offered as per packing list (for verification of coil details as per Test certificate & healthiness of packaging).
Unique numbering inside of each sample of PRIME CRGO coil and verification of records to be maintained in the register for consumption of CRGO coil.
ISI logo sticker on packed mother coil and ISI logo in Material TC.

2.2. During inspection of PRIME CRGO, surveillance testing of sample shall be carried out for Stacking Factor, Permeability, Specific watt loss at 1.5 Tesla

and/or 1.7 Tesla depending on the grade of PRIME CRGO and aging test etc. applicable as per relevant IS/ IEC standard, Tech. Spec., MQP and Transformer manufacturer plant standard.

Inspection Clearance Report would be issued after this inspection

3 Inspection of PRIME CRGO laminations: Transformer manufacturer will maintain records for traceability of laminations to prime CRGO coils and burr/bow on laminations shall be measured. Utility can review these records on surveillance basis.

4. Inspection at the time of core building:
Visual Inspection of PRIME CRGO laminations. In case of suspected mix-up/ rusting/decoloration, samples may be taken for testing on surveillance basis for tests mentioned in A.2.2 above.

Above tests shall be witnessed by Utility. In case testing facilities are not available at Manufacturer's work, the sample(s) sealed by Utility to be sent to approved labs for testing.

Inspection Clearance Report would be issued after this inspection

(i) In case PRIME CRGO cutting is at Sub-vendor of Transformer Manufacturer:

Review of documents:

Purchase Order (unpriced) to PRIME CRGO supplier/ Authorised Agency

Purchase Order (unpriced) to Core Cutter

Manufacturer test certificate

Invoice of the Supplier

Packing List

Bill of Lading

Bill of Entry Certificate by Customs Deptt.

Reconciliation Statement as per format below
Certificate of origin
BIS Certification

Format for Traceability records as below:-
Packing List No./date /Quantity of PRIME CRGO received
Name of Manufacturer
Manufacturer test certificate No./date

Serial No.	Name of Customer	Deatails of Package/Job	Drawing Reference	Quantity Invoved	Commulative Quantity Consumed	Balance Stock	Dispatch details

(ii) 1 Inspection of PRIME CRGO Coils:

PRIME CRGO-Manufacturer's Identification Slip on PRIME CRGO Coils
Visual Inspection of PRIME CRGO Coils offered as per packing list (for verification of coil details as per Test certificate & healthiness of packaging).
Unique numbering inside of each sample of PRIME CRGO coil and verification of records to be maintained in the register for consumption of CRGO coil.
ISI logo sticker on packed mother coil and ISI logo in Material TC.

2.2. During inspection of PRIME CRGO, surveillance testing of sample shall be carried out for Stacking Factor, Permeability, Specific watt loss at 1.5 Tesla and/or 1.7 Tesla, thickness depending on the grade of PRIME CRGO and aging test etc. applicable as per relevant IS/ IEC standard, Tech. Spec., MQP and Transformer manufacturer plant standard.

Inspection Clearance Report would be issued after this inspection

3 Inspection of PRIME CRGO laminations**:**

Transformer manufacturer representative will inspect laminations and issue their internal Inspection Clearance Report. Inspection will comprise of review of traceability to prime CRGO coils, visual Inspection of PRIME CRGO laminations and record of burr/bow. After clearance given by transformer manufacturer, Utility will issue an Inspection Clearance Report after record review. If so desired by Utility, their representative may also join transformer manufacturer representative during this inspection.

Inspection Clearance Report would be issued after this inspection

vi) Inspection at the time of core building:

Visual Inspection of PRIME CRGO laminations. In case of suspected mix-up/rusting/decoloration, samples may be taken for testing on surveillance basis for tests mentioned in B.2.2.

Inspection Clearance Report would be issued after this inspection

NOTE :-

a) Transformer Manufacturer to ensure that PRIME CRGO is procured from POWERGRID approved vendors and CRGO manufacturer should have valid BIS Certificate for respective offered Grade.

14.1 Transformer Manufacturer should also involve themselves for ensuring the

quality of CRGO laminations at their Core Cutter's works. They should visit the works of their Core cutter and carry out necessary checks.

a) General

If a surveillance sample is drawn and sent to TPL (if testing facility not available with the manufacturer), the Transformer manufacturer can continue manufacturing at their own risk and cost pending TPL test report on PRIME CRGO sample drawn. Decision for acceptance of PRIME CRGO shall be based upon report of the sample drawn.

These checks shall be read in-conjunction with approved Quality Plan, specification as a whole and conditions of contract.

Sampling Plan (PRIME CRGO)

33 / 11 kV - 1st transformer and subsequently at random 10% of Transformers (min. 1) offered for inspection.

DTs and other ratings -1st transformer and subsequently at random 2% of Transformers (min. 1) offered for inspection.

NOTE: - One sample for each lot of CRGO shall be drawn on surveillance basis.

CRGO has to be procured only from Discom/POWERGRID approved vendors. List of such vendors is available at the following website. Since the list is dynamic in nature, the site may be checked from time to time to see the list of approved vendors.

http://apps.powergridindia.com/ims/ComponentList/Power-former%20upto%20420%20kV-CM%20List.pdf

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS : (To be furnished and signed by the tenderer for each category of Transformer).

GUARANTEED TECHNICAL PARTICULARS			
Sl. No.	Particulars		
1.	Name and address of the manufacturer	:	
2.	Country of origin	:	
3.	Applicable standard	:	
4.	Maximum continuous rating (in MVA)	:	
5.	No load voltage ratio at Principal (Nominal) tap (in KV/KV)	:	
6.	Rated frequency (in Hz)	:	
7.	Number of phases	:	
8.	Type of Cooling	:	
9.	Connections	:	
	(i) H.V. Winding	:	
	(ii) L.V. Winding	:	
10.	Vector Symbol	:	
11.	Tappings	:	
	(a) Range	:	
	(b) Number of steps		
	(c) Variation of voltage in each step (in KV)		
	(d) No load voltage ratio in each tap (in KV/KV) for 6.3 & 10 MVA 33/11KV TR.	:	

GUARANTEED TECHNICAL PARTICULARS					
	Tap Number	Voltage ratio in KV/KV		Tap Number	Voltage ratio in KV/KV
	1.			10.	
	2.			11.	
	3.			12.	
	4.			13.	
	5.			14.	
	6.			15.	
	7.			16.	
	8.			17.	
	9.				

12.	(i) Temperature rise under normal operating condition above ambient temperature	:	
	(a) Top oil (in Degree C)	:	
	(b) Windings (in Degree C)	:	
	(ii) Maximum hot spot temperature of Copper windings (in Degree C)	:	
13.	Magnetising current referred to H.V. at rated frequency	:	
	(a) at 90% rated voltage : (in Amps)	:	
	(b) at 100% rated voltage : (in Amps)	:	
	(c) at 110% rated voltage (in Amps)	:	
14.	Power factor of magnetizing current at 100% rated voltage & frequency	:	
15.	No load current at rated voltage and Rated frequency (in Arms)	:	
16.	No load loss in KW at rated frequency and voltage	:	
	(a) at Lowest tap	:	
	(b) at principal tap	:	
	(c) at highest tap	:	
17.	Load loss in KW at 75 Deg. C. at Rated output and frequency	:	

GUARANTEED TECHNICAL PARTICULARS			
	(a) at Lowest tap	:	
	(b) at principal tap	:	
	(c) at highest tap	:	
18.	Percentage Regulation at full load at 75 Deg.C	:	
	(a) at unity power factor	:	
	(b) at 0.8 power factor lagging	:	
19.	Efficiencies at 75 Deg.C (in percentage)	:	
	a) at full load (i) at unity power factor	:	
	(ii) at 0.8 power factor lagging	:	
	(b) at 3/4 full load (i) at unity power factor	:	
	(ii) at 0.8 power factor lagging	:	
	(c) at 1/2 full load (i) at unity power factor	:	
	(ii) at 0.8 power factor lagging	:	
20.	Impedance voltage on rated MVA base at rated current and frequency for the Principal tapping 75 Deg.C. (in percentage)	:	

21.	a) Reactance voltage at rated current and frequency for the principal tapping at 75 Deg.C. (in percentage) b) Resistance voltage at rated current and frequency for the principal tapping at 75 Deg.C. (in percentage)	:	
22.	Resistance at H.V. base at 75 Deg.C.		
	(a) at Lowest tap	:	
	(b) at principal tap	:	
	(c) at highest tap	:	
23.	Reactance at H.V. base at 75 Deg.C.		
	(a) at Lowest tap	:	
	(b) at principal tap	:	
	© at highest tap	:	
24.	Withstand time without injury for three phase dead short circuit at terminal (in seconds)	:	
25.	Short time current rating for short circuit with duration	:	
	a) H.V. winding (in K. Amps)	:	
	b) L.V. winding (in K Amps)	:	
	c) Duration (in seconds)	:	
26.	Permissible overloading with time	:	
27.	Core :		
	i) Type	:	
	ii) Flux density of Core and yoke at principal tap	:	
	a) at 100% rated voltage at 50 Hz (in lines/sq.cm	:	
	b) at 110% rated voltage at 50 Hz (in lines/sq.cm.)	:	
	iii) Thickness of Stamping (in mm)	:	
	iv) Type of insulation between core laminations	:	
	v) Core bolt withstand Insulation (in KV rms for 1 min)	:	
	vi) Approximate area of Cross Section of Core and yoke (in sq.mm.)	:	
	vii) Material of Core clamping plate	:	
	viii) Thickness of Core clamping plate (in mm)	:	
	ix) Insulation of Core clamping plate	:	
	x) Describe location/Method of Core grounding	:	
28	Terminal Arrangement	:	
	i) High Voltage	:	
	ii) Low Voltage	:	
29	Positive Sequence Impedance between HV & L.V. winding on rated MVA base at rated Current and frequency at 75 Deg.C. winding temperature	:	

	i) At principal tapping (in percent)	:	
	ii) At lowest tapping (in percent)	:	
	iii) At highest tapping (in percent)	:	
30	Zero Sequence Impedance at reference temperature of 75 Deg.C at principal tap (in percent)	:	
31	Details of windings	:	
	i) Type of Winding	:	
	(a) High Voltage	:	
	(b) Low Voltage	:	
32	Winding conductor	:	
i)	Material of the winding conductor		
	(a) High Voltage	:	
	(b) Low Voltage	:	
ii)	Conductor Area :		
	(a) High Voltage (in sq.cm)	:	
	(b) Low Voltage (in sq.cm)	:	

iii)	Current density of windings at rated MVA	At principal tapping 1	At lowest tapping 2	At highest tapping 3
(a)	High voltage (Amp.per sq.cm)			
(b)	Low voltage (Amp.per sq.mm)			

iv)	Insulating material used for	
	(a) High voltage winding	:
	(b) Low voltage winding	:
v)	Insulting material used between	:
	(a) High voltage and low voltage winding	:
	(b) Low voltage winding and core	:
vi)	Whether adjustable coil clamps are	

38.	Bushing :	High voltage	Low voltage
i)	Make		
ii)	Type		
iii)	Applicable standard		
iv)	Insulation withstand test Voltage		
a)	Lightning Impulse withstand test voltage (1.2 x 50 micro seconds in KV peak)		
b)	Power frequency withstand test voltage (in KV rms for 1 min)		
	1)Dry		
	2)Wet		
v)	Creepage distance		
	a) Total (in mm)		
	b) Protected (in mm)		
vi)	Minimum height of the bushing		

39.	Minimum clearance (in mm)				
			In Oil	In Air	
		Between Phases	Phase to Ground	Between Phases	Phase to Ground
	i) H.V.				
	ii) L.V.				
40.	Particulars of Bushing & Neutral C.T.				
	i) Type				
	ii) Ratio				
	iii) Accuracy Class				
	iv) Knee Point Voltage				
	v) RCT at 75 Deg.C				
	vi) Magnetising Current at Knee Point Voltage				
	vii) Additional winding particulars of testing on the C.T.	:			
	viii) Short Time Rating				
	ix) Reference Standard				
41	Approximate weight of Transformer (in Kgs)				
	i) Core with clamping				
	ii) Coil with insulation				
	iii) Core and winding				
42.	Tank and fitting with accessories				
	v) Untanking weight				
	vi) Oil required for first filling				
	vii) Total weight with Core, Winding, Oil Fittings				
43.	Details of Tank				
i)	Type of tank				
ii)	Approximate thickness of Sheet (in mm)				
	a) Sides				
	b) Bottom				
	c) Cover				
	d) Radiators				
iii)	Vacuum recommended for hot oil circulation (in torr.)				

iv)	Vacuum to which the tank can be subjected without distorsion (in torr.)	
v)	Under carriage dimensions	
	a)No. of bidirectional wheels provided	
	b) Track gauge required for the wheels	Axis
		Transverse Longitudinal
	Dimension of base channel (in mm x mm)	
	vi) Type of Pressure relief device / Explosion Vent and pressure at which it operates	
44.	Conservator	
	i) Total volume (in Litres)	
	ii)Volume between the highest and Lowest visible oil level (in litres)	
45.	Oil Quality	
	i) Applicable standard	
	ii)Total quantity of oil (in Litres)	
46.	Radiator	
	i) Number of Radiator Bank	
	ii) Number of tubes/fins in each radiator Bank	
	iii) Thickness of tubes/fins (in mm)	
	iv) Overall dimensions (in mm)	
	a) Length b) Breadth c) Height	
	v) Type of mounting	
	viii)Vacuum withstand capability	
47	Gas And Oil Actuated Relay	
	i) Make	
	ii) Type	
	iii)Number of float contacts	

48	Temperature Indicators	Oil Temprature Indicator	Winding Temprature Indicator
i)	Make		
ii)	Type		
iii)	Permissible setting ranges for alarm and trip		
iv)	Number of contacts		
v)	Current rating of each contact		
49.	Approximate overall Dimensions (in mm)		
	a) Length		
	b) Breadth		
	c) Height		
	d) Minimum height of bottom most protion of bushing from bottom of base channel		
50.	Minimum clearance height for lifting tank cover (in mm)		
51.	Make of OLTC		
52.	Whether OLTC is Type tested		
53.	whether OLTC is in line with the specification		
54.	Make of RTCC		
	whether RTCC is in line with the specification		
55.	Whether agreeable to carry out Type Tests, in line with specification at your Cost ?		
56.	Whether all particulars as specified above are furnished?		

2. Single Phase Oil Immersed Distribution Transformers (Outdoor Type)

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 11 kV/240 V, 11/√3 kV/240 V single phase distribution transformers for outdoor use.

1.2 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 the 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.

1.5 STANDARD RATINGS

1.5.1 Standard ratings of single-phase transformers shall be 5, 10, 16 and 25 kVA.

2 STANDARDS:

2.1 The materials shall conform in all respects to the relevant Indian Standard, with latest amendments thereof unless otherwise specified herein; some of them are listed below.

2.2 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 bidder who wishes to offer material conforming to the other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. Four copies of such standards with authentic English translations shall be furnished along with the offer.

3 SERVICE CONDITIONS:

Indian Standards	Title	International Standards
IS -2026	Specification for Power Transformers	IEC 76
IS 1180 (Part-I): 2014	Outdoor Type Oil Immersed Distribution Transformers up to and including 2500kVA, 33kV- Specification	
IS 12444	Specification for Copper wire rod	ASTM B-49
IS-335	Specification for Transformer/Mineral Oil	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- 3024	Cold rolled grain oriented electrical sheets and strips	
IS - 4257	Dimensions for clamping arrangements 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 - 6162	Paper covered Aluminum conductor	
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.	

3.1 The distribution 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 country
ii)	Max ambient air temperature (^{0}C)	:	50
iii)	Minimum ambient air temperature (^{0}C)	:	-5
iv)	Maximum Average daily ambient air temperature (^{0}C)	:	40
v)	Maximum Yearly weighted average ambient temperature (^{0}C)	:	32
vi)	Maximum altitude above 5000 meters mean sea level (metres)	:	For HP, J&K, Uttrakhand, Sikkim, Assam, Meghalaya, Manipur, Nagaland, Tripura,Arunachal Pradesh and Mizoram

Note:

1. The climatic conditions specified above are indicative and can be changed by the user as per requirements.
2. The equipment shall generally be for use in moderately hot and humid tropical climate, conducive to rust and fungus growth unless otherwise specified.

4 PRINCIPAL PARAMETERS:

4.1 The Transformer shall be suitable for outdoor installation with single phase, 50 Hz, 11 kV systems in which the neutral is effectively earthed and they should be suitable for service under fluctuations in supply voltage up to plus 12.5% to minus 12.5%.

4.2 The transformer shall conform to the following specific parameters. Rated HV side value (11 kV or 11/√3 kV) shall be specified in the detailed bill of quantity by purchaser.

Sl.No	ITEM	SPECIFICATION
1.	System voltage(max)	7/ 12 kV
2.	Rated voltage HV Rated voltage LV	11/√3 or 11 kV 240 V*
3.	Frequency	50 Hz +/- 5%
4.	No. of Phases	Single
5.	Type of cooling	ONAN

4.3 INSULATION LEVELS

Voltage (Volts)	Impulse Voltage (kV Peak)	Power Frequency (kV)
433	-	3
11000	75	28
11000/√3	60	20

5 **TECHNICAL REQUIREMENTS:**

5.1 **CORE MATERIAL:**

5.1.1 Transformer core shall be wound core type construction using new and high quality cold rolled grain oriented (CRGO) steel with heat resistant insulating coating or Amorphous metal.

5.1.2 The bidder should offer the core for inspection and approval by the purchaser during manufacturing stage. CRGO steel for core shall be purchased only from the approved vendors, list of which is available at http://apps.powergridindia.com/ims/ComponentList/Power-

former%20upto%20420%20kV-CM%20List.pdf

5.1.3 The transformer shall be suitable for over fluxing (due to combined effect of voltage and frequency) upto12.5% without injurious heating. The operating flux density shall be such that there is a clear safe margin over the over fluxing limit of 12.5%.

5.1.4 No-load current shall not exceed 3% of full load current and will be measured by energizing the transformer at rated voltage and frequency. Increase of 12.5% of rated voltage shall not increase the no-load current by 6% of full load current.

5.1.5 Please refer to "**Check-list for Inspection of Prime quality CRGO for Transformers"** attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.

5.2 WINDINGS MATERIALS:

5.2.1 HV and LV windings shall be wound from Aluminum/Copper conductors covered with double paper/enamel. The inter layer insulation shall be of nomex/epoxy resin dotted kraft paper.

5.2.2 Proper bonding of inter layer insulation with the conductor shall be ensured. Test for bonding strength to be conducted.

5.2.3 The core coil assembly shall be dried in an oven. The type of winding shall be indicated in the tender. Whether LV windings are of conventional type or foil wound shall be indicated.

5.2.4 Dimensions of winding coils are very critical. Dimensional tolerances for winding coils shall be within limits as specified in guaranteed technical particulars (GTP).

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

5.2.6 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.

5.3 WINDING CONNECTION AND TERMINAL ARRANGEMENTS:

5.3.1 For 11 kV transformers both ends of primary winding shall be brought out through HV

bushings. For $11/\sqrt{3}$ kV transformers, neutral end of the primary HV

winding shall be brought out for connecting to 'Neutral' supply wire through 1 kV bushings. There shall be provision for connecting 'Neutral' terminal, to local 'Earth' by way of a tinned Copper strip of adequate size and dimension. The secondary winding shall be connected to two LV bushings.

5.4 OIL:

5.4.1 The insulating oil shall comply with the requirements of IS 335.Use of recycled oil is not acceptable. The specific resistance of the oil shall not be less than $2.5x10^{12}$ ohm-cm at 27 ^{0}C when tested as per IS 6103.

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

5.4.3 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.

6 LOSSES:

6.1 The bidder shall guarantee individually the no-load loss and load loss without any positive tolerance. The bidder shall also guarantee the total losses (no load + load losses at 75 ^{0}C) at the 50% of rated load and total losses at 100% of rated shall not exceed the maximum total loss values given in Table-9 of IS 1180(Part-1):2014.

6.2 The maximum allowable losses at rated voltage and rated frequency permitted at 75 ^{0}C for 11/0.433 kV transformers can be chosen by the utility as per **Table-9 for ratings 5,10, 16, 25kVA** as per **Energy Efficiency Level-2 specified in IS 1180 (Part-1): 2014** for single phase distribution transformers.

6.2 The above losses are maximum allowable and there would not be any positive tolerance. Bids with higher losses than the above specified values would be treated as non-responsive. However, the manufacturer can offer losses less than above stated values. The utility can evaluate offers with losses lower than the maximum allowable losses on total owning cost basis in accordance with methodology given in Annex-I.

7 PERCENTAGE IMPEDANCE:

7.1 The percentage impedance of single-phase transformers at 75 ^{0}C for different ratings upto 25 kVA shall be as per Table 9 of IS 1180(Part-1):2014.

8 TEMPERATURE RISE:

8.1 The permissible temperature rise shall be as per IS: 1180

8.2 Bids not conforming to the above limits of temperature rise will be treated as non-responsive.

9 PENALTY FOR NON PERFORMANCE

9.1 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.

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

9.3 Purchaser shall reject any transformer during the test at supplier's works, if the impedance values differ from the guaranteed values including tolerance and if they do not meet the requirements of clause 7.1

10 BUSHINGS:

10.1 The bushings shall be either porcelain or epoxy type and shall conform to the relevant standards specified. Polymer insulator bushings conforming with relevant IEC can also be used.

10.2 For HV, 12 kV class bushings shall be used and for LV, 1 kV class bushings shall be used.

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

10.4 The HV bushings shall be fixed to the top cover of the transformer and the LV bushings shall be fixed to transformer on sides and in the same plane.

10.5 The bushing rods and nuts shall be of brass/stainless steel.

10.6 Arcing horns will be provided on HV bushings shall not have arcing horns and 1 clamp for LA shall
also be provided for each HT bushing. Supply of LA is not included in DT supplier's scope.

10.7 Bushings shall be marked with manufacturer's name, month and year of manufacture.

11 BUSHING TERMINALS:

11.1 HV terminal shall be designed to directly receive ACSR conductor upto 7/2.59 mm (without requiring the use of lug) and the LV terminals shall be suitable for directly receiving LT cables (aluminum) ranging from 10 Sq mm to 25 Sq mm both in vertical and horizontal position and the arrangements should be such as to avoid bimetallic corrosion. Terminal connectors must be type tested as per IS 5561.

12 TANK:

12.1 The oil volume inside the tank shall be such that even under the extreme operating conditions, the pressure generated inside the tank does not exceed 0.4 kg/sq. cm positive or negative. There must be sufficient space from the core to the top cover to take care of oil expansion.

12.2 The tank cover shall have plasticized surface at the top to guard against bird faults. Alternately, suitable insulating shrouds shall be provided on the bushing terminals.

12.3 The Transformer tank shall be of robust construction round/rectangular in shape and shall be built up of tested CRCA/Mild Steel Sheet.

12.4 The tank shall be capable of withstanding a pressure of 1 kg/cm^2 (g) and a vacuum of 760 mm of Hg for 30 minutes without any permanent deflection (Air pressure test shall be conducted as per IS -1180(Part-I):2014.

12.5 The L - seam joint, C - seam joint and all fittings and accessories shall be oil tight and no deflection / bulging should occur during service.

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

12.7 The circular bottom plate edges of the tank should be folded upward, for at least 25 mm, to have sufficient overlap with vertical sidewall of the transformer.

12.8 The Transformer tank and the top cover shall be designed in such a manner as to leave no external pockets in which water can lodge.

12.9 Tank shall have permanent lugs for lifting the transformer bodily and there shall be facilities for lifting the core coil assembly separately.

12.10 The transformer shall be provided with two mounting lugs suitable for

fixing the transformer to a single pole by means of 2 bolts of 20 mm diameter as per ANSI C 57.12.20-1988.

12.11 Both mounting lugs are made with steel of minimum 5 mm thickness.

12.12 Jump proof lips shall be provided for upper mounting lug.

12.13 Mounting lug faces shall be in one plane.

12.14 Minimum Oil level mark shall be embossed inside the tank (at 25^0 C).

12.15 The top cover shall be fixed to the tank through clamping only.

12.16 HV bushing pocket shall be embossed to top side of the top cover so as to eliminate ingress of moisture and water.

12.17 The edges of the top cover shall be formed, so as to cover the top end of the tank and gasket.

12.18 Nitrile/ polyurethane /neoprene rubber gaskets' conforming to latest IS 4253 part-II shall be provided between tank and top cover.

12.19 The gaskets shall be continuous i.e. without any joint.

13 TANK SEALING:

13.1 The space on the top of the oil shall be filled with dry air or nitrogen. The nitrogen plus oil volume inside the tank shall be such that even under extreme operating conditions, the pressure generated inside the tank does not exceed 0.4 kg/sq. cm positive or negative. The nitrogen shall conform to commercial grade of the relevant standards.

14 SURFACE PREPARATION AND PAINTING:

14.1 GENERAL

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

14.1.2 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.

14.2 CLEANING ANDSURFACE PREPARATION:

14.2.1 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. Steel surfaces shall be prepared by Shot blast cleaning (IS 9954) to grade Sa. 2.5 of ISO 8501-1 or chemical cleaning including phosphating (IS 3618).

14.2.2 The pressure and volume of the compressed air supply for blast cleaning shall meet the work requirements and shall be sufficiently free from all water contamination to ensure that the cleaning process is not impaired.

14.2.3 Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale and shall only be used where shot blast cleaning is impractical. Manufacturer shall indicate such location, for purchaser's information, in his offer.

14.3 PROTECTIVE COATING:

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

14.4 PAINT MATERIAL:

Following are the types of paint that may be suitably used for the items to be painted at shop and supply of matching paint to site:

14.4.1 The painting shall be as per Annexure-Paint which is attached herewith.

14.4.2 For external surfaces one coat of Thermo Setting paint or 1 coat of epoxy primer followed by 2 coats of polyurethene base paint. These paints can be either air-drying or stoving.

14.4.3 In case of highly polluted area, chemical atmosphere or at a place very near the sea coast, paint as above with one intermediate coat of high build MIO (Micaceous iron oxide) as an intermediate coat may be used to give a total dry film thickness of 150 to 180 microns.

14.5 PAINTING PROCEDURE:

14.5.1 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.

14.5.2 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. In all instances where two or more coats of the same paint are specified, such coatings may or may not be of contrasting colours.

14.5.3 DAMAGED PAINTWORK:

14.5.4 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 employed.

14.5.5 Any damaged paint work shall be made good as follows:

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

14.5.7 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.

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

14.6 DRY FILM THICKNESS:

14.6.1 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.

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

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

14.7 TESTS:

- The painted surface shall be tested for paint thickness.
- The painted surface shall pass the cross hatch adhesion test and impact test as routine test, Salt spray and Hardness test as type test as per the relevant ASTM standards.

14.8 The paint shade shall be as per Annexure-Paint which is attached herewith.

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

15 RATING AND TERMINAL PLATES:

15.1 Each transformer shall be provided with rating plate made of anodized aluminum/stainless steel material securely fixed on the outer body, easily accessible, showing the information given in Fig.2 of IS 1180(Part-1):2014 for single phase transformers. The entries on the rating plates shall be indelibly marked by engraving.

15.2 Each transformer shall be provided with a terminal marking plate in accordance with Fig.5 of IS 1180(Part-1):2014. The rating and terminal marking plates may be combined into one plate at the option of manufacturer.

15.3 The distribution transformer be marked with the Standard Mark and the use of Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and regulations made thereunder. As per Quality Control Order for Electrical Transformers- 2015, issued by Dept. of Heavy Industries, the Standard / ISI marking on Distribution Transformers is mandatory and the product should be manufactured in compliance with IS 1180 Part-1: (2014).

16 PRESSURE AND VACCUM REQUIREMENTS:

16.1 Single phase transformers up to 25kVA, the transformer tank shall be of roboust construction, round in shape shall be capable of withstanding a pressure of 100kPa and a vacuum of 760 mm of mercury.

17 FITTINGS:

17.1 The following standard fittings shall be provided :

17.1.1 Two earthing terminals with earthing symbol.

17.1.2 Lifting lugs for the complete transformer as well as for core and winding assembly.

17.1.3 HV side neutral grounding strip(where one of the bushing terminal is connected to earth).

17.1.4 Rating and terminal marking plates.(Non detachable type)

17.1.5 Pressure relief device or self-ventilating cover

17.1.6 HV bushings.

17.1.7 LV bushings.

17.1.8 HV and LV terminal connectors.

17.1.9 Top cover fixing clamps.

17.1.10 Mounting lugs - 2 Nos.

17.1.11 Bird guard.

17.1.12 LV earthing arrangement.

17.1.13 Any other fitting required as per IS: 1180 (Part 1)

18 FASTENERS:

18.1 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.

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

18.3 All nuts and pins shall be adequately locked.

18.4 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.

18.5 All All bolts/nuts/washers exposed to atmosphere should be as follows.

a) Size 12 mm or below – Stainless steel
b) Above 12 mm- steel with suitable finish like electro galvanized with passivation or hot dip galvanized.

18.6 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 inaccessible by means of ordinary spanners, special spanners shall be provided.

18.7 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.

18.8 Taper washers shall be provided where necessary. Protective washers of suitable material shall be provided front and back or the securing screws.

19 OVER LOAD CAPACITY:

19.1 The transformer shall be suitable for loading as per latest IS 6600.

20 TESTS:

All the equipment offered shall be fully type tested by the bidder as per the relevant standards including the additional type tests mentioned at clause 23.The type test must have been conducted on a transformer of same design during the last five years at the time of bidding. The bidder shall furnish four sets of type test reports along with the offer. **In case, the offered transformer is not type tested, the bidder will conduct the type test as per the relevant standards including the additional type tests at his own cost in CPRI/ NABL accredited laboratory in the presence of employers representative(s) without any financial liability to employer in the event of order placed on him.**

20.1 Special tests other than type and routine tests, as agreed between purchaser and bidder shall

also be carried out as per the relevant standards

20.2 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. However, if the same are not available at the time of bidding, the same may be submitted after order but before commencement of supply.

20.3 The procedure for testing shall be in accordance with IS 1180(Part-1): 2014/2026 as the case may be except for temperature rise.

20.4 Before dispatch each of the completely assembled transformer shall be subjected to the routine tests at the manufacturers works.

21 ROUTINE TESTS:

21.1 Ratio, polarity tests.

21.2 No load current and losses at service voltage and normal frequency.

21.3 Load losses at rated current and normal frequency.

21.4 Impedance Voltage test.

21.5 Resistance of windings cold (at or near the test bed temperature).

21.6 Insulation resistance.

21.7 Induced over voltage withstand test.

21.8 Separate source voltage withstand test. This test will not be applicable for single phase DTs with 11/√3 kV as primary voltage.

21.9 Oil sample test (one sample per lot) to comply with IS 1866.

21.10 Air pressure test on empty tank as per IS 1180

22 TYPE TESTS TO BE CONDUCTED ON ONE UNIT:

In addition to the tests mentioned above following tests shall be conducted:

22.1 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.

22.2 Impulse voltage withstand test: As per IS 2026 part-III.
Basic insulation level (BIL) for 11 kV shall be 75 kV peak while for 11/√3 kV, it will be 60KVp

22.3 Air pressure test: As per IS 1180 (Part-I):2014.

22.4 Short circuit withstand test: Thermal and dynamic ability.

22.5 Oil samples (Post short circuit and temperature rise test) - Only DGA & BDV test shall be conducted.

22.6 Noise level measurement.

22.7 Permissible flux density and over fluxing withstand test.

22.8 Type test certificates for the tests carried out on prototype of same specifications shall be
Submitted along with the bid.

22.9 The purchaser may select the transformer for type tests randomly.

23.10 Short Circuit Test and Impulse Voltage Withstand Test: 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.

23.11 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.

23.12 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.

23.13 It may also be noted that the purchaser reserved the right to conduct short circuit test and impulse voltage test in accordance with the IS, afresh on each ordered rating at purchaser's 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 their 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.

24 TESTS AT SITE:

24.1 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.

25 ACCEPTANCE TESTS:

25.1 The transformers shall be subjected to the following routine/ acceptance test in the presence of purchaser's representative at the place of manufacture before despatch without any extra charges. The testing shall be carried out in accordance with IS 1180, Part-1 (2014) and IS 2026. Checking of mass, dimensions, fitting and accessories, tank sheet thickness, oil quality, material, finish and workmanship as per GTP/QA plan and contract drawings.

25.2 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.

25.3 All tests as specified in clause 22.

26 INSPECTION:

26.1 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 manufacturers' test certificate as well as the proof of purchase from the manufacturers (excise gate pass) for information of the purchaser. The bidder shall furnish following documents along with their offer in respect to the raw materials :

26.1.1 Invoice of supplier.

26.1.2 Mill's certificate.

26.1.3 Packing List.

26.1.4 Bill of landing.

26.1.5 Bill of entry certificate by custom.

Please refer to "**Check-list for Inspection of Prime quality CRGO for Transformers"** attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.

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

26.2.1 Online anytime during receipt of raw material and manufacture/ assembly whenever the purchaser desires.

26.2.2 When the raw material is received, and the assembly is in process in the shop floor.

26.2.3 At finished stage i.e. transformers are fully assembled and are ready for despatch.

26.3 After the main raw-materials i.e. core and coil materials 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 seven days from the date of intimation. During the stage inspection a few assembled core shall be dismantled (only in case of CRGO material) to ensure that the CRGO laminations used are of good quality. Further, as and when the transformers are ready for despatch, an offer intimating about the readiness of transformers, for final inspection for carrying

out tests as per relevant IS and as in clauses above, 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.

26.4 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.

26.5 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.

26.6 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.

26.7 Along with the bid the manufacturer shall prepare Quality Assurance Plan (QAP) identifying the various stages of manufacture, quality checks performed at each stage and the customer hold points. The document shall also furnish details of method of checking, inspection and acceptance standards/values and get the approval of purchaser or his representative before proceeding with manufacturing. However, purchaser or his representative shall have the right to review the inspection reports, quality checks and results of manufacturer's in house inspection department which are not customer hold points and the manufacturer shall comply with the remarks made by purchaser or his representative on such reviews with regards to further testing, rectification or rejection etc. Manufacturer should submit the list of equipment for testing along with latest calibration certificates to the purchaser.

26.8 Purchaser shall have every right to appoint a third party inspection to carry out the inspection

process. 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 of supply. 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 has every right to reject the entire lot or penalise the manufacturer, which may lead to blacklisting among other things.

27 QUALITY ASSURANCE PLAN:

27.1 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 material offered.

27.2 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 test normally carried out on raw materials in presence of bidder's representative and copies of test certificates.

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

27.4 List of manufacturing facilities available.

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

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

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

27.8 Quality assurance plan with hold points for purchaser's inspection.

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

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

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

27.10 The successful bidder shall submit the routine test certificates of

bought out accessories and central excise passes for raw material at the time of routine testing.

27.11 ISI marking on the transformer is mandatory. As per Quality Control Order for Electrical Transformers- 2015, issued by Dept. of Heavy Industries, the Standard / ISI marking on Distribution Transformers is mandatory and the product should be manufactured in compliance with IS 1180 Part-1:(2014).

28 DOCUMENTATION:

28.1 Completely dimensioned drawings indicating general arrangement and details of fittings, clearances and winding details shall accompany the tender.

28.2 Drawings of internal constructional details and fixing details of coils should also be indicated. Tank dimensions, position of fittings, clearances between leads within the transformer, core grade of laminations, distance of core centers, area of conductor bare and with insulation. No. of coils, No. of turns per coil material of bushing metal parts etc., shall also be furnished with tender.

29 PACKING and FORWARDING:

29.1 The packing shall be done as per the manufacturer's standard practice. However, he should ensure the packing is such that, the material should not get damaged during transit by rail/road.

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

30 GUARANTEE:

31.1 The manufacturers of the transformer shall provide a guarantee of 60 months from the date of commissioning. In case the transformer fails within the guarantee period, the supplier will depute his representative within 15 days from date of intimation by utility for joint inspection. In case, the failure is due to the reasons attributed to supplier, the transformer will be replaced/repaired by the supplier within 2 months from date of joint inspection.

31.2 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.

31.3 In the event of the supplier's inability to adhere to the aforesaid provisions, suitable penal action will be taken against the supplier,

which may inter alia include blacklisting of the firm for future business with the purchaser for a certain period.

(ii) Methodology for computing total owning cost*

Annex-I

TOC = IC + (A xWi) + (B xWc) ; Losses in KW		
Where,		
TOC	=	Total Owning Cost
IC	=	Initial cost ta o transfor a quo b the manufacturer
A factor	=	Cost of no load losses in Rs/KW (A = 288239)
B factor	=	Cost of load losses in Rs/KW (B = 93678)
Wi	=	No load losses quoted by the manufacturer in KW
Wc	=	Load losses quoted by the manufacturer in KW

Note:

No (+)ve tolerance shall be allowed at any point of time on the quoted losses after the award. In case, the losses during type testing ,routine testing etc. are found above the quoted losses, the award shall stand cancelled. In such a case, the CPG money shall also be forfeited.

* Amendment issued vide letter No. REC/DDUGJY/SBD/DTR-TS/969 Dated 29.09.2016

Annexure-Paint

Painting-Transformer Main tank, pipes, Conservator Tank, Radiator etc.-

	Surface Preparation	primer coat	intermediate under coat	finish coat	total DFT	Colour shade
Main tank, pipes, conservator tank, etc. (External surfaces)	Blast cleaning Sa2½	Epoxy base Zinc primer 30-40 micron	Epoxy base Zinc primer 30-40 micron	Aliphatic Polyurethane (PU Paint) (min 50 micron	Min 110 micron	541 shade of IS:5
Main tank, pipes (above 80 NB), conservator tank, etc (Internal surfaces)	Blast cleaning Sa2½	Hot oil resistant, non-corrosive varnish or paint	--	--	Min 30 micron	Glossy white for paint
Radiator (External surfaces)	Chemical / blast cleaning (Sa2½)	Epoxy base zinc primer 30-40 micron	Epoxy base Zinc primer Min 30-40 micron	Aliphatic Polyurethane(PU Paint) (min)50 micron	Min 110 micron	541 shade of IS:5
Radiator and pipes up to 80 NB (Internal surfaces)	Chemical cleaning if required	Hot oil proof low viscosity varnish or hot oil resistant non corrosive paint	--	--	--	Glossy white for paint

GUARANTEED TECHNICAL PARTICULARS FOR COMPLETELY SELF PROTECTED DISTRIBUTION TRANSFORMERS

Sl.No.	Description	6.3 kVA	10 kVA	16 kVA	25 kVA
1.	Name of the manufacturer and place of manufacture				
2.	Continuous maximum rating as per this specification.				
3.	Normal ratio of transformer				
4.	Method of connection HV/LV				
5.	Maximum current density in Windings : 1. HV (A/sq mm) 2. LV (A/sq mm)				
6.	Maximum hot spot temperature ^{0}C. (Ambient air temperature on which above is based) ^{0}C.				
7.	Maximum temperature : ^{0}C				
	(a) Maximum observable oil temperature (ambient air temperature on which above is based)				
	b) Maximum winding temperature at an ambient temperature of				
8.	No-load losses at rated voltage (watt)				
9.	Full load losses at 75 ^{0}C (watt)				
10.	Total losses at 100% load (watt)				
11.	Total losses at 50% load (watt)				
12.	Efficiency at normal voltage :				
	(i) Unity Power Factor				
	(a) At 50% load				
	(b) At 75% load				

(c) At full load

(ii) 0.8 Power Factor

(a) At 50% load

(b) At 75% load

(c) At full load

13. Regulation as percentage of normal voltage :

(a) At unity power factor

(b) At 0.8 power factor lagging

14. Percentage impedance voltage at normal ratio between HV and LV windings

15. Type of transformers, CRGO/ amorphous type

16. Type of Insulation used in
HV Windings
LV Windings

17. Type of insulation used in
Core bolts
Core bolt washers
End plates
Core lamination

18. Impulse withstand test voltage level (kV)
HV Windings LV Windings

19. Characteristics of transformer oil

20. Total content of oil in litres

21. Whether transformer will be transported with oil?

22. Type of transformer tank

23. Approximate overall dimensions

a Height m
b Length m
c Width m

Tank dimensions

a Diameter m
b Height m

24. Mass of insulated conductor

HV (minimum) kg
LV (minimum) kg

25. Mass of core (minimum) kg (CRGO or amorphous metal)

26. Mass of complete transformer arranged for transport (kg)

ADDITIONAL DETAILS

Sl. No.	Description	
1.	Core grade	
2.	Core dimensions	mm
3.	Gross core area	cm^2
4.	Net Core area	cm^2
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 center distance of the core	mm
10.	No. of LV Turns	
11.	No. of HV turns	
12.	Size of LV Conductor bare/ covered (dia)	mm
13.	Size of HV conductor bare/covered (dia)	mm
14.	No. of parallels	
15.	Current density of LV winding	A/sq mm
16.	Current density of HV winding	A/sq mm
17.	Mass of the LV winding for Transformer	kg
18.	Mass of the HV winding for Transformer	kg
19.	No. of of LV Coils/phase	
20.	No. of HV coils . phase	
21.	Height of LV Windings	mm
22.	Height of HV winding	mm
23.	ID/OD of LV winding HV	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 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

SOURCE OF MATERIALS/PLACES OF MANUFACTURE, TESTING AND INSPECTION

Sl. No.	Item	Source of Material	Place of Manufacture	Place of testing and inspection
1.	Laminations			
2.	Aluminium/Copper			
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			

Annexure - A

Check-list for Inspection of Prime quality CRGO for Transformers

During inspection of PRIME CRGO, the following points needs to be checked by the Transformer manufacturer. Utilitity's inspector shall verify all these points during inspection:-

ii) **In case PRIME CRGO cutting is at works of Transformer Manufacturer:**

Review of documents:

Purchase Order (unpriced) to PRIME CRGO supplier/Authorised Agency
Manufacturer's test certificate

Invoice of the Supplier

Packing List

Bill of Lading

Bill of Entry Certificate by Customs Deptt.

Reconciliation Statement as per format below
Certificate of Origin
BIS Certification

Format for Reconciliation/Traceability records

Packing List No./date /Quantity of PRIME CRGO received
Name of Manufacturer
Manufacturer test certificate No./date

Serial No.	Details of Package/Job	Drawing reference	Quantity Involved	Commulative Quantity Consumed	Balance Stock

(iii).1 Inspection of PRIME CRGO Coils:

PRIME CRGO-Manufacturer's Identification Slip on PRIME CRGO Coils
Visual Inspection of PRIME CRGO Coils offered as per packing list (for verification of coil details as per Test certificate & healthiness of packaging).
Unique numbering inside of each sample of PRIME CRGO coil and verification of records to be maintained in the register for consumption of CRGO coil.
ISI logo sticker on packed mother coil and ISI logo in Material TC.

2.2. During inspection of PRIME CRGO, surveillance testing of sample shall be carried out for Stacking Factor, Permeability, Specific watt loss at 1.5 Tesla

and/or 1.7 Tesla depending on the grade of PRIME CRGO and aging test etc. applicable as per relevant IS/ IEC standard, Tech. Spec., MQP and Transformer manufacturer plant standard.

Inspection Clearance Report would be issued after this inspection

3 Inspection of PRIME CRGO laminations: Transformer manufacturer will maintain records for traceability of laminations to prime CRGO coils and burr/bow on laminations shall be measured. Utility can review these records on surveillance basis.

4. Inspection at the time of core building:

Visual Inspection of PRIME CRGO laminations. In case of suspected mix-up/ rusting/decoloration, samples may be taken for testing on surveillance basis for tests mentioned in A.2.2 above.

Above tests shall be witnessed by Utility. In case testing facilities are not available at Manufacturer's work, the sample(s) sealed by Utility to be sent to approved labs for testing.

Inspection Clearance Report would be issued after this inspection

(ii) In case PRIME CRGO cutting is at Sub-vendor of Transformer Manufacturer:

Review of documents:

Purchase Order (unpriced) to PRIME CRGO supplier/ Authorised Agency

Purchase Order (unpriced) to Core Cutter

Manufacturer test certificate

Invoice of the Supplier

Packing List

Bill of Lading

Bill of Entry Certificate by Customs Deptt.

Reconciliation Statement as per format below
Certificate of origin
BIS Certification

Format for Traceability records as below:-

Packing List No./date /Quantity of PRIME CRGO received

Serial No.	Name of consumer	Details of Package/Job	Drawing reference	Quantity Involved	Commulative Quantity Consumed	Balance Stock	Dispatch

(iv).1 Inspection of PRIME CRGO Coils:

PRIME CRGO-Manufacturer's Identification Slip on PRIME CRGO Coils

Visual Inspection of PRIME CRGO Coils offered as per packing list (for verification of coil details as per Test certificate & healthiness of packaging).

Unique numbering inside of each sample of PRIME CRGO coil and verification of records to be maintained in the register for consumption of CRGO coil.

ISI logo sticker on packed mother coil and ISI logo in Material TC.

2.2. During inspection of PRIME CRGO, surveillance testing of sample shall be carried out for Stacking Factor, Permeability, Specific watt loss at 1.5 Tesla and/or 1.7 Tesla, thickness depending on the grade of PRIME CRGO and aging test etc. applicable as per relevant IS/ IEC standard, Tech. Spec., MQP and Transformer manufacturer plant standard.

Inspection Clearance Report would be issued after this inspection

3 Inspection of PRIME CRGO laminations**:**

Transformer manufacturer representative will inspect laminations and issue their internal Inspection Clearance Report. Inspection will comprise of review of traceability to prime CRGO coils, visual Inspection of PRIME CRGO laminations and record of burr/bow. After clearance given by transformer manufacturer, Utility will issue an Inspection Clearance Report after record review. If so desired by Utility, their representative may also join transformer manufacturer representative during this inspection.

Inspection Clearance Report would be issued after this inspection

vii) Inspection at the time of core building:

Visual Inspection of PRIME CRGO laminations. In case of suspected mix-up/rusting/decoloration, samples may be taken for testing on surveillance basis for tests mentioned in B.2.2.

Inspection Clearance Report would be issued after this inspection

NOTE :-

a) Transformer Manufacturer to ensure that PRIME CRGO is procured from POWERGRID approved vendors and CRGO manufacturer should have valid BIS Certificate for respective offered Grade.

14.2 Transformer Manufacturer should also involve themselves for ensuring the quality of CRGO laminations at their Core Cutter's works. They should visit the works of their Core cutter and carry out necessary checks.

b) General

If a surveillance sample is drawn and sent to TPL (if testing facility not available with the manufacturer), the Transformer manufacturer can continue manufacturing at their own risk and cost pending TPL test report on PRIME CRGO sample

drawn. Decision for acceptance of PRIME CRGO shall be based upon report of the sample drawn.

These checks shall be read in-conjunction with approved Quality Plan, specification as a whole and conditions of contract.

Sampling Plan (PRIME CRGO)

33 / 11 kV 10% of	-1st transformer and subsequently at random Transformers (min. 1) offered for inspection.
DTs and other ratings 2% of	-1st transformer and subsequently at random Transformers (min. 1) offered for inspection.

NOTE:- One sample for each lot of CRGO shall be drawn on surveillance basis.
CRGO has to be procured only from POWERGRID approved vendors. List of such vendors is available at the following website. Since the list is dynamic in nature, the site may be checked from time to time to see the list of approved vendors.
http://apps.powergridindia.com/ims/ComponentList/Power-former%20upto%20420%20kV-CM%20List.pdf

GUARANTEED TECHNICAL PARTICULARS FOR COMPLETELY SELF PROTECTED DISTRIBUTION TRANSFORMERS

Sl.No.	Description	6.3 kVA	10 kVA	16 kVA	25 kVA
1.	Name of the manufacturer and place of manufacture				
2.	Continuous maximum rating as per this specification.				
3.	Normal ratio of transformer				
4.	Method of connection HV/LV				
5.	Maximumcurrent densityin Windings :				
	1. HV (A/sq mm)				
	2. LV (A/sq mm)				
6.	Maximum hot spot temperature ^{0}C. (Ambient air temperature on which above is based) ^{0}C.				
7.	Maximum temperature : 0C				
	(a) Maximum observable oil temperature (ambient air temperature on which				

above is based)

b) Maximum winding temperature at an ambient temperature of

8. No-load losses at rated voltage (watt)

9. Full load losses at 75 ^{0}C (watt)

10. Total losses at 100% load (watt)

11. Total losses at 50% load (watt)

12. Efficiency at normal voltage :

(i) Unity Power Factor

(a) At 50% load
(b) At 75% load
(c) At full load

(ii) 0.8 Power Factor

(a) At 50% load
(b) At 75% load
(c) At full load

13. Regulation as percentage of normal voltage :

(a) At unity power factor
(b) At 0.8 power factor lagging

14. Percentage impedance voltage at normal ratio between HV and LV windings

15. Type of transformers, CRGO/ amorphous type

16. Type of Insulation used in

HV Winding s LV Winding s

17. Type of insulation used in

Core bolts

Core bolt washers End plates

Core lamination

18. Impulse withstand test voltage level (kV)

HV Windings LV Windings

19. Characteristics of transformer oil

20. Total content of oil in litres

21. Whether transformer will be transported with oil?

22. Type of transformer tank

23. Approximate overall dimensions

a) Height mm
b) Length mm
c) Width mm

Tank dimensions

a) Diameter mm
b) Height mm

24. Mass of insulated conductor

HV
(minimum) kg LV
(minimum) kg

25. Mass of core (minimum) kg (CRGO or amorphous metal)

26. Mass of complete transformer arranged for transport (kg)

ADDITIONAL DETAILS

Sl. No.	Description	
1.	Core grade	
2.	Core dimensions	mm
3.	Gross core area	cm2
4.	Net Core area	cm2
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 center distance of the core	mm
10.	No. of LV Turns	
11.	No. of HV turns	
12.	Size of LV Conductor bare/ covered (dia)	mm
13.	Size of HV conductor bare/covered (dia)	mm
14.	No. of parallels	
15.	Current density of LV winding	A/sq mm
16.	Current density of HV winding	A/sq mm
17.	Mass of the LV winding for Transformer	kg
18.	Mass of the HV winding for Transformer	kg
19.	No. of of LV Coils/phase	
20.	No. of HV coils . phase	
21.	Height of LV Windings	mm
22.	Height of HV winding	mm
23.	ID/OD of LV winding HV	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 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

SOURCE OF MATERIALS/PLACES OF MANUFACTURE, TESTING AND INSPECTION

Sl. No.	Item	Source of Material	Place of Manufacture	Place of testing and inspecti
1.	Laminations			
2.	Aluminium/Copper			
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			

3. 3-Phase Distribution Transformers 11 or 33 kV/433-250V (Outdoor Type)

1. **SCOPE:**

i) 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 11 kV/433 - 250 V and 33 kV/433-250 V distribution transformers for outdoor use.

ii) 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.

iii) 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.

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

2 STANDARDS:

2.1 The major materials used in the transformer shall conform in all respects to the relevant/specified Indian Standards and international Standards with latest amendments thereof as on bid opening date, unless otherwise specified herein. Some of the applicable Indian Standards are listed as hereunder:

3.2

Indian Standards	Title	International Standards
IS -2026	Specification for Power Transformers	IEC 76
IS 1180 (Part-I): 2014	Outdoor Type Oil Immersed Distribution Transformers upto and including 2500kVA, 33kV-Specification	
IS 12444	Specification for Copper wire rod	ASTM B-49
IS-335	Specification for Transformer/Mineral Oil	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- 3024	Cold rolled grain oriented electrical sheets and strips	
IS - 4257	Dimensions for clamping arrangements 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 - 6162	Paper covered Aluminium conductor	
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 STANDARD RATINGS:

The standard ratings shall be 16, 25, 63, 100,160, 200, 250, 315, 400, 500, 630, 1000, 1250, 1600, 2000 and 2500 kVA for 11 kV distribution transformers and 100, 160, 200, 315, 400, 500, 630, 1000, 1250, 1600,2000, 2500 kVA for 33 kV distribution transformers.

4 SERVICE CONDITIONS:

4.1 The Distribution 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 country

ii) Maximum ambient air temperature (^{0}C) : 50

iii) Minimum ambient air temperature (^{0}C) : -5

iv) Maximum average daily ambient air temperature (^{0}C):40

v) Maximum yearly weighted average ambient temperature(^{0}C) : 32

vi) Maximum altitude above mean sea level (meters) : Altitude of 5000 meters for HP, J&K, Uttrakhand, Sikkim , Assam, Meghalaya, Manipur, Nagaland, Tripura, Arunachal Pradesh and Mizoram

(iii) Note:

1. The climatic conditions specified above are indicative and can be changed by the user as per requirements.
2. The equipment shall generally be for use in moderately hot and humid tropical climate, conducive to rust and fungus growth unless otherwise specified.

5 PRINCIPAL PARAMETERS:

5.1 The transformers shall be suitable for outdoor installation with three phase, 50 Hz, 11 kV or 33 kV system in which the neutral is effectively earthed and they should be suitable for service with fluctuations in supply voltage upto plus 12.5% to minus 12.5%.

(i) The transformers shall conform to the following specific parameters :

Sl. No.	Item	11 kV Distribution Transformers	33 kV Distribution Transformers

1	System voltage (Max.)	12 kV	36 kV
2	Rated Voltage (HV)	11 kV	33 kV
3	Rated Voltage (LV)	433 - 250 V*	433 - 250 V*
4	Frequency	50 Hz +/- 5%*	50 Hz +/- 5%
5	No. of Phases	Three	Three
6	Connection HV	Delta	Delta
7	Connection LV	Star (Neutral brought out)	Star (Neutral brought out)
8	Vector group	Dyn-11	Dyn-11
9	Type of cooling	ONAN	ONAN

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

kVA rating	Audible sound levels (decibels)
0-50	48
51-100	51
101-300	55
301-500	56
750	57
1000	58
1500	60
2000	61
2500	62

(iv) TECHNICAL REQUIREMENTS:

6.1.1 CORE MATERIAL

6.1.2.1 The core shall be stack / wound type of high grade Cold Rolled Grain Oriented or Amorphous Core 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 value 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. CRGO steel for core shall be purchased only from the approved vendors, list of which is available at http://apps.powergridindia.com/ims/ComponentList/Power-former%20upto%20420%20kV-CM%20List.pdf

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 up to 200kVA shall not exceed 3% of full load current and will be measured by energising the transformer at rated voltage and frequency. Increase of 12.5% of rated voltage shall not increase the no-load current by 6% of full load current.

or

No-load current above 200kVA and upto 2500kVA shall not exceed 2% of full load current and will be measured by energising the transformer at rated voltage and frequency. Increase of 12.5% of rated voltage shall not increase the no-load current by 5% of full load current.

6.1.2.5 Please refer to "**Check-list for Inspection of Prime quality CRGO for Transformers"** attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.

7 WINDINGS:

(i) Material:

7.1.1 HV and LV windings shall be wound from Super Enamel covered /Double Paper covered Aluminum
/ Electrolytic 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 bonding of inter layer insulation with the conductor shall be ensured. Test for bonding 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 The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions.

7.1.8 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 TAPPING RANGES AND METHODS:

8.1.1 No tapping shall be provided for distribution transformers up to 100 kVA rating.

8.1.2 The tapping shall be as per provisions of IS: 1180 Part-I (2014).

8.1.3 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. Arrangement for pad locking shall be provided. Suitable aluminum 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 IS 335. Use of recycled oil is not acceptable. The specific resistance of the oil shall be as per IS 335.

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	11	75	28
3	33	170	70

11 **LOSSES:**

11.1 The transformer of HV voltage up to 11kV,the total losses(no-load + load losses at 75 ^{0}C) at 50% of rated load and total losses at 100% of rated load shall not exceed the maximum total loss values given in Table-3 upto 200kVA & Table-6 for ratings above 200kVA of IS 1180(Part-1):2014.

11.2 The maximum allowable losses at rated voltage and rated frequency permitted at 75 ^{0}C for 11/0.433 kV transformers can be chosen by the utility as per **Table-3 upto 200kVA** and **Table-6 for ratings above 200kVA** as per **Energy Efficiency Level-2 specified in IS 1180 (Part-1):2014** for all kVA ratings of distribution transformers.

11.3 The above losses are maximum allowable and there would not be any positive tolerance. Bids with higher losses than the above specified values would be treated as non-responsive. However, the manufacturer can offer losses less than above stated values. The utility can evaluate offers with losses lower than the maximum allowable losses on total owning cost basis in accordance with methodology given in Annex-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:

The percentage impedance of transformers at 75 ^{0}C for different ratings upto 200 kVA shall be as per Table 3 and for ratings beyond 200 kVA shall be as per Table 6 of IS 1180(Part-1):2014.

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

14.1 The permissible temperature rise shall be as per IS: 1180 (Part-I):2014.

14.2 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.

17.1 TANK:

- Transformer tank construction shall conform in all respect to clause 15 of IS 1180(Part-1):2014.
- 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.
- All joints of tank and fittings shall be oil tight and no bulging should occur during service.
- Inside of tank shall be painted with varnish/hot oil resistant paint.
- The top cover of the tank shall be slightly sloping to drain rain water.

- 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/Hook Type.

- 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.

i) 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 3.15 mm for the bottom and top and not less than 2.5 mm for the sides for distribution transformers upto and including 25 kVA, 5.0 mm and 3.15 mm respectively for transformers of more than 25 kVA and up to and including 100 kVA and 6 mm and 4 mm respectively above 100 kVA. Tolerances as per IS1852 shall be applicable.

17.2.2 In case of rectangular tanks above 100 kVA 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^2 for 30 minutes. In case of transformers of 100 kVA and below, there shall be no joints at corners and there shall not be more than 2 joints in total.

17.2.3 Under operating conditions the pressure generated inside the tank should not exceed 0.4 kg/ sq. cm positive or negative. There must be sufficient space from the core to the top cover to take care of oil expansion. The space above oil level in the tank shall be filled with dry air or nitrogen conforming to commercial grade of IS 1747 for DT up to 63 KVA. For DT of 63 KVA and above rating, conservator shall be provided.

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

(ii) 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:

(All figures are in mm)

Horizontal length of flat plate	Permanent deflection
Up to and including 750	5.0
751 to 1250	6.5

1251 to 1750	8.0
1751 to 2000	9.0

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

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

17.3 CORRUGATED TANK:

17.3.1 The bidder may offer corrugated tanks for transformers of all ratings.

17.3.2 The transformer tank shall be of robust construction corrugated in shape and shall be built up of tested sheets.

17.3.3 Corrugation panel shall be used for cooling. 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.

17.3.4 Tanks with corrugations shall be tested for leakage test at a pressure of 0.25kg/ sq cm measured at the top of the tank.

17.3.5 The transformers with corrugation should be provided with a pallet for transportation, the dimensions of which should be more than the length and width of the transformer tank with corrugations.

18 CONSERVATOR:

(i) Transformers of rating 63 kVA and above with plain tank construction, the provision of conservator is mandatory. For corrugated tank and sealed type transformers with or without inert gas cushion, conservator is not required.

(ii) 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. In addition, the cover of the main tank shall be provided with an air release plug.

(iii) 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 500g of silica gel conforming to IS 3401 for transformers upto 200 kVA and 1 kg for transformers above 200 kVA .

(iv) 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 variations. The total volume of conservator shall be such as to contain10% quantity of the oil. Normally 3% quantity the oil shall be contained in the conservator.

(v) 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.

(vi) 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 -5 ^{0}C) should be above the sump level.

19 SURFACE PREPARATION AND PAINTING:

(i) 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:

a) 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.

b) 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).

c) 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 A s 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:

i) 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

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

iii) For highly polluted areas, chemical atmosphere or for places very near to the sea coast, paint as above with one coat of high build Micaceous iron oxide (MIO) as an intermediate coat may be used.

19.5 PAINTING PROCEDURE:

i) 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.

ii) 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 thickens by more than 25%.

19.6 DAMAGED PAINTWORK:

(i) 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.

(ii) 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.

19.6.2.4 The paint shade shall be as per Annexure-Paint which is attached herewith.

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. Overspray, 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	30 25 each

			01	35/10

19.8 TESTS FOR PAINTED SURFACE:

(v)

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 arrangement shall be decided by utility during detailed engineering.

20.2 For 33 kV-36 kV class bushings shall be used for transformers of ratings 500 kVA and above. And for transformers below 500 KVA, 33 kV class bushings, for 11 kV - 12 kV class bushings and for
0.433 kV- 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 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

20.5 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	350mm	320mm
11 kV	255mm	140mm
LV	75mm	40mm

For DTs of 200 KVA and above, the clearances of cable box shall be as below:

Voltage	Clearance	
	Phase to phase	Phase to earth
33 kV	350mm	220mm
11 kV	130mm	80mm
LV	25mm	20mm

20.6 Arcing horns shall be provided on HV bushings.

20.7 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.

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

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

21 TERMINAL CONNECTORS:

21.1 The LV and HV bushing stems shall be provided with suitable terminal connectors 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.

22 LIGHTNING ARRESTORS:

22.1 9 kV, 5 kA metal oxide lightning arrestors of reputed make conforming to IS 3070 Part-III, one number per phase shall be provided.(To be mounted on pole or to be fitted under the HV bushing with GI earth strip 25x4 mm connected to the body of the transformer with necessary clamping arrangement as per requirement of purchaser.) Lightening arrestors with polymer insulators in conformance with relevant IEC can also be used. 1 clamp for LA shall also be provided for each HT bushing. Supply of LA is not included in DT supplier's scope.

23 CABLE BOXES:

No cable box shall be provided in transformer below 100 kVA. 100 kVA & above 200kVA, Cable Boxes shall be provided on both HV & LV side.

23.1 In case HV/LV terminations are to be made through cables the transformer shall be fitted with suitable cable box on 11 kV side to terminate one 11kV/ 3 core aluminium

conductor cable up to 240 sq. mm. (Size as per requirement).

The bidder shall ensure the arrangement of HT Cable box so as to prevent the ingress of moisture into the box due to rain water directly falling on the box. The cable box on HT side shall be of the split type with faces plain and machined and fitted with Neo-k-Tex or similar quality gasket and complete with brass wiping gland to be mounted on separate split type gland plate with nut-bolt arrangement and MS earthing clamp. The bushings of the cable box shall be fitted with nuts and stem to take the cable cores without bending them. The stem shall be of copper with copper nuts. The cross section of the connecting rods shall be stated and shall be adequate for carrying the rated currents. On the HV side the terminal rod shall have a diameter of not less than 12 mm. The material of connecting rod shall be copper. HT Cable support clamp should be provided to avoid tension due to cable weight.

23.2 The transformer shall be fitted with suitable LV cable box having non-magnetic material gland plate with appropriate sized single compression brass glands on LV side to terminate 1.1 kV/single core XLPE armoured cable (Size as per requirement).

24 TERMINAL MARKINGS:

High voltage phase windings shall be marked both in the terminal boards inside the tank and on 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 terminal is to be brought out and connected to local grounding terminal by an earthing strip.

26.1 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 (for non-sealed transformer)

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 No . Only clamps for lightning arrestor shall be provided.

xiii. Prismatic oil level gauge.

xiv. Drain cum sampling valve.

xv. One filter valve on upper side of the transformer (For transformers above 200 kVA)

xvi. Oil filling hole having p. 1- ¼ '' thread with plug and drain plug on the conservator.

xvii. Silica gel breather (for non-sealed type transformer)

xviii. Base channel 75x40 mm for up to 100 kVA and 100 mmx50 mm above 100 kVA, 460 mm long with holes to make them suitable for fixing on a platform or plinth.

xix. 4 No. rollers for transformers of 200 kVA and above.

xx. Pressure relief device or explosion vent (above 200 kVA)

xxi. Oil level gauge

A. -5 ˚C and 90˚C marking for non-sealed type Transformers

B.- 30˚C marking for sealed type transformers

xxii. Nitrogen / air filling device/ pipe with welded cover Capable of reuse (for sealed type transformers)

xxiii. Inspection hole for transformers above 200 kVA

xxiii. Pressure gauge for sealed type transformers above 200 kVA.

xxiv. Buchholz relay for transformers above 1000 KVA.

27 FASTENERS:

27.1 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.

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

27.3 All nuts and pins shall be adequately locked.

27.4 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.

27.5 All bolts/nuts/washers exposed to atmosphere should be as follows.
a) Size 12 mm or below – Stainless steel
b) Above 12 mm- steel with suitable finish like electro galvanized with passivation or hot dip galvanized.

27.6 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 inaccessible by means of ordinary spanners, special spanners shall be provided.

27.7 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.

27.8 Taper washers shall be provided where necessary.

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

28 OVERLOAD CAPACITY:

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

29 TESTS:

29.1 All the equipment offered shall be fully type tested by the bidder or his collaborator as per the relevant standards including the additional type tests. The type test must have been conducted on a transformer of same design **during the last five years** at the time of bidding. The bidder shall furnish four sets of type test reports along with the offer. **In case, the offered transformer is not type tested, the bidder will conduct the type test as per the relevant standards including the additional type tests at his own cost in CPRI/ NABL accredited laboratory in the presence of employers representative(s) without any financial liability to employer in the event of order placed on him.**

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

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

29.4 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.

29.5 The procedure for testing shall be in accordance with IS1180 (Part-1) :2014 /2026 as the case may be except for temperature rise test.

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

30 ROUTINE TESTS:

30.1 Ratio, polarity, phase sequence and vector group.

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

30.3 Load losses at rated current and normal frequency.

30.4 The test certificates for all routine and type tests for the transformers and also for the bushings and transformer oil shall be submitted after the receipt of order.

30.5 Impedance voltage test.

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

30.7 Insulation resistance.

30.8 Induced over voltage withstand test.

30.9 Separate source voltage withstand test.

30.10 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.

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

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

30.13 Pressure and vacuum test for checking the deflection on one transformer of each type in every inspection.

31 TYPE TESTS TO BE CONDUCTED ON ONE UNIT:

In addition to the tests mentioned in clause 30 and 31 following tests shall be conducted:

31.1 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.

31.2 Impulse voltage test: with chopped wave of IS 2026 part-III. BIL for 11 kV shall be 75 kV peak.

31.3 Short circuit withstand test: Thermal and dynamic ability.

31.4 Air Pressure Test: As per IS – 1180 (Part-1):2014.

31.5 Magnetic Balance Test.

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

31.7 Noise-level measurement.

31.8 Measurement of zero-phase sequence impedance.

31.9 Measurement of Harmonics of no-load current.

31.10 "Vacuum Type Test on Transformer Tank" shall be carried out as per IS 1180 (Part-1): 2014 i.e. The transformer tank shall be subjected to air pressure 80 kPa for 30 minutes and vacuum of 250 mm of mercury for 30 minutes. * The permanent deflection of flat plates after the vacuum has been released shall not exceed the values specified below:

*Amendment issued vide letter No. REC/DDUGJY/SBD/TS/2017-18/D.No. 3091 dated 25.08.2017

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	9.0

31.11 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.

31.12 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.

31.13 **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.

31.13.1 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.

31.13.2 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.

31.13.3 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.

32 ACCEPTANCE TESTS:

32.1 **At least 10% transformers of the offered lot (minimum of one)** shall be subjected to the following routine/ acceptance test 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 (Part-1): 2014 and IS:2026.

32.2 Checking of weights, dimensions, fitting and accessories, tank sheet thickness, oil

quality, material, finish and workmanship as per GTP and contract drawings on one transformer of each type in every inspection.

32.3 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.

32.4 Temperature rise test on one unit of the total ordered quantity.

33 TESTS AT SITE:

(vi)

The purchaser will conduct the following test on receipt of transformers in their store. The utility shall arrange all equipment, tools & tackle and manpower for the testing. The bidder will depute his representative to witness the same. All such test shall be conducted by utility not later than 10 days from receipt of transformers.

i) Megger Test

ii) Ratio test

34 INSPECTION:

34.1 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 manufacturers' 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.

Please refer to "**Check-list for Inspection of Prime quality CRGO for Transformers"** attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.

35 INSPECTION AND TESTING OF TRANSFORMER OIL:

35.1 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 as per IS: 335 , after taking out the sample from the manufactured transformers and tested in the presence of purchaser's representative.

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

35.2.1 Anytime during receipt of raw material and manufacture/ assembly whenever the purchaser desires.

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

35.3 The stage inspection shall be carried out in accordance with **Annexure-II.**

35.4 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 seven days from the date of intimation. During the stage inspection a few assembled core shall be dismantled to ensure that the laminations used are of good quality. Further, as and when the transformers are ready for despatch, 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 Distribution transformers is placed at **Annex- III**.

35.5 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.

35.6 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.

35.7 The manufacturer shall provide all services to establish and maintain quality of workman ship 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.

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

35.9 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.

36 QUALITY ASSURANCE PLAN:

36.1 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.

36.2 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.

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

36.4 List of manufacturing facilities available.

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

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

36.7 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 posses 0.1 accuracy class instruments for measurement of losses.

36.8 Quality Assurance Plan (QAP) withhold points for purchaser's inspection.

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

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

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

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

36.9.4 ISI marking on the transformer is mandatory. As per Quality Control Order for Electrical Transformers- 2015, issued by Department of Heavy Industries, Government of India, the Standard / ISI marking on Distribution Transformers is mandatory and the product should be manufactured in compliance with IS 1180 Part-1: (2014).

37 DOCUMENTATION:

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

37.2 Dimensional tolerances.

37.3 Weight of individual components and total weight.

37.4 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.

37.5 Typical general arrangement drawings of the windings with the details of the insulation at

each point and core construction of transformer.

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

38 PACKING AND FORWARDING:

38.1 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.

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

39 GUARANTEE

41.1 The manufacturers of the transformer shall provide a guarantee of 60 months from the date of receipt of transformer at the stores of the Utility. In case the transformer fails within the guarantee period, the supplier will depute his representative within 15 days from date of intimation by utility for joint inspection. In case, the failure is due to the reasons attributed to supplier, the transformer will be replaced/repaired by the supplier within 2 months from date of joint inspection.

41.2 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.

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

40 SCHEDULES:

42.1 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

41 DEVIATIONS :

43.1 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 specifications and no post-bid negotiations shall take place in this regard.

43.2 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.

43.3 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.

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

(vii) Annex-I

METHODOLOGY FOR COMPUTING TOTAL OWNING COST*

TOC = IC + (A xWi) + (B xWc) ; Losses in KW		
Where,		
TOC	=	Total Owning Cost
IC	=	Initial cost including taxes of transformer as quoted by the manufacturer
A factor	=	Cost of no load losses in Rs/KW (A = 288239)
B factor	=	Cost of load losses in Rs/KW (B = 93678)
Wi	=	No load losses quoted by the manufacturer in KW
Wc	=	Load losses quoted by the manufacturer in KW

Note: No (+)ve tolerance shall be allowed at any point of time on the quoted losses after the award. In case, the losses during type testing, routine testing etc are found above the quoted losses, the award shall stand cancelled. In such a case, the CPG money shall also be forfeited.

* Amendment issued vide letter No. REC/DDUGJY/SBD/DTR-TS/969 Dated 29.09.2016

Annexure-Paint

Painting-Transformer Main tank, pipes, Conservator Tank, Radiator etc.-

	Surface Preparation	primer coat	intermediate under coat	finish coat	total DFT	Colour shade
Main tank, pipes, conservator tank, etc. (External surfaces)	Blast cleaning Sa2½	Epoxy base Zinc primer 30-40 micron	Epoxy base Zinc primer 30-40 micron	Aliphatic Polyurethane (PU Paint) (min 50 micron	Min 110 micron	541 shade of IS:5
Main tank, pipes (above 80 NB), conservator tank, etc (Internal surfaces)	Blast cleaning Sa2½	Hot oil resistant, non-corrosive varnish or paint	--	--	Min 30 micron	Glossy white for paint
Radiator (External surfaces)	Chemical / blast cleaning (Sa2½)	Epoxy base zinc primer 30-40 micron	Epoxy base Zinc primer Min 30-40 micron	Aliphatic Polyurethane(PU Paint) (min)50 micron	Min 110 micron	541 shade of IS:5
Radiator and pipes up to 80 NB (Internal surfaces)	Chemical cleaning if required	Hot oil proof low viscosity varnish or hot oil resistant non corrosive paint	--	--	--	Glossy white for paint

(viii) Annexure – II

PROFORMA FOR STAGE INSPECTION OF DISTRIBUTION TRANSFORMERS

(A) GENERAL INFORMATION:

1. Name of firm : M/s.
2. Order No. and Date :
3. Rating-wise 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) A quantity of less than 100 Nos. shall not be entertained for stage inspection. If the awarded quantity is less than 100 Nos., then whole lot shall be offered in single lot.

(ii) The stage inspection shall be carried out in case :-

(a) At least 25% quantity offered has been tanked and

(b) core coil assembly of further at least 30% of the quantity offered has been completed.

(iii) 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)	Inspection of Core: (I) Core Material (1) Manufacturer's Characteristic Certificate in respect of grade of lamination used. (Please furnish test certificate)			
	(2) Remarks 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.	1	2	3	4	5	6	7	8	9	10	11	12
	As offered:												
	W mm												
	T mm												
	As found:												
	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) Painting									
	(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) This will not be applicable for Amorphous core. For Amorphous core, core clamps with locking arrangement with tank base cover will be provided. This will not be applicable for Amorphous core. For Amorphous core, core clamps with locking arrangement with tank base cover will be provided. .									
	(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)	INSPECTION OF WINDING			
	(I) Winding material			
	(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			
	(II) CONSTRUCTIONAL DETAILS (1) Size of Cross Sectional area of conductor for :			
	(a) HV winding			
	(b) LV winding			
	(2) Type of insulation for conductor of :			
	a) HV winding			
	(b) LV winding			
	(3) Diameter of wire used for delta formation (mm)			

	(4) Diameter of coils in:			
	a) LV winding			
	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)	INSULATION MATERIALS :			
	(I) MATERIAL :			
	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)	CLEARANCES : (mm)			
	(I) Related to core and windings			
	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 per phase between HV coils			
	7) Size of duct between LV and HV winding (mm)			
	(II) Between core - coil assembly and tank : (mm)			
	1) Between winding and body:			
	a) Tank lengthwise			
	b) Tank Breadth wise			
	2) Clearance between top cover and top yoke upto 100 kVA and between top cover and top most live part of tap changing switch for 200 kVA and above.			
(H)	TANK : (I) Constructional details : 1) Rectangular shape 2) Thickness of side wall (mm) 3) Thickness of top and bottom plate (mm) 4) Provision of slopping top cover towards HV bushing.			

GUARANTEED TECHNICAL PARTICULARS

Sr. No.	Particulars	Unit / Type	As per Firm's Offer
1	**Name of manufacturer**		
2	**Place of Manufacturing**		
3	**Transformer capacity**	KVA	
4	**Voltage**	11/0.433-0.250 KV	
5	**No. of Phases**	3 No./1 No.	
6	**Vector Group**	DY-11	
7	**Type of Cooling**	ONAN	
8	**Type of Transformer**	Sealed/Unsealed	
9	**For 200 KVA/500 KVA transformers**		
	a) No. of tap positions in HV winding		
	b) Voltage variation		
10	**Energy Efficiency Level**	Level-1/Level-2	
11	**Losses**		
i	Core loss	Watts	
	a) at Normal Voltage	Watts	
	b) at Maximum Voltage	Watts	
ii	Full Load losses at 75 deg.C.	Watts	
iii	Total losses at 50 % loading at 75 deg.C.	Watts	
iv	Total losses at 100 % loading at 75 deg.C.	Watts	
12	**Percentage Impedance at 75 deg.C.**	%	
13	**Maximum temperature rise of**		
	a) Windings by resistance method	40 deg C (35 deg C for 5KVA)	
	b) Oil by Thermometer	35 deg C (30 deg C for 5KVA)	
14	**Clearances**		
	a) Core & LV	mm	
	b) LV & HV	mm	
	c) HV Phase to Phase	mm	
	d) End insulation clearance to Earth	mm	
	e) Any point of winding to tank	mm	
	f) HV to earth creepage distance	mm	

Sr. No.	Particulars	Unit / Type	As per Firm's Offer
	g) LV to earth creepage distance	mm	
15	**Efficiency at 75 deg.C.**		
	a) Unity P.F.		
	1) 125% load	%	
	2) 100% load	%	
	3) 75% load	%	
	4) 50% load	%	
	5) 25% load	%	
	b) 0.8 P.F.		
	1) 125% load	%	
	2) 100% load	%	
	3) 75% load	%	
	4) 50% load	%	
	5) 25% load	%	
16	**Regulation at**		
	a) Unity P.F.		
	b) 0.8 P.F. at 75 deg.C.		
17	**CORE**	**CRGO/ Amorphous**	
i	Core Grade		
ii	Core diameter	mm	
iii	Gross Core area	Mtr^2	
iv	Net Core area	Mtr^2	
v	Flux density	Wb/Mtr^2	
vii	Wt. of Core	Kg	
viii	Loss per kg. of Core at the specified Flux density	Watts	
ix	Core window height	mm	
x	Centre to centre distance of the core	mm	
xi	The nominal flux density at		
	a) 100% rated voltage	≤ 1.69 Wb/Mtr^2	
	b) 110% of rated voltage	≤ 1.9 Wb/Mtr^2	
xii	% No load current of full load current at rated voltage and frequency on the secondary and Increase of voltage by 112.5%		
	(i) CRGO Core: at 100% and 112.5% of rated		

Sr. No.	Particulars	Unit / Type	As per Firm's Offer
	Voltage		
	a)Up to 200 KVA Transformer	≤ 3% and ≤ 6 %	
	b) Above 200 KVA Transformer	≤ 2% and ≤ 5 %	
	(ii) Amorphous Core: at 100% and 112.5% of rated Voltage		
	a) All Ratings	≤ 2% and ≤ 5 %	
18	**WINDINGS**	**Aluminium / Copper**	
i	No. of L.V. Turns	No.	
ii	No. of H V turns	No.	
iii	Size of LV Conductor bare/ covered	mm	
iv	Size of HV conductor bare/covered	mm	
v	No. of parallels	No.	
vii	Resistance of HV winding at 20 deg.C	Ohm	
viii	Resistance of LV winding at 20 deg.C	Ohm	
ix	Current density of LV winding	Amps/sq.mm.	
x	Current density of HV winding	Amps/sq.mm.	
xi	Wt. of the LV winding for Transformer	kg.	
xii	Wt. of the HV winding for Transformer	kg.	
xiii	No. of LV Coils/phase	No.	
xiv	No. of HV coils / phase	No.	
xv	Height of LV Windings	mm	
xvi	Height of HV winding	mm	
xvii	ID/OD of LV winding	mm	
xviii	ID/OD of HV winding	mm	
xix	Size of the duct in LV winding	mm	
xx	Size of the duct in HV winding	mm	
xxi	Size of the duct between HV & LV	mm	
xxii	Inter layer insulation provided in design for		
	1) Top & bottom layer		
	2) In between all layer		
	3) Details of end insulation		
	4) Whether wedges are provided at 50% turns of the HV coil		
xxiii	Insulation materials provided		
	a) For Conductors		

Sr. No.	Particulars	Unit / Type	As per Firm's Offer
	(1) HV		
	(2) LV		
	B) For Core		
xxiv	Material and Size of the wire used		
	1) HV a) SWG	No.	
	b) Dia	mm	
	2) LV a) Strip size	mm X mm	
	b) No. of Conductors in parallel	No	
	c) Total area of cross section	sq.mm.	
19	**Weight content of**		
	a) Core lamination (min)	KG	
	b) Windings (min) Aluminium/Copper	KG	
	c) Tank & Fittings	KG	
	d) Oil	KG	
	e) Oil qty (min)	Litre	
	f) Total Weight	KG	
20	**Oil Data**		
	1. Qty for first filling (min)	Litre	
	2. Grade of oil used		
	3. Maker's name		
	4. BDV at the time of filling	KV	
21	**Transformer**		
	1) Overall length x breadth x height	mm X mm X mm	
	2) Shape of Tank		
	2) Tank length x breadth x height	mm X mm X mm	
	3) Thickness of plates for		
	a) Side plate (min)	mm	
	b) Top & Bottom plate (min)	mm	
	4) Conservator Dimensions	mm X mm	
	5) Tank base channel dimensions	mm X mm X mm	
22	**HV Bushings & Terminals**		
	1) Make of HV bushing		
	2) Rating in KV	KV	
	3) Turret Height	mm	
	4) Material of HV terminal	Brass/Copper	

Sr. No.	Particulars	Unit / Type	As per Firm's Offer
	5) Current Density of HV terminal	Amps/sq.mm.	
23	**LV Bushings & Terminals**		
	1) Make of LV bushing		
	2) Rating in KV	KV	
	3) Turret Height	mm	
	4) Material of LV terminal	Brass/Copper	
	5) Current Density of LV terminal	Amps/sq.mm.	
24	**Details of MCCB (for transformers having rating upto 25**		
	Make		
	Rated thermal current	Amp.	
	Current setting	Amp.	
	Minimum short circuit breaking current	KA	
25	**Radiation**		
	1) Heat dissipation by tank walls exclusive top & bottom		
	2)Heat dissipation by cooling tube		
	3)Dia & 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.	Yes/No	
26	Whether the name plate gives all particulars as required in Tender	Yes/No	
27	Whether the transformer offered is already type tested for the design and test reports enclosed	Yes/No	

Name Plate Details

Digit/letter No.	Details	TIN	Remark
1	Name of Company	M	First letter of DISCOM name
2	KVA rating	5	for 5/10/16/25/63/100/200/500 KVA ratings digits will be respectively 1/2/3/4/5/6/7/8
3	Type of Core Material	1	CRGO-1,Amorphous-2
4	Core construction	1	Stack-1, Wound-2
5	Supplier Name Code	1	each supplier will be given 2 digit code no. e.g. M/s XYZ given code no.15
6		5	
7	Month of manufacturing	0	2 digits for Month of manufacturing
8		2	
9	Year of manufacturing	1	2 digits for Year of manufacturing
10		7	
11	CPP Tender No.	9	4 digits for CPP tender no.
12		0	
13		3	
14		2	
15	Sr. No. of transformer given by Supplier	0	5 digits for transformer sr. no. given by supplier (e.g. M/s XYZ will give transformer sr. no. from 00001 to 00260 for P.O. of 260 no. transformers issued to them vide CPP tender no.9032)
16		0	
17		0	
18		0	
19		1	

4. ACSR Conductor

1. SCOPE

This section covers design, manufacture, testing before dispatch, packing, supply and delivery for destination of Kms of ACSR Squirrel, Weasel, Rabbit", Racoon, Dog and Panther Conductor.

2. STANDARDS

The Conductor shall also comply in all respects with the IS: 398(Part-II)-1996 with latest amendments unless otherwise stipulated in this specification or any other International Standards which ensure equal or higher quality material.

The ACSR Conductor shall also conform to the following standards.

Sl. No.	Indian Standards	Title	International
1	IS:209-1979	Specification for Zinc	BS-3436-1961
2	IS:398-1996	Specification for aluminum conductors for overhead transmission purposes.	
	Part-II	Aluminum conductors	IEC-209-1966
		Galvanized steel reinforced	BS-215(Part-II)
3	IS:1521-1972	Method of Tensile Testing of Steel wire	ISO/R89-1959
4	IS:1778-1980	Reels and Drums for Bare conductors	BS-1559-1949
5	IS:1841-1978	E.C. Grade Aluminum rod produced by rolling	
6	IS:2629-1966	Recommended practice for Hot Dip Galvanizing of iron and steel	
7	IS:2633-1986	Method of testing uniformity of coating of zinc coated articles.	
8	IS:4826-1968	Galvanized coatings on round steel wires.	ASTM A472-729
9	IS:5484-	E.C. Grade Aluminium rod produced by	

	1978	continuous casting and rolling.	
10	IS:6745- 1972	Methods of determination of weight of zinc-coating of zinc coated iron and steel articles	BS-443-1969

Offers conforming to standards other than IS-398 shall be accompanied by the English version of relevant standards in support of the guaranteed technical particulars to be furnished as per format enclosed.

3. GENERAL TECHNICAL REQUIREMENTS

The General Technical Requirements are given in Section-II. The Conductor shall conform to these technical requirements.

The Bidder shall furnish guaranteed technical particulars in Section-III.

3.1. MATERIALS/WORKMANSHIP

3.1.1. The material offered shall be of best quality and workmanship. The steel cored aluminum conductor strands shall consist of hard drawn aluminium wire manufactured from not less than 99.5% pure electrolytic aluminium rods of E.C. grade and copper content not exceeding 0.04%. They shall have the same properties and characteristics as prescribed in IEC: 889- 1987. The steel wire shall be made from material produced either by the acid or basic open hearth process or by electric furnace process or basic oxygenprocess. Steel wire drawn from Bessemer process shall not be used.

3.1.2. The steel wires shall be evenly and uniformly coated with electrolytic high grade, 99.95% purity zinc complying with the latest issue of IS-209 for zinc. The uniformity of zinc coating and the weight of coating shall be in accordance with Section-II and shall be tested and determined according to the latest IS-2633 or any other authoritative standard.

3.1.3. The steel strands shall be hot dip galvanized as per IS: 4826. The coating shall be smooth, continuous, and of uniform thickness,free from imperfections and shall withstand minimum three dips after stranding in standard preece test. The steel strands shall be preformed and postformed in order to prevent spreading of strands in the event of cutting of composite core wire. The properties and characteristics of finished strands and individual wires shall be as prescribed in IEC: 888- 1987. If tested after

stranding, reference shall also be made to cl. 4.1.1 and cl. 4.2.3 of IS : 4826.

4. CONDUCTOR PARAMETERS

The Parameters of individual strands and composite steel cored aluminum conductor, shall be in accordance with the values given in Section-II.
Creep in a conductor is attributed partly due to settlement of strands and partly due to non-elastic elongation of metal when subjected to load. The manufacturer of conductor shall furnish the amount of creep which will take place in 10, 20, 30, 40 and 50 years along with the supporting calculations. The calculations should be based on everyday temperature of 32 ℃ and everyday tension of 25% of UTS of conductor of 11/33 KV Lines.

5. TOLERANCES

The tolerances on standard diameter of Aluminum and Steel wires shall be as detailed in specific technical requirements.
The cross-section of any wire shall not depart from circularity by more than an amount corresponding to the tolerance on the standard diameter.
The details of diameters, lay ratios of Aluminum and steel wires shall be in accordance with the Section-II "Technical Requirements".

6. SURFACE CONDITIONS

All aluminum and steel strands shall be smooth, and free from all imperfections, spills/and splits. The finished conductor shall be smooth, compact, uniform and free from all imperfections including spills and splits, die marks, scratches, abrasions, scuff marks, kinks (protrusion of wires), dents, pressmarks, cut marks, wire cross-over, over-riding looseness, pressure and/or unusual bangle noise on tapping, material inclusions, white rust, powder formation or black spots (on account of reaction with trapped rain water etc.,), dirt, grit, etc. The surface of 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 upto 50% of the ultimate strength of the conductor, the surface shall not depart from the 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.

7. JOINTS IN WIRES

7.1. **Aluminum wires**

During stranding, no aluminum wire welds shall be made for the purpose of achieving the required conductor length.
No joint shall be permitted in the individual aluminum wires in the outer most layer of the finished Conductor. However, joints in the 12 wire & 18 wire inner layer of the conductor are permitted but these joints shall be made by the cold pressure butt welding and shall be such that no two such joints shall be within 15 meters of each other in the complete stranded conductor.

7.2. Steel wires

There shall be no joints in finished steel wires forming the core of the steel reinforced aluminum conductor.

8. STRANDING

The wires used in construction of the stranded conductor, shall, before stranding, satisfy all requirements of IS-398 (Part-II) 1996.

In all constructions, the successive layers shall be stranded in opposite directions. The wires in each layer shall be evenly and closely stranded round the underlying wire or wires. The outer most layer of wires shall have a right hand lay. The lay ratio of the different layers shall be within the limits given under Section-II.

9. PACKING

9.1. The conductor shall be supplied in non-returnable strong wooden drums provided with lagging of adequate strength constructed to protect the conductor against any damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The drums shall generally conform to IS-1778-1980 and latest version except as otherwise specified hereinafter. The conductor drums shall be adequate to wind one or more standard length of 2500 meters of SQUIRREL/WEASEL/RABIT/RACOON/DOG/ PANTHER ACSR conductor.

9.2. The drums shall be suitable for wheel mounting and for letting off the conductor under a minimum controlled tension of the order of 5KN. The conductor drums shall be provided with necessary clamping arrangements so as to be suitable for tension stringing of power conductor.

9.3. The bidders should submit their drawings of the conductor drums along with the bid. After placement of letter of intent the Manufacturer shall submit four copies of fully dimensioned drawing of the drum for Employer's approval. After getting approval from the Employer, Manufacturer shall submit 30 more copies of the approved drawings for further distribution and field use.

9.4. All wooden components shall be manufactured out of seasoned soft wood free from defects that may materially weaken the component parts of the drums. Preservative treatment for anti-termite/anti fungus shall be applied to the entire drum with preservatives of a quality which is not harmful to the conductor.

9.5. All flanges shall be 2-ply construction with 64 mm thickness. Each ply shall be nailed and clenched together at approximately 90 degrees. Nails shall be driven from the inside face of the flange, punched and then clenched on the outer face. Flange boards shall not be less than the nominal thickness by more than 2 mm. There shall not be less than 2 nails per board in each circle.

9.6. The wooden battens used for making the barrel of the conductor shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.

9.7. Barrel studs shall be used for construction of drums. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing.

9.8. Normally, the nuts on the studs shall stand protruded of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be countersunk. The ends of the barrel shall generally be flushed with the top of the nuts.

9.9. The inner cheek of the flanges and drum barrel surface shall be painted with bitumen based paint.

9.10. Before reeling, card board or double corrugated or thick bituminized waterproof bamboo paper or HDPE sheet shall be secured to the drum barrel and inside of flanges of the drum by means of a suitable commercial adhesive material. The paper should be dried before use. After reeling the conductor the exposed surface of the outer layer of conductor shall be

wrapped with thin polythene sheet across the flanges to preserve the conductor from dirt, grit and damage during transportation and handling and also to prevent ingress of rain water during storage/transport.

9.11. A minimum space of 75 mm shall be provided between the inner surface of the external protective lagging and outer layer of the conductor. Outside the protective lagging, there shall be minimum of two binders consisting of hoop iron/galvanised steel wire. Each protective lagging shall have two recesses to accommodate the binders.

9.12. Each batten shall be securely nailed across grains as far as possible to the flange edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nail shall not protrude above the general surface and shall not have exposed sharp edges or allow the battens to be released due to corrosion.

9.13. The conductor ends shall be properly sealed and secured with the help of U-nails on one side of the flanges.

9.14. Only standard lengths of conductor shall be wound on each drum. The method of lagging to be employed shall be clearly stated in the tender.

9.15. As an alternative to wooden drum Bidder may also supply the conductors in non-returnable
painted steel drums. The painting shall conform to IS:9954-1981,reaffirmed in 1992. Wooden/ steel drum will be treated at par for evaluation purpose and accordingly the Bidder should quote the package.

10. LABELLING AND MARKING

The drum number shall be branded or gauged or stencilled into the flange. An arrow shall be marked on the sides of the drum, together with the words "Roll this way". Each drum shall have the following information provided on the outside of the flange stencilled with indelible ink.

i) Manufacturer's name and address.
ii) Contract/Specification number.
iii) Size and type of conductor.
iv) Net weight of the conductor.
v) Gross weight of the conductor and drum.
vi) Length of the conductor.
vii) Position of the conductor end.
viii) Drum and lot number.
ix) Name and address of the consignee.

x) Month and year of manufacture.

xi) The drum may also be marked with standard specification as per which the conductor is manufactured.

11. STANDARD LENGTHS

11.1. The standard length of the conductor shall be 2500 metres. A tolerance of plus or minus 5% on the standard length offered by the bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths.

11.2. Random lengths will be accepted provided no length is less than 70% of the standard length and total quantity of such random length shall not be more than 10% of the total quantity order. When one number random length has been manufactured at any time, five (5) more individual lengths, each equivalent to the above random length with a tolerance of +/-5% shall also be manufactured and all above six random lengths shall be dispatched in the same shipment. At any point, the cumulative quantity supplied including such random lengths shall not be more than 12.5% of the total cumulative quantity supplied including such random lengths. However, the last 20% of the quantity ordered shall be supplied only in standard length as specified.

11.3. Bidder shall also indicate the maximum single length, above the standard length, he can manufacture in the guaranteed technical particulars of offer. This is required for special stretches like river crossing etc. The Employer reserves the right to place orders for the above lengths on the same terms and conditions applicable for the standard lengths during the pendency of the Contract.

12. QUALITY ASSURANCE PLAN

A Quality Assurance Plan including customer hold points covering the manufacturing activities of the material shall be required to be submitted by the tenderer to the Employer along with the tender. The Quality Assurance Plan after the same is found acceptable, will be approved by the Employer.

The contractor shall follow the approved Quality Assurance Plan in true spirit. If desired by the Employer, he shall give access to all the documents and materials to satisfy the Employer that the Quality Assurance Plan is being properly followed.

13. TESTING

13.1. SELECTION OF TEST SAMPLES FOR TYPE TESTS

13.1.1. The samples shall be taken from a continuous length of conductor and subjected to all the tests specified in clause 14.

13.2. SELECTION OF TEST SAMPLES FOR ACCEPTANCE TESTS

13.2.1. Before dispatch from the works individual wire and finished steel coredaluminum conductor shall be subjected to the tests as specified in IS:398 or any other authoritative standard.

13.2.2. Sample for individual wires for test shall be taken before stranding from outer ends of not less than ten per cent of the spools in the case of aluminum wire and ten per cent of the wire coils in the case of steel wires. If samples are taken after stranding, they shall be obtained by cutting 1.2 meters from the outer ends of the finished conductor from not more than 10 per cent of the finished reels.

13.2.3. The routine tests shall be same as acceptance test. The manufacturer will draw samples for routine tests as per Cl. 13.1.1 or 13.1.2 of IS: 398 (Part 2) and will maintain the record of routine tests for buyer's review. For acceptance tests, the sample shall be taken as per Cl. shall be as per Cl.13.1.2 of IS: 398 (Part 2).

14. TESTS

The following tests shall be carried out on sample/samples of conductor.

14.1 Type Tests

(i) Visual examination
(ii) Measurement of diameters of individual aluminum and steel wires.
(iii) Measurement of lay ratio of each layer
(iv) Breaking load test
(v) Ductility test
(vi) Wrapping test
(vii) Resistance test on aluminum wires.
(viii) DC resistance Test on aluminum wires.
(ix) Galvanizing test
(x) Surface condition test
(xi) Stress Strain test
(xii) Procedure qualification test on welded joint of Aluminum Strands.

NOTE:-The type test reports shall not be older than FIVE years and shall be valid up to expiry of validity of offer.
The above additional lists if not conducted earlier, shall be done under the subject project package at no extra cost.

14.2 Acceptance tests and Routine tests

(ii) Visual and dimensional check on drum.
(iii) Visual examination
(iv) Measurement of diameters of individual aluminum and steel wires.
(v) Measurement of lay ratio of each layer
(vi) Breaking load test
(vii) Ductility test
(viii) Wrapping test
(ix) Resistance test on aluminum wires.
(x) DC resistance Test on Composite Conductor.
(xi) Galvanizing test

14.3 Tests During Manufacture

The following tests during manufacture shall be carried out.

(i) Chemical analysis of zinc used for galvanising,
(ii) Chemical analysis of aluminum used for making aluminumstrands,
(iii) Chemical analysis of steel used for making steel strands,

14.4 Visual examination

The conductor shall be examined visually for good workmanship and general surface finish of the conductor. The conductor drums shall be rewound in the presence of Inspecting Officer. The Inspector will initially check for Scratches, Joints etc., and that the conductor shall generally conform to the requirements of the specifications/IS 398(Part-II)-1996.

14.5 Measurement of diameters of individual Aluminum and Steel Wires.

The diameters of individual Aluminum and Steel Wires shall be checked to ensure that they conform to the requirements of this specification.

14.6 Measurement of lay-ratios

The lay-ratios of each layer of the conductor shall be measured and checked to ensure that they conform to the requirements of this specification and IS:398 (Part-II)-1996.

14.7 Breaking load test

a) **Breaking load test on complete conductor.**

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5m length between fixing arrangement suitably fixed on a tensile testing machine. The load shall be increased at a steady rate upto 50% of minimum specified 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 steady rate to 100% of UTS and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

b) **Breaking load test on individual aluminum and galvanized steel wires.**

This test shall be conducted on both Aluminum and Galvanized steel wires. The breaking load of one specimen cut from each of the samples taken shall be determined by means of suitable tensile testing machine. The load shall be applied gradually and the rate of separation of the jaws of the testing machine shall be not less than 25 mm/min. and not greater than 100 mm. / min. The ultimate breaking load of the specimens shall be not less than the values specified in the Section-II.

14.8 Ductility Test

For the purpose of this test both torsion and elongation tests shall be carried out on galvanized steel wires only.

14.9 Torsion Test

One specimen cut from each of the samples taken shall be gripped in two vices exactly 15 cms. apart. One of the vices shall be made to revolve at a speed not exceeding one revolution per second and the other shall be capable of moving longitudinally to allow for contraction or expansion during testing. A small tensile load not exceeding 2 (two) percent of the breaking load of the wire shall be applied to the samples during testing. The test shall be continued until fracture

occurs and the fracture shall show a smooth surface at right angles to the axis of the wire. After fracture, the specimen shall be free from helical splits. The sample shall withstand a number of twists equivalent to not less than 18 on length equal to 100 times the diameter. When twisted 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. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to the next higher whole number. The fracture shall show a smooth surface at right angles to the axis of the wire.

14.10 Elongation Test

The elongation of one specimen cut from each of the samples taken shall be determined. The specimen shall be straightened by hand and an original gauge length of 200 mm. shall be marked on the wire. A tensile load shall be applied as described in 1.1.4.6.2.1 and the elongation shall be measured after the fractured ends have been fitted together. If the fracture occurs outside the gauge marks, or within 25 mm. of either mark and the required elongation is not obtained, the test shall be disregarded and another test conducted. When tested before stranding, the elongation shall be not less than 4 percent and when tested after stranding, the elongation shall be not less than 3.5 percent.

14.11 Wrapping Test

This test shall be conducted on both Aluminum and Galvanized steel wires.

14.11.1 Aluminum wires

One specimen cut from each of the samples of aluminum wires shall be wrapped round a wire of its own diameter to form a close helix of 8 turns. Six turns shall then be unwrapped and closely wrapped in the same direction as before. The wire shall not break or show any crack.

14.11.2 Galvanized steel wires

One specimen cut from each of the samples of galvanized steel wire taken shall be wrapped round a mandrel of diameter equal to 4 times the wire diameter to form a close helix of 8 turns. Six turns shall then

be unwrapped and again closely wrapped in the same direction as before. The wire shall not break.

14.12 Resistance Test

This test shall be conducted on aluminum wires only, conforming to procedure as per IEC:889. The electrical resistance of one specimen of aluminum wire cut from each of the samples taken shall be measured at ambient temperature. The measured resistance shall be corrected to the value corresponding to 20 degrees C. by means of following formula.

$$R_{20} = R_T \frac{1}{1 + \text{alpha} \times (T-20)}$$

Where

R_{20} = Resistance corrected at 20 degrees C.

R_T = Resistance measured at T degrees C.

alpha = Constant mass temperature coefficient ofresistance 0.004. T = Ambient temperature during measurement

This resistance calculated to 20 degrees C. shall be not more than the maximum value specified in section-II.

14.13 Galvanizing Test

This test shall be conducted on galvanized steel wires only. The uniformity of Zinc coating and the weight of coating shall be in accordance with IS 4826-1979.

14.14 Surface Condition Test

A sample of the finished conductor for use in 11/33 KV system having a minimum length of 5 meters with compression type dead end clamps compressed on both ends in such manner as to permit the conductor to take its normal straight line shape, shall be subjected to a tension of 50 percent 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 as indicated in Section-II.

14.15 Stress-Strain Test

The test is contemplated only to collect the creep data of the conductor from the manufacturer. A sample of conductor of minimum 10 meters length shall be suitably compressed with dead end clamps. (applicable only for conductors of nominal aluminium area 100 sq. mm and above)

15. TEST SET-UP

15.1. The test sample shall be supported in a trough over its full length and the trough adjusted so that theconductor will not be lifted by more than 10mm under tension. This shall be ascertained by actual measurement.

15.2. 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 1mm + 0.1mm from the value before the test.

15.3. 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.

16. TEST LOADS FOR COMPLETE CONDUCTOR

The loading conditions for repeated stress-strain tests for complete conductor shall be as follows:

16.1. 1KN 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 tension.

16.2. For non-continuous stress-strain data, the strain readings at 1KN intervals at lower tensions and 5 KN intervals above 30% of UTS shall be recorded.

16.3. The sample shall be reloaded to 30% 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 then after the hold period.

16.4. 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 then after the hold period.

16.5. Reloading upto 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. The load shall be released.

16.6. Reloading upto 85% 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 the load shall be released then.

16.7. 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 upto 90% of UTS at the intervals described under Clause 16.6.

17. TEST LOADS FOR STEEL CORE ONLY (applicable only for conductors of nominal aluminum area 100 sq. mm and above)

The loading conditions for repeated stress-strain tests for the steel core of ACSR shall be as follows:

17.1. The test shall consist of successive applications of load applied in a manner similar to that for the complete conductor at 30%, 50%, 70% and 85% of UTS.

17.2. 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.

18. STRESS-STRAIN CURVES

The design stress-strain curve shall be obtained by drawing a smooth curve
through the0.5 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 standard stress-strain curves shall be submitted to the Employeralongwith test results. The stress-strain data obtained during the test shall be corrected to the standard temperature i.e. 20 deg.C.

19. DC RESISTANCE TEST ON COMPOSITE CONDUCTOR

On a conductor sample of minimum 5m length, two contact clamps shall be fixed with a pre-determined bolt torque. The resistance of the sample 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 deg C as per clause no. 12.8 of IS:398 (Part-II)-1982/1996.The corrected resistance value at 20 deg.C shall conform to the requirements of this specification.

20. PROCEDURE QUALIFICATION TEST ON WELDED ALUMINUM STRANDS.

Two Aluminum wires shall be welded as per the approved quality plan and shall be subjected to tensile load. The breaking strength of the welded joint of the wire shall not be less than the guaranteed breaking strength of individual strands.

21. CHEMICAL ANALYSIS OF ALUMINUM AND STEEL

Samples taken from the Aluminum and Steel ingots / coils/ strands shall be chemically/ spectrographically analyzed. The same shall be in conformity with the requirements stated in this specification.

22. CHEMICAL ANALYSIS OF ZINC

Samples taken from the zinc ingots shall be chemically / spectrographically analysed.The same shall be in conformity with the requirements stated in this specification.

23. 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.

24. REJECTION AND RETEST

24.1. In case of failure in any type test, the Manufacturer is either required to manufacture fresh sample lot and repeat all the tests successfully once or repeat that particular type test three times successfully on the sample selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

24.2. 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 material shall be suitably marked and segregated.

25. CHECKING AND VERIFICATION OF LENGTH OF CONDUCTOR

The contractor should arrange for inspection by the representative of the Employer specially authorised for this purpose. At least 50% of the total number of drums of conductor subject to minimum of two taken at random should be checked to ascertain the length of conductor. Arrangements should be made available in the works of the manufacturer for transferring the conductor from one reel to another at the same time measuring the length of the conductor so transferred by means of a meter.

26. ADDITIONAL TESTS

The Employer reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at Bidder's premises, at site, or in any other standard Laboratory in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the materials comply with the specifications.

27. TESTING EXPENSES

27.1. The breakup of the testing charges for the type tests specified shall be indicated separately.

27.2. Bidder shall indicate the laboratories in which they propose to conduct the type test. They shall ensure that adequate facilities are available in the laboratories and the tests can be completed in these laboratories within the time schedule guaranteed by them.

27.3. The entire cost of testing for the acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the

quoted unit price of the conductor, except for the expenses of the inspector/Employer's representative.

27.4. In case of failure in any type test, if repeat type tests are required to be conducted then
all the expenses for deputation of Inspector/Employer's representative shall be deducted from the contract price. Also if on receipt of the Manufacturer's notice of testing, the Employer's representative does not find 'plant' to be ready for testing, the expenses incurred by the Employer for re - deputation shall be deducted from contract price.

28. TEST REPORTS

28.1. Copies of type test reports shall be furnished in at least six copies alongwith one original. One copy will be returned duly certified by the Employer only after which the commercial production of the material shall start.

28.2. Record of Routine test reports shall be maintained by the Manufacturer at his works for periodic inspectionby the Employer's representative.

28.3. Test certificates of Tests during manufacture shall be maintained by the Manufacturer. These shall be produced for verification as and when desired by the Employer.

29. TEST FACILITIES

The following additional test facilites shall be available at the Manufacturer's works:

(i) Calibration of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burette, thermometer, barometer,etc.

(ii) Standard resistance for calibration of resistance bridges.

(iii) Finished Conductor shall be checked for length verification and surface finish on separate rewinding machine at reduced speed(variable from 8 to 16 meters per minute).The rewinding facilities shall have appropriate clutch system and be free of vibrations, jerks etc. with traverse laying facilities.

30. INSPECTION

30.1. The Employer's representative shall, at all times, be entitled to have

access to the works and all places of manufacture where conductor shall be manufactured and the representative shall have full facilities for unrestricted inspection of the Bidder's works, raw materials and process of manufacture and conducting necessary tests as detailed herein.

30.2. The Bidder shall keep the Employer informed in advance of the time of starting and of the progress of manufacture of conductor in its various stages so that arrangements can be made for inspection.

30.3. The contractor will intimate the Employer about carrying out of the tests at least 45 days in advance of the scheduled date of tests during which the Employer will arrange to depute his representative/s to be present at the time of carrying out of the tests. Six (6) copies of the test reports shall be submitted.

30.4. No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested, Unless the inspection is waived off by the employer in writing. In the later case also, the conductor shall be dispatched only after satisfactory testing for all tests specified herein has been completed and approved by the employer.

30.5. The acceptance of any quantity of material shall in no way relieve the Bidder of any of his responsibilities for meeting all requirements of the specification, and shall not prevent subsequent rejection if such material is later found to be defective.

30.6. At least 50% of the total number of drums subject to minimum of two in any lot put up for inspection, shall be selected at random to ascertain the length of conductor by the following method:

"At the works of the manufacturer of the conductor, the conductor shall be transferred from one drum to another at the same time measuring its length with the help of a graduated pulley and Cyclometer. The difference in the average length thus obtained and as declared by the Bidder in the packing list shall be applied to all the drums if the conductor is found short during checking".

31. SCHEDULE OF DEVIATIONS/VARIATIONS

If the tenderer has any exceptions to any of the clause/s laid down in this specification, these should beclearly stated in the schedule of deviations / variations.

SECTION - II SPECIFIC TECHNICAL REQUIREMENTS SCOPE

This section of the specification covers climatic and isoceraunic conditions, specific technical particulars, schedule of requirements & desired deliveries, for conductor for 11/33 kV lines.

1. CLIMATIC & ISOCERAUNIC CONDITIONS TO BE SPECIFIED BY EMPLOYER

1.1 1Maximum Temperature	
a) Conductor	ºC.
1.2	2Minimum Temperature ºC.
1.3 i)Max. ambient temperature	ºC
ii) Mean annual / every day temperature	ºC
2.4Basic wind speed m/s	
2.5Relative humidity	
i) Maximum	%
ii) Minimum	%
2.6Average Rainfall (Max.) mm per annum	
2.7a)Rainy months	May to Sept.
	15 Rainy days in a year (days)
2.8 Average number of thunder storm	
2.9 Altitude varying from sea level	
2.10Basic horizontal Seismic Co-efficient(horizontal) Basic vertical Seismic Co-efficient	
2.11System Particulars	
a) Line Voltage (kV)	

b) Highest System Voltage (kV)

c) Number of Circuits

d) Frequency HZ

e) Neutral

f) Short circuit level (KA)

2. SPECIFIC TECHNICAL REQUIREMENTS

CONDUCTOR: 1. Conductor: Rabbit/Raccoon/Dog/Weasel/Panther ACSR 2. IS applicable: IS-398 (part-II) 1996 latest revision					
3. Wire Diameter	Rabbit	Raccoon	Dog	Weasel	Panther
Aluminium (mm)	6/3.35	6/4.06	6/4.72	6/2.59	30/3.00
Steel(mm)	1/3.35	1/4.09	7/1.57	1/2.59	7/3.00
4. Number of strands:					
Steel centre		1	1	1	1
1st steel layer	-		6		6
1st Aluminium layer	6	6	6	6	12
2nd Aluminium layer					18
5. Sectional Area of Aluminium (sq. mm.)	52.88	78.83	105	31.61	212.1
6. Total Sectional Area(sq.mm.)	61.7	91.97	118.5	36.88	261.5
7. Overall diameter(mm)	10.05	12.27	14.15	7.77	21
8. Approximate weight(Kg./Km.)	10.05	12.27	14.15	7.77	21
9. Calculated D.C rersistance at 20 degrees C., maximum. (Ohms/Km)	0.552	4.371	2.2792	0.9289	0.139
10. Ultimate tensile	18.25	26.91	32.41	11.12	89.67

strength (KN)					
11. Final modulas of elasticity (GN/sq.m)	79	79	75	79	80
12. Coefficient of linear expansion x 10-6 per◦C	19.1	19.1	19.8	19.1	17.8
13. Lay ratio	Max Min	Max Min	Max Min	Max Min	Max Min
Steel core 6 wire layer			28 13		28 13
AluminiumIst layer	14 10	14 10	14 10	14 10	14 10
2nd layer					16 10

14. Technical Particulars

a.	Diameter-mm		Rabbit		Raccon		Dog		Weasel		Panther
		Al	Steel	Al	Steel	Al	Steel	Al	Steel	Al	Steel
	Standard(mm)	3.35	3.35	4.09	4.09	1.57	4.72	2.59	2.59	3.00	3.00
	Maximum (mm)	3.42	3.38	4.17	4.13	1.60	4.77	2.64	2.62	3.06	3.03
	Minimum (mm)	3.28	3.32	4.01	4.05	1.54	4.67	2.54	2.56	2.94	2.97
b.	Cross-sectional area of nominal diameter wire (mm^2)	8.814		8.814	13.14	13.14		1.936	17.50	5.269	5.269	7.069
c.	Weight (Kg./Km)	68.75	23.82	102.48	35.51	15.10	47.30	41.09	14.24	55.13	19.11	
d.	Min. breaking load (KN)											
	Before stranding	11.58	1.43	17.27	2.08	2.70	2.78	6.92	0.89	9.29	1.17	
	After Stranding	11.00	1.36	16.4	1.98	2.57	2.64	6.57	0.85	8.83	1.11	

e. D.C resistance at 20℃ min. (Ohm/Km)

-3.265	-2.194	1.65	-5.49	-4.079

15. Zinc coating of steel core:

(i) The steel strands shall be hot dip galvanized as per IS: 4826.

(ii) Process of Galvanizing: Hot dip.

(iii) Quality of Zinc : IS-209/1979 or latest edition.

16. Joints in strands

16.1 Steel : Not permitted

16.2 **Aluminium:** No joint shall be permitted in the Aluminum wires in the outer most layer of the ACSR conductor. But permitted in the inner layers such that no two such joints are within 15 meters of each other in the complete stranded conductor.

15. Chemical composition of high carbon steel wire:

Element	% Composition
i) Carbon	0.5 to 0.85
ii) Manganese	0.5 to 1.10
iii) Phosphorus	Not more than 0.035
iv) Sulphur	Not more than 0.045
v) Silicon	0.10 to 0.35

Guaranteed Technical Particulars of Conductor (To be filled in by the Tenderer)

1. Code Word
2. Maker's name and address

a. Aluminium Rods
b. Steel Rods
c. Complete Conductor

3. Stranding and Wire diameter

a. Aluminium

i) Nominal ii) Minimum iii) Maximum

b. Steel

i) Nominal ii) Minimum iii) Maximum

4. Nominal Aluminium Area in sq. mm
5. Sectional Area of Aluminium in Sq. mm.
6. Total Sectional Area in Sq.mm.
7. Cross Sectional area of Nominal Diameter wire in sq.mm.
   a) Aluminium b) Steel c) Overall diameter of conductor in mm.
8. Breaking load of conductor in KN.
9. Minimum breaking load for
   a. Aluminium Wire --- i) Before stranding ii) After stranding
   b. Steel Wire --- i) Before stranding ii) After stranding
10. Zinc Coating of steel wire
    a. Uniformity of coating, number & duration of dips process test, withstood
       i) Before stranding ii) After stranding 1 Min x nos.
       1/2 Min x nos
    b. Minimum Weight of coating gm/sq.m
       i) Before stranding ii) After stranding
11. Mass in kg. per Km.
    a. Aluminium
    b. Steel
    c. Conductor
12. Resistance in ohm per Km at 20^0 C i) Aluminium ii) Conductor
13. Continuous maximum current rating of conductor (Amps. in still air at 45^0 C ambient temperatures).
14. Modulus of elasticity of conductor
15. Co-efficient of linear expansion per degree centigrade of :
    a. Aluminum wire
    b. Steel Wire
    c. Conductor
16. Standard length of each piece in Km.
17. Approximate dimensions of the drum in mm.
18. Weight of the conductor in one drum in Kg.
19. Weight of the drum in Kg.
20. Gross weight of the drum including weight of the conductor.
21. Standard according to which the conductor will be manufactured and tested.
22. Other particulars if any.

5. AAA Conductor

1.1 TECHNICAL DESCRIPTION OF AAAC CONDUCTOR

DETAILS OF CONDUCTORS

1.1.1 The AAAC Conductors shall generally conform to IS: 398 (Part-IV), IEC: 104-1987 except where otherwise specified herein.

1.1.2 The details of the AAAC Conductors of various sizes are given in the enclosed Table-I

1.2 WORKMANSHIP

1.2.1 All the Al-alloy strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions, etc., after drawing and also after stranding.

1.2.2 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protrusion of wires), scuff marks, dents, pressmarks, cut marks, wire cross over, over riding, looseness (wire being dislocated by finger/hand pressure and/or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.

1.3 JOINTS IN WIRES

1.3.1 1No joint shall be permitted in any layer of finished conductor.

1.4 STRANDING

In all constructions, the successive layers shall be stranded in opposite directions. The wires in each layer shall be evenly and closely stranded round the underlying wire or wires. The outer most layer of wires shall have a right hand lay. The lay ratio shall be as follow**.**

Number of wires in Conductor	3/6 Wire layer		12 Wire layer		18 Wire layer	
	Min	Max	Min	Max	Min	Max
3	10	14	-	-	-	-
7	10	14	-	-	-	-
19	10	16	10	14	-	-
37	10	17	10	16	10	14

1.5 **TOLERANCES**

The manufacturing tolerances in diameter of individual aluminium alloy strand shall be as per **Table-I**.

1.6 **MATERIALS**

1.6.1 **ALUMINUM ALLOY**

The wire shall be of heat treated aluminum, magnesium silicon alloy having a composition appropriate to the mechanical & electrical properties as specified in IS 398(Part-4).

The Aluminum Alloy strands drawn from heat treated aluminium alloy redraw rods conforming to Type B as per IEC:104-latest amendment. The chemical composition of redrawn rods shall conform to IS 1997-91, as given below:

Elements	*Percent*
Si	0.50-0.90
Mg	0.60-0.90
Fe	0.50 max
Cu	0.10 max
Mn	0.03 max
Cr	0.03 max
Zn	0.10 max
B	0.06 max
Other Element (Each)	0.03 max
Other Element (Total)	0.10 max
Al	Remainder

1.7 **STANDARD LENGTH**

1.7.1 The standard length of the conductor shall be 2000 meters. A tolerance of +/-5% on the standard length offered by the Bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths. The conductor drums shall be adequate to wind one or more standard length of 2000 meters of SQUIRREL/WEASEL/RABIT/RACOON/DOG/ PANTHER AAA conductor.

1.7.2 Random lengths will be accepted provided no length is less than 70% of the standard length and the total quantity of such random lengths shall not be more than 10% of the total quantity ordered.

1.7.3 Bidder shall also indicate the maximum single length, above the

standard length, he can manufacture in the guaranteed technical particulars of offer. The Owner reserves the right to place orders for the above lengths on the same terms and conditions applicable for the standard lengths during the execution of the Contract.

1.8 **TESTS AND STANDARDS**

The following tests to be conducted for AAAC conductors shall conform to IS 398(Part -IV) 1979 and IEC 888 & 889.

1.8.1 **TYPE/PERIODIC**

The following tests shall be conducted on samples of each type of conductor :

a) UTS test on stranded conductor

b) DC resistance test on stranded conductor

1.8.2 ACCEPTANCE TESTS

(a) Visual check for joints scratches etc. and length measurement of conductor by rewinding

(b) Dimensional check on Al-alloy strands

(c) Check for lay-ratio

(d) Elongation test

(e) Breaking load/tensile test on Aluminum alloy strands

(f) DC resistance test on Aluminum alloy strands

(g) Wrap test on Aluminum alloy strands (IEC 104, IEC 1089)

(h) Visual and dimensional (IS:1778-1980) check on drum

1.8.3 **ROUTINE TEST**

(a) Check to ensure that there are no joints.

(b) Check that there are no cuts, fins etc. on the strands.

(c) Check that drums are as per Specification.

(d) All acceptance test as mentioned above to be carried out on each coil.

1.8.4 TESTS DURING MANUFACTURE

(a) Chemical analysis of

Aluminum alloy used for making strands

1.8.5 **TESTING EXPENSES**

i) The type test charges for the conductor should be quoted in the relevant schedule of Bid Proposal Sheets.

ii) Contractor shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that adequate facilities are available in the laboratories and the tests can be completed in these laboratories within the time schedule guaranteed by them.

iii) In case of failure in any type test, the Contractor is either required to manufacture fresh sample lot and repeat all the tests successfully once or repeat that particular type test three times successfully on the sample selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing, then the lot already manufactured shall be rejected.

iv) The entire cost of testing for the acceptance and routine tests and Tests during manufacture specified herein shall be treated as included in the quoted unit price of conductor, except for the expenses of the inspector/Owner's representative.

v) In case of failure in any type test, if repeat type tests are required to be conducted, then all the expenses for deputation of Inspector/Owner's representative shall be deducted from the contract price. Also if on receipt of the Contractor's notice of testing, the Owner's representative does not find 'The material or testing facilities' to be ready for testing the expenses incurred by the Owner for re-deputation shall be deducted from contract price.

1.8.6 **ADDITIONAL TESTS**

i) The Owner reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises, at site or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the materials comply with the Specifications.

ii) The Owner also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Contractor's premises or at any other test centre. In case of evidence of non-compliance, it shall be binding on the part of Contractor to prove the compliance of the items to the technical specifications by repeat tests, or correction of deficiencies, or replacement of defective items all without any extra cost to the Owner.

1.8.7 **SAMPLE BATCH FOR TYPE TESTING**

i) The Contractor shall offer material for selection of samples for type testing only after getting Quality Assurance Plan approved from Owner's Quality Assurance Deptt. The sample shall be manufactured

strictly in accordance with the Quality Assurance Plan approved by Owner.

ii) The Contractor shall offer at least three drums for selection of sample required for conducting all the type tests.

iii) The Contractor is required to carry out all the acceptance tests successfully in presence of Owner's representative before sample selection.

1.8.8 **TEST REPORTS**

i) Copies of type test reports shall be furnished in at least six copies along with one original. One copy will be returned duly certified by the Owner only after which the commercial production of the material shall start.

ii) Record of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Owner's representative.

iii) Test Certificates of tests during manufacture shall be maintained by the Contractor. These shall be produced for verification as and when desired by the Owner.

1.9 **INSPECTION**

1.9.1 The Owner's representative shall at all times be entitled to have access to the works and all places of manufacture, where conductor shall be manufactured and representative shall have full facilities for unrestricted inspection of the Contractor's works, raw materials and process of manufacture for conducting necessary tests as detailed herein.

1.9.2 The Contractor shall keep the Owner informed in advance of the time of starting and of the progress of manufacture of conductor in its various stages so that arrangements can be made for inspection.

1.9.3 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested, unless the inspection is waived off by the Owner in writing. In the latter case also, the conductor shall be dispatched only after satisfactory testing for all tests specified herein have been completed.

1.9.4 The acceptance of any quantity of material shall in no way relieve the Contractor of any of his responsibilities for meeting all requirements of the Specification, and shall not prevent subsequent rejection if such material is later found to be defective.

1.9.5 **TEST FACILITIES**

The following additional test facilities shall be available at the Contractor's works:

i) Calibration of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burette, thermometer, barometer etc.

ii) Standard resistance for calibration of resistance bridges.

iii) Finished conductor shall be checked for length verification and surface finish on separate rewinding machine at reduced speed (variable from 8 to 16 meters per minute). The rewinding facilities shall have appropriate clutch system and free of vibrations, jerks etc. with traverse laying facilities.

1.10 **PACKING**

1.10.1 The conductor shall be supplied in non-returnable, strong, wooden drums provided with lagging of adequate strength, constructed to protect the conductor against any damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The Contractor shall be responsible for any loss or damage

during transportation handling and storage due to improper packing. The drums shall generally conform to IS:1778-1980, except as otherwise specified hereinafter.

1.10.2 The drums shall be suitable for wheel mounting and for letting off the conductor under a minimum controlled tension of the order of 5 KN.

1.10.3 The Contractor should submit their proposed drum drawings along with the bid.

1.10.4 The Contractor may offer more than one length of the conductor in a single drum.

1.10.5 All wooden components shall be manufactured out of seasoned soft wood free from defects that may materially weaken the component parts of the drums. Preservative treatment shall be applied to the entire drum with preservatives of a quality, which is not harmful to the conductor.

1.10.6 The flanges shall be of two ply construction with a total thickness of 64 mm with each ply at right angles to the adjacent ply and nailed together. The nails shall be driven from the inside face flange, punched and then clenched on the outer face. Flange boards shall not be less than the nominal thickness by more than 2mm. There shall not be less than 2 nails per board in each circle. Where a slot is cut in the flange to receive the inner end of the conductor the entrance shall be in line with the periphery of the barrel.

1.10.7 The wooden battens used for making the barrel of the conductor shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.

1.10.8 Barrel studs shall be used for the construction of drums. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing.

1.10.9 Normally, the nuts on the studs shall stand protruded of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be counter sunk. The ends of barrel shall generally be flushed with the top of the nuts.

1.10.10 The inner cheek of the flanges and drum barrel surface shall be painted with a bitumen based paint.

1.10.11 Before reeling, card board or double corrugated or thick bituminous water-proof bamboo paper or HDPE sheet shall be secured to the drum barrel and inside of flanges of the drum by means of a suitable commercial adhesive material. The paper should be dried before use. After reeling the conductor the exposed surface of the outer layer of conductor shall be wrapped with thin polythene sheet across the flanges to preserve the conductor from dirt, grit and damage during transportation and handling and also to prevent ingress of rain water during storage/transport.

1.10.12 A minimum space of 75 mm for conductor shall be provided between the inner surface of the external protective lagging and outer layer of the conductor. Outside the protective lagging, there shall be minimum of two binders consisting of hoop iron/ galvanized steel wire. Each protective lagging shall have two recesses to accommodate the binders.

1.10.13 Each batten shall be securely nailed across grains as far as possible to the flange, edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nails shall not protrude above the general surface and shall not have exposed sharp, edges or allow the battens to be released due to corrosion.

1.10.14 The nuts on the barrel studs shall be tack welded on the one side in order to fully secure them. On the second end, a spring washer shall be used.

1.10.15 A steel collar shall be used to secure all barrel studs. This collar shall be located between the washers and the steal drum and secured to the central steel plate by welding.

1.10.16 Outside the protective lagging, there shall be minimum of two binder consisting of hoop iron/ galvanized steel wire. Each protective lagging shall have two recesses to accommodate the binders.

1.10.17 The conductor ends shall be properly sealed and secured with the help of U-nail on the side of one of the flanges to avoid loosening of the conductor layers during transit and handling.

1.10.18 As an alternative to wooden drum Contractor may also supply the conductors in non-returnable painted steel drums. After preparation of steel surface according to IS: 9954, synthetic enamel paint shall be applied after application of one coat of primer. Wooden/Steel drum will be treated at par for evaluation purpose and accordingly the Contractor should quote in the package.

1.11 MARKING

Each drum shall have the following information stenciled on it in indelible ink along with other essential data :

a. Contract/Award letter number.
b. Name and address of consignee.
c. Manufacturer's name and address.
d. Drum and lot number
e. Size and type of conductor
f. Length of conductor in meters
g. Arrow marking for unwinding
h. Position of the conductor ends
i. Number of turns in the outer most layer.
j. Gross weight of drum after putting lagging.
k. Average weight of the drum without lagging.
l. Net weight of the conductor in the drum.

m. Month and year of manufacture of conductor

The above should be indicated in the packing list also.

1.12 VERIFICATION OF CONDUCTOR LENGTH

The Owner reserves the right to verity the length of conductor after unreeling at least Two (2) percent of the drums in a lot offered for inspection.

For the balance drums, length verification shall be done by the owner based on report/certification from Manufacturer/Contractor.

1.13 STANDARDS

1.13.1 The conductor shall conform to the following Indian/International Standards, which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification.

1.13.2 In the event of the supply of conductor conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the standards proposed by the Contractor and those specified in this document will be provided by the Contractor to establish their equivalence.

SL .NO.	Indian Standard	Title	International Standard
1	IS:398 (Part-IV)	Aluminum Alloy stranded conductor	IEC : 208-1966 BS-3242-1970
2	IS : 9997-1988	Aluminum Alloy Redraw Rods	IEC 104-1987
3	IS : 1778-1980 Reels	Reels and Drums for bare conductors	BS:1559-1949

ANNEXURE-A

1.0 TESTS ON AAAC CONDUCTORS

1.1 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 between fixing arrangement suitably fixed on a tensile testing machine. The load shall be increased at a steady rate upto 50% of minimum specified 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 steady rate to minimum UTS and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.2 D.C. Resistance Test on Stranded Conductor

On a conductor sample of minimum 5m length two contact-clamps shall be fixed with a predetermined 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 $20^{\circ}C$ as per IS:398-(Part-V)-1982. The resistance corrected at $20^{0}C$ shall conform to the requirements of this Specification.

1.3 CHEMICAL ANALYSIS OF ALUMINIUM ALLOY

Samples taken from the Aluminium alloy ingots/coils/strands shall be chemically/spectrographically analyzed. The same shall be in conformity to the requirements stated in this Specification.

1.4 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.

1.5 VISUAL CHECK FOR JOINTS, SCRATCHES ETC.

Conductor drums shall be rewound in the presence of the Owner. The Owner shall visually check for scratches, joints etc. and that the conductor generally conforms to the requirements of this

Specification. **Two percent (2%)** drums from each lot shall be rewound in the presence of the Owner's representative.

1.6 **DIMENSIONAL CHECK ON ALUMINUM ALLOY STRANDS**

The individual strands shall be dimensionally checked to ensure that they conform to the requirement of this Specification.

1.7 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.

1.8 **TORSION AND ELONGATION TESTS ON ALUMINUM ALLOY STRANDS**

The test procedures shall be as per clause No. 10.3 of IEC : 888. In torsion test, the number of complete twists before fracture shall not be less than 18 on a length equal to 100 times the standard diameter of the strand. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 250 mm.

1.9 **CHECK ON BARREL BATTEN STRENGTH OF DRUMS**

The details regarding barrel batten strength test will be discussed and mutually agreed to by the Contractor & Owner in the Quality Assurance Programme.

1.10

Breaking Load Test on Individual Aluminium Alloy Wires

The test shall be conducted on Aluminum alloy wires. The breaking load of one specimen cut from each of the samples taken shall be determined by means of suitable tensile testing machine. The load shall be applied gradually **Si** the jaws of the testing machine shall be not less than 25 mm/min. and not greater than 100 mm./ min. The ultimate breaking load of the specimens shall be not less than the values specified in the Specification.

1.11 RESISTANCE TEST ON ALUMINUM ALLOY WIRE

The test shall be conducted on aluminium alloy wires only, conforming to procedure as per IEC: 889. The electrical resistance of one specimen of aluminium wire cut from each of the samples taken shall be measured at ambient temperature. The measured resistance shall be corrected to the value corresponding to 20 degree C. by means of following formula**.**

$$R_{20} = R_T \frac{1}{1+\text{alpha} \times (T-20)}$$

Where

R20 = Resistance corrected at 20 degrees C.

RT = Resistance measured at T degrees C.

alpha = Constant mass temperature coefficient of resistance 0.004.

T = Ambient temperature during measurement

This resistance calculated to 20 degrees C. shall be not more than the maximum value specified in the specification.

Table-1

Details of parameters of AAA conductor

S. N.	Parameter	Squirrel	Weasel	Rabbit	Raccon	DOG	wolf	Panther
1	Total sectional area of conductor (sqmm)	22	34	55	80	100	173	232
2	(No of Al strand/dia in mm)	7/2.00	7/2.50	7/3.15	7/3.81	7/4.26	19/3.40	19/3.94
3	Overall diameter (mm)	6	7.5	9.45	11.43	12.78	17	19.7
4	approx mass (kg/km)	60.16	94	149.2	218.26	272.86	474.02	636.67
5	Resistance at 20 deg cel (ohms/km)	1.541	0.99	0.621	0.425	0.339	0.1969	0.1471
6	approx calculated breaking load	6.45	10.11	16.03	23.41	29.26	50.54	68.05

	(kN)							
7	Final modulus of Elasticity, GN/sqm (kg/sq cm)	0.6324 x 10 (pwr 6)	0.6324 x 10	0.6324 x 10	0.6324 x 10	0.6324 x 10	0.612x10	0.612x10
8	Coefficient of linear Expansion/ ° C	23.0 X10 (pwr -6)	23.0 X10	23.0 X10	23.0 X10	23.0 X10	23.0 X10	23.0 X10
9	Details of Aluminium							

S.N.	Parameter	Squirrel	Weasel	Rabbit	Racon	DOG	wolf	Panther
	Strands							
a	Minimum breaking load of the strand before	0.97	1.52	2.41	3.52	4.4	2.8	3.77
b	Minimum breaking load of the strand after stranding	0.92	1.44	2.29	3.34	4.18	2.66	3.58
c	Maximum DC resistance of strands at 20 deg C	10.653	6.845	4.29	2.938	2.345	3.677	2.746
d	Mass (kg/km)	8.482	13.25	21.04	30.78	38.48	24.51	32.92
e	Diameter							
i	Nominal	2.0	2.50	3.15	3.81	4.26	3.40	3.94
ii	Maximum	2.02	2.53	3.18	3.85	4.30	3.43	3.98
iii	Minimum	1.98	2.47	3.12	3.77	4.22	3.37	3.90

GUARANTEED TECHNICAL PARTICULARS (GTP)

Size of Conductor: 34 mm2 AAAC Weasel	Size of Conductor: 55 mm2 AAAC Rabbit	Size of Conductor: 100mm2AAACDog

Bidder has to confirm following important requirements.

Sl.No.	PARTICULARS				CONFIRMATION
A1	Conductor shall be manufactured as per IS-398 Part-IV/1994 or latest amendment of it.				
A2	Wooden drums shall be as per IS-1778/1980 with latest amendment, if any and shall be painted as per specification				
A3	Spacing between outer layer of conductor and inner surface of lagging shall be 75mm min.				
A4	Standard length shall be (a) 2000 meters for 34 mm2 & 55 mm2 and (b) 1100 meters for 100 mm2 sizes with 5% (five percent) tolerance.				
A5	Short length shall not be less than 50% of the standard length. Also such random / short length shall not exceed 5% (five percent) of the ordered quantity.				
A6	Maximum three numbers of random length shall be wound on any one drum.				
A7	Conductor shall have 7 Nos. of wires. And outer lay shall be right handed.				
A8	Drum Size shall be as per IS-1778/80 with Amendment No. I of 1989				
9	Properties of individual wires shall be as under:				
	Dia of wire Weasel Rabbit Dog				
	Nominal	2.5	3.15	4.26	
	Minimum	2.47	3.12	4.22	
	Maximum	2.53	3.18	4.30	
	Mass in kg/km	13.25	21.04	38.48	
	Min.BL after stranding	1.44	2.29	4.18	
	Res.at 20ºC (max)	6.845	4.290	2.345	
	App. overall diam. of complete stranded conductor in mm	7.50	9.45	12.78	
	App. mass in kg /km	94.00	149.20	272.86	
	Approx. calculated breaking load in KN	10.11	16.03	29.26	
	Calculated max. res. at 20ºC in ohms/km	0.990	0.621	0.339	
	Minimum lay ratio	10	10	10	
	Maximum lay ratio	14	14	14	

Sl.No.	PARTICULARS	CONFIRMATION
B1	BIS License number(Copy Enclosed)	
B2	Validity Up to	
B3	List of Plant & Machinery.	
B4	List of NABL approved test house calibrated Testing equipment.	

6. PCC Poles

As per State Practice.

7. Tubular Steel Poles for Overhead Lines

1 SCOPE:

This specification covers the general requirements towards design, manufacture, testing at manufacturers works, supply and delivery for tubular steel poles of circular cross section (swaged type) for overhead lines.

2 STANDARD:

The tubular steel poles shall conform to the latest edition of Indian Standard specification IS: 2713 (Part – I, III): 1980 or any other authoritative standards (as amended up-to-date) except where specified otherwise in this specification.

3 Topography and Climatic Condition:

The materials offered, shall be suitable for operation in tropical climate and will be subjected to the sun and inclement weather and shall be able to withstand wide range of temperature variation. For the purpose of design, average atmospheric temperature may be considered to be 50ºC with humidity nearing saturation.

4 Materials:

4.1 The materials used in construction of tubular steel poles shall be of the tested quality of steels of minimum tensile strength 540 MPa (: 55 Kgf/mm^2).

4.2 The materials, when analysed in accordance with IS: 228 (Part-III: 1972) and IS : 228 (Part-IX) shall not show sulpher and phosphorous contents of more than 0.060 percent each.

5 Types, Size and construction:

5.1 Tubular Steel Poles shall be swaged type.

5.2 Swaged poles shall be made of seamless or welded tubes of suitable lengths swaged and jointed together. No circumferential joints shall be permitted in the individual tube lengths of the poles. If welded tubes are used they shall have one longitudinal weld seam only: and the longitudinal welds shall be staggered at each swaged joint.

5.3 Swaging may be done by any mechanical process. The upper edge of each joint shall be chamfered if at an angle of about 45^{o}. The upper edge need not be chamfered if a circumferential weld is to be deposited in accordance with clause No. 5.3 2 of IS: 2713 (Part-I):1980.

5.4 The length of joints on swaged poles shall be in accordance with clause No. 5.4 of IS: 2713 (Par-I): 1980.

5.5. Poles shall be well-finished, clean and free from harmful surface defects. Ends of the poles shall be cut square. Poles shall be straight, smooth and culindrical. The weld joints, if any, shall be of good quality, free from scale, surface defects, cracks, etc.

5.6. Tolerances for outside diameter, thickness, length, weight and straightness shall be in accordance with IS: 2713 (Part-I) : 1980.

5.7. The poles shall be coated with black bituminous paint conforming to IS: 158-1968 throughout, internally and externally, upto the level which goes inside the earth. The remaining portion of the exterior shall be painted with one coat of red oxide primer as specified in IS: 2074-1979.

6 Earthing Arrangements:

For earthing arrangement a through hole of 14mm diameter shall be provided in each pole at a height of 300mm above the planting depth.

7 Tests and Test Certificates:

7.1 The following tests shall be conducted on finished poles :

A. Tensile test and chemical analysis for sulpher and phosphorous,
B. Deflocation test,
C. Permanent set test, and
D. Drop test.

7.2 In addition to above verification of dimensions as per IS: 2713 (Part-III) : 1980 shall be carried out during acceptance lots.

7.3 Number of poles selected for conducting different tests shall be in accordance to clause No. 10.1.1 and No. 10.1.12: of IS: 2713 (Part-I) 1980.

7.4 Tests shall be carried out before supply of each consignment at the manufacturers woks and test certificates should be submitted to the purchaser for approval prior to delivery.

7.5 Re-tests, if any, shall be made in accordance with IS: 2713 (Part-I) 1980.

7.6 Purchaser reserves the right to inspect during manufacturing and depute his representative to inspect/test at the works.

7.7 If any extra cost is required for carrying out the above specified tests, the same shall be borne by the manufacturer.

8 Marking:

8.1 The poles shall be marked with designation, manufacturer's identification, year of manufacture and name of the purchaser: Employer Name; RDSS

8.2 The poles may also be marked with the ISI certification mark.

9 Guaranteed technical particulars:

9.1 The manufacturer shall furnish all necessary guaranteed technical particulars in the prescribed Performa enclosed hereinafter.

10 Performance:-

10.1 The manufacturer shall furnish a list of the major supplies effected during the last 3 (three) years indicating the volume of supply and actual delivery dates.

10.2 Manufacturer may not be considered if the past manufacturing experience is found to be less that 3 (three) years.

11 Deviation:-

Any deviation in technical specification shall be clearly indicated with sufficient reasons thereof. Purchaser shall however reserve the right to accept and/or reject the same without assigning any reasons what-so-ever.

ANNEXURE –'A'

SPECIFIC TECHNICAL REQUIREMENTS FOR TUBULAR STEEL POLES : SWAGED TYPE

	9 meters long	**11 meters long**	**13 meters long**	**12 meters long**
1) Standard	IS: 2713 (Pat-I and III): 1980 as amended upto date			
2) Type of Pole	Swaged Type			
3) Designation	540 SP 28	540 SP 52	540 SP 72	410 SP 60
4) Overall Length	9 meters	11 meters	13 meters	12 meters
5) Planting depth	1.5 meters	1.8 meters	2.0 meters	2.0 meters
6) Height above ground	7.5 meters	9.2 meters	11.0 meters	10.0 meters
7) Effective length of Each section.				
a) Bottom	5.0 meters	5.6 meters	5.80 meters	5.80 meters
b) Middle	2.0 meters	2.7 meters	3.60 meters	3.10 meters
c) Top	2.0 meters	2.7 meters	3.60 meters	3.10 meters
8) Outside diameter and Thickness of each Section.				
a) Bottom	139.7x 4.50 mm	165.1x4.50 mm	219.1x5.90 mm	165.1x5.40mm
b) Middle	114.3x3.65 mm	139.7x4.50 mm	193.7x4.85 mm	139.7x4.50 mm
c) Top	88.9x3.25 mm	114.3x3.65 mm	165.1x4.50 mm	114.3x3.65 mm
9) Joint Length (in cm.):				
a) Bottom (J2)	30 cm.	35 cm.	45 cm.	35 cm.
b) Top (J1)	23 cm.	30 cm.	40 cm.	30 cm.
10) Approximate weight of Pole	113 Kg.	175 Kg.	343 Kg.	208 Kg.
11)Point of application of load below/top (mtr.)	0.3 mtr.	0.6 mtr.	0.6 mtr	0.6 mtr
12) Breaking load (inKgf)	478	567	1084	469
13) Working load with factor of Safety : 2.5 (in Kgf)	191	227	435	188

14) Crippling load (inKgf)	339	403	770	333
15) Load for permanent set Not exceeding 13mm (in Kgf)	232	276	527	228
16) Load for Temporary Deflection of 157.5 mm (in Kgf)	76	74	121	61
17) Tolerance	IS : 2713 (Part-I & Part-III): 1980			
18) Finish				
19) Manufacturing clause				

8. Hot rolled parallel flange steel sections for pole support, beams and columns

Parallel flange sections (WPS160 x 160 x 30.44 kg/m) and (WPS 160 x 23.83 kg/m) are hot rolled steel sections, with parallel or nearly parallel flange with square toes and curves at the root of flange and web as per IS12778: 2004.

This standard covers the nominal dimensions; mass and sectional properties of hot rolled parallel flange beams.

REFERENCES All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the following standards:

a) IS 2062:1999 Steel for general structural purposes — Specification (fifth revision)
b) IS 8500:1991 Structural steel — Micro alloyed (medium and high strength qualities) — Specification (first revision)
c) IS 12779:1989 Rolling and cutting tolerances for hot rolled parallel flange beam and cutting sections

Wide Parallel Flange Beams, WPB These are doubly symmetric shapes, generally used as beams or columns whose inside flange surfaces are substantially parallel. Beams or columns under the standard have nominal flange width same as depth up to nominal beam depth 300 mm. Beam depth larger than 300 mm have nominal flange width 300 to 400 mm. Columns may have flange widths more than the depths. Beams and column section are manufactured with heavy, medium and light flange and web thickness. Beams and columns are designated by nominal depth and nominal flange width and mass in kg/m. For example, WPB 600 x 300 x 128.79 would mean wide parallel flange beam having nominal depth 600 mm nominal flange width of 300 mm and

beam mass of 128.79 kg/m; WPB 360 x 370 x 136.20 would mean wide parallel flange columns having nominal depth of 360 mm and nominal flange width of 370 mm and a mass of 136.20 kg/m.

Nominal dimensions and mass of wide parallel flange beams shall conform to the values given in Tables 1 to 3, respectively of the standard IS12778: 2004.

Sectional properties of the beam are given in Tables 1 to 3 of IS12778: 2004. Steel grades - Material strength of steel sections shall be conforming to IS 2062 for mild steel and IS 8500 for medium and high strength steel. Dimensional and mass tolerances of the various sections shall conform to the appropriate values stipulated in IS 12779.

Product shall be tested in NABL accredited laboratory of M/S RITES for relevant properties or the test certificate be issued by manufacturer for Parallel Flanged Section WPB 160 as per IS 2062 after testing license from BIS.

9. Hot Rolled Steel Beams (Joists)

1. SCOPE :-

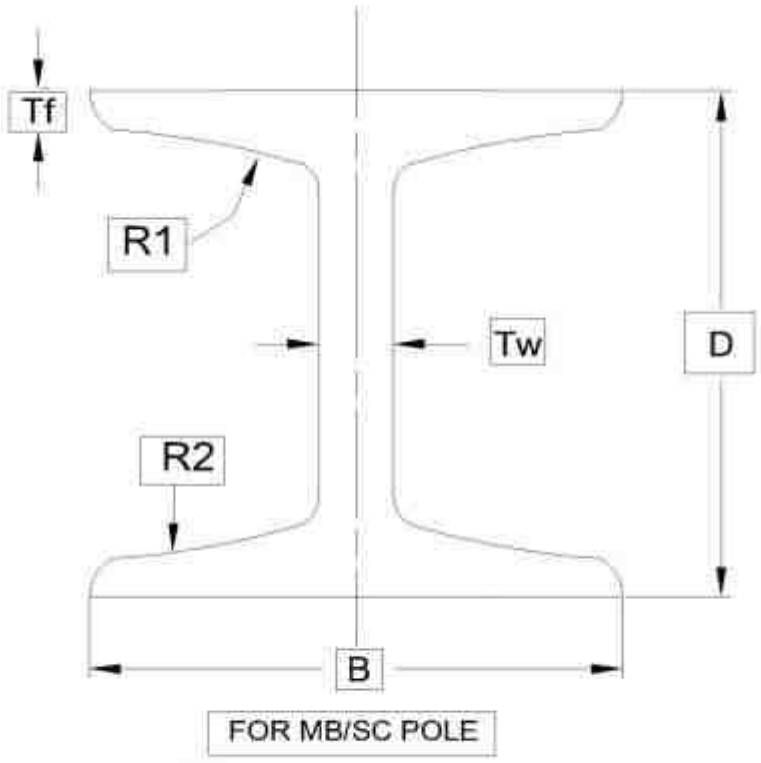
Specification covers the manufacture, testing at works and supply of various sizes of Hot rolled steel beams.

2. APPLICABLE STANDARDS:

The Mild shall be conforming to IS:2062 – 1992 GRADE ' A ' modified upto date or its equivalent international standard for steel materials, document for which shall be made available at the time of inspection to the Employer's representative. The dimensions of Hot Rolled Steel Beams shall be conforming to IS: 808 / 1989 amended upto date andtolerance as per IS : 1852 modified upto date.

3. GENERAL REQUIREMENTS :

Material shall be supplied as per the sizes and technical details as per following requirements and drawing.



FOR MB/SC POLE

Note: 1) All Dimensions are as per annexure-I
2) Drawing is not to the scale

GUARANTEED TECHNICAL PARTICULARS

RSJ POLE/HDG RSJ POLE

Sr. No.	Particulars	Employer's Requirement/ To be offered by the Bidder				
1.	Designation (DxB) (mm x mm)	116x100	MB 125x70	MB 175x85	SC 152x152	UC 152x152
2.	Length of joist-Meter with ±100 mm tolerance	9m/10m/ 11m/13m	8m/9m	9m	11m/13m	11m/13m
3.	Weight (kg/M)	23.0	13.3	19.6	37.1	37.0
4.	Sectional area (A) (Sq.cm.)	29.3	17.0	25.0	47.4	47.11
5.	Depth of section (D) (mm)	116	125	175	152	161.8
6.	Width of flange (B) (mm)	100	70	85	152	154.4
7.	Thickness of flange (Tf) (mm)	10	8	9	11.9	11.5
8.	Thickness of Web (Tw) (mm)	8.5	5	5.8	7.9	8.0
9.	Radius of fillet or root (R1)(mm)	15	9	10	11.7	7.6
10.	Radius of tow (R2) (mm)	3	4.5	5	3	--
11.	Moment of Inertia (i) Ixx (cm^4) (ii) I yy (cm^4)	 643.8 143.5	 445 38.5	 1260 76.7	 1970 700	 2210 706.2
12.	Radius of Gyration GR xx (cm)	4.69	5.16	7.13	6.45	6.85
13.	Modulus of Section (i)Z xx (cm^3) (ii)Z yy (cm^3)	 111 28.7	 71.2 11	 144 18	 259 91.9	 273.2 91.48
14.	Tolerance in dimensions and weight	---------- As per IS: 1852 Updated ----------				

10. Mild Steel Channel, Angle And Flat

1) APPLICABLE STANDARDS:

The mild steel shall conform to IS: 2062 grade 'a' modified upto date or equivalent international standard for steel materials, documents for which shall be made available at the time of inspection to the owner's representative.

2) GENERAL REQUIREMENTS:

Material shall be supplied as per the following sizes:
100x50 ISMC channel conforming to IS: 2062 grade 'a' modified upto date or its equivalent International Standard having length ranging from 5.5 to 13.5 meters. 75x40 ISMC channel conforming to IS: 2062 grade 'a' modified upto date or its equivalent International Standard having length ranging from 5.5 to 135 meters.
50x50x8 mm or 6 mm ISA angles conforming to IS: 2062 grade 'a' modified upto date or its equivalent international standard having length ranging from 5.5 to 13.5 meters.
45X45X5 mm ISA angles conforming to IS: 2062 grade 'a' modified upto date or its equivalent international standard having length ranging from 5.5 to 13.5 meters.
60x65x6 mm ISA angles conforming to IS: 2062 grade 'a' modified upto date or its equivalent international standard having length ranging from 5.5 to 13.5 meters.
25X3mm, 50X6mm, 50x8mm, 75X8mm and 80X8 flats conforming to IS: 2062 grade 'a' modified upto date or its equivalent international standard having length ranging from 5.5 to 9.5 meters.

3) GALVANISATION:

All above steel members shall be fabricated as per approved drawing having smooth edge, drilled circular/elliptical holes of suitable measurements.
All structural steel members and bolts shall be galvanized as per IS:4759 and zinc coating shall not be less than 610gm/sq. meter for all structural steel members. All weld shall be 6mm filled weld unless specified otherwise. All nuts and bolt shall be of property class 5.6 of IS 1367. Plain washers shall be as per IS 2016 and spring washers shall be IS:3063

4) INSPECTION:

All inspection/test will be carried out by representative of owner.
All tests and inspection shall be made at the place of manufacturer unless otherwise specially agreed upon by the manufacturer and the owner. The manufacturer shall provide all reasonable facilities, without charge to satisfy him that the material is being supplied in accordance with the specification.

11. 11 & 33 KV Outdoor Type Current Transformer

4.1 INTRODUCTION

This section covers the specification of 33 kV and 11kV Current Transformer suitable for outdoor service. Any other parts not specifically mentioned in this specification but otherwise required for proper functioning of the equipment should be included by the tender in the offer. The CTs should normally be installed above VCB. The VCB & CT should be installed on common mounting structure. In places, where VCB are not provided in the Substation separate CT mounting structure shall be provided with CTs.

4.2 APPLICABLE STANDARDS

Unless otherwise modified in this specification, the Current Transformer shall comply with the latest version of relevant standards (IS 2165, IS 2705(I-IV), IS 2099, IS 5621, IS 2071, IS 335, IS 13947(part I), IEC 185, IEC 270, IEC 44(4), IEC 171, IEC 60, IEC 8263, IEC 815, Indian electricity Rules 2003) or better international standards. This list of standards is for guidance only. The contractor shall be solely responsible to design & manufacture the CT suitable for 33kV & /11 kV systems.

4.3 AMBIENT CONDITIONS

The CT supplied against these specifications shall be suitable for satisfactory continuous operation under the tropical conditions. The detail condition is mentioned in General Technical requirement.

4.4 SYSTEM PARTICULARS

a)	Nominal System Voltage	33kV & 11kV
b)	Highest system Voltage	36kV & 12kV
c)	Rated Frequency	50Hz & 50Hz
d)	No of phases	Three & Three
e)	System neutral earthing	-Solidly Earthed-
f)	One minute Power Freq. withstand voltage (rms)	70kV & 28kV
g)	Lighting Impulse withstand Voltage	170kVp & 75kVp

i) System fault level -25kA for 3sec-

4.5 TECHNICAL PARAMETERS OF CT

a)	Type	Single phase, dead tank, outdoor,oil filled & hermetically sealed
b)	Type of mounting	Pedestal type
c)	Rated primary current	As per BPS
d)	Rated Continuous thermal current Primary current	120 % of rated
e)	Rated short time withstand Requirement for sec. Winding	As per IS 2705 Pt. I
f)	Rated short time withstand Current	25kA(RMS)
	i) Duration (for primary current of 150amps and above)	3Sec
	ii) Duration (for primary current below 150amps)	1Sec
g)	Rated dynamic withstand Current (KA rms)	62.5
h)	Max temp rise	As per IEC-185/ IS 2705
i)	Minimum creepage distance of porcelain housing(mm)	25 mm /KV
j)	One minute power frequency Withstand voltage between Secondary terminal & earth	3 kV
k)	Detail of Secondary Cores	Metering Protn.
	Current ratio	(As per BPS)
Accuracy class		0.5 5P10
Burden (VA)		30 30

Instrument security Factor	≤5	-
Accuracy Limit Factor	-	≥10

Note: The ratings indicated for instrument transformer are tentative only and may be changed to meet the requirements.

4.6 PORCELAIN HOUSING

It shall be single piece of homogeneous, vitreous porcelain of high mechanical & dielectric strength. It will be glazed with uniform Brown or Dark brown colour with smooth surface finish. The creepage distance for the porcelain housing shall be at least 25 mm per kV.

4.7 WINDING

1 PRIMARY WINDING

It shall be made of high conductivity rigid copper wire. The primary winding current density shall not exceed the limit of 1.6 Amp per sq. mm for normal rating.

The design current density for short circuit current as well as conductivity of metal used for primary winding shall be as per IS 2705. The calculation for the selection of winding cross section shall be furnished by contractor.

The primary terminal shall be of maximum* size of 30 mm dia x 80 mm length of heavily tinned (min. thickness 15 micron) electrolytic copper of 99.9 % conductivity. Manufacturer shall design the diameter of primary terminal keeping current density 1.6A per sq. mm for the given capacity of CT.*

*Amendment issued vide letter No. REC/DDUGJY/SBD/2017/2148 Dated 21.07.2017.

2 SECONDARY WINDING

shall be made of insulated copper wire of electrolytic grade. Type of insulation used shall be described in the offer. For multi ratio design, the multi ratio will be achieved by reconnection of the primary winding or secondary winding. The excitation current of the CT shall be as low as possible. The contractor shall furnish the magnetization curves for all the cores.

The terminal box shall be dust free & vermin proof. The size of the terminal box shall be big enough to enable easy access and working space with the use of normal tools.

The secondary terminals studs shall be provided with at least 3 nuts and two plain washers, these shall be made of brass duly nickel plated. The min. stud outer dia shall be 6 mm & length 15 mm. The min spacing between the centres of the adjacent studs shall be 1.5 time the outer dia of the stud.

3 POLARITY

The polarity shall be marked on each CT at the primary and secondary terminals.

4.8 TANK & HARDWARES

The CT will be dead tank type. The tank shall be fabricated of MS steel sheet of min. 3.15 mm for sides & 5 mm for top & bottom. The tank will be finished with min. 2 coats of zinc rich epoxy paint externally. The inner surface shall be painted with oil resistance white enamel paint.

All ferrous hardwares, exposed to atmosphere shall be hot dipped galvanized.

4.9 INSULATION OIL

The first filling of oil in CT shall be in contractor's scope. The oil shall be as per IS 335.

To ensure prevention of oil leakage, the manufacturer will give following details supported by drawings:

i) Location of emergence of Primary & Secondary terminals

ii) Interface between porcelain & metal tanks

iii) Cover of the secondary terminal box

Any nut & bolt and screw used for fixation of the interfacing porcelain bushing for taking out the terminals shall be provided on flanges cemented to the bushings & not on the porcelain.

If gasket joints are used, Nitrite Butyl Rubber gasket shall be used. The grooves shall be machined with adequate space for accommodating gasket under pressure.

The CT shall be vacuum filled with oil after processing. It will be properly sealed to eliminate breathing & to prevent air & moisture from entering the tank. The sealing methods/arrangement shall be described by the contractor & be approved by the owner.

4.10 OIL LEVEL INDICATOR

The CT shall be fitted with prismatic type oil sight window at suitable location so that the oil level is clearly visible with naked eye to an observer standing at ground level.

To compensate oil volume variation due to temperature variation, Nitrogen cushion or the stainless steel bellows shall be used. Rubber diaphragms are not permitted for this purpose.

4.11 EARTHING

Two earthling terminals shall be provided on the metallic tank of size 16 mm dia & 30 mm length each with one plain washer & one nut for connection to the station earth mat

4.12 Junction Box

The junction box shall be of MS sheet having thickness of 2mm, synthetic enamel painted as per procedure mentioned in General Technical Requirement (Min. thickness 55 micron). The shade of junction box shall be 697 of IS: 5. Disconnecting type terminal blocks for CT secondary lead shall be provided. The junction boxes shall be weather proof type with gaskets, as per section-I (Introduction and general technical requirements) conforming to IP-55 as per IS-13947 (Part-I).

4.13 LIFTING & MOUNTING ARRANGEMENT

The CT shall be provided with two lifting eyes to lift the CT. This shall be so positioned so as to avoid any damage to the CT during lifting for instillation or transportation purpose. This shall be detailed in General Arrangement drawing.

The CT shall be of pedestal mounting type suitable for outdoor installation on steel/cement concrete structures. All the clamps, bolts, nut and washers etc. required for mounting the CT on the structure shall be supplied along with the CT and shall be galvanized. The contractor shall supply all the terminal connectors etc. required for connection to the CT.

4.14 TESTING

All Type and Routine Tests shall be as per relevant IS and/or IEC.

GUARANTEED TECHNICAL PARTICULARS OF CURRENT TRANSFORMER

Sl.No.	Particular of GTP Parameter	Bidders Confirmation	
		33kV CT	11kV CT
1	Manufacturer's Name & address		
2	Type of equipment		
3	Type of Mounting		

Sl.No.	Particular of GTP Parameter	Bidders Confirmation	
		33kV CT	11kV CT
4	Equipment Conforming to Standards		
5	Rated Voltage / Highest System Voltage in KV		
6	Rated Primary Current (Amp)		
7	Rated Secondary Current (Amp)		
8	Frequency (HZ)		
9	Ratio of Current Transformer		
10	Details of Cores		
i)	Number of Cores		
ii)	Purpose		
iii)	Burden (VA)		
iv)	Class of Accuracy		
11	Rated Short Time Withstand Current for 1 Sec. duration		
12	Rated Dynamic Withstand Current (KAp)		
13	Method of Earthing system to be connected to		
14	One-minute Dry Power Frequency Withstand Voltage (KV rms) of Primary Winding		
15	One-minute Wet Power Frequency Withstand Voltage (KV rms) of Primary Winding		
16	1.2/50 micro-second Impulse Withstand Voltage (KVP)		
17	The die-electric Withstand values (KVp)of external & internal insulation		
18	One minute Power Frequency Withstand Voltage (KV rms) of Secondary Winding		
19	Minimum Creepage Distance (mm)		
20	Weight of oil (kg/Ltrs.)		
21	Total Weight (kg)		
22	Mounting details		
23	Overall dimension		
24	Type of Winding		
25	Material of Winding		
26	Size & Cross Section of Primary Winding		
27	Size & Cross Section of Secondary Winding		
28	No. of Primary Turns		
29	No. of Secondary Turns		
30	Current Density of Primary & Secondary Winding (max. – 1.6A/sq.mm)		
31	Primary Terminal		
32	Type of Insulation		
33	Whether Current Transformer confirms to Temperature Rise		

12. 33 & 11 kV Outdoor Type Potential Transformer

1 INTRODUCTION

This chapter covers specification of 33kV and 11kV Potential Transformer suitable for outdoor service. Any other parts not specifically mentioned in this specification but otherwise required for proper functioning of the equipment should be included by the tender in the offer.

2 APPLICABLE STANDARDS

Unless otherwise modified in this specification, the Potential Transformer shall comply with the latest version of relevant standards (IS 3156, IS 2099, IS 5621, IS 335, IS 13947(Part I), IEC 186, Indian electricity Rules 2003, IEC 815) or better international standards. This list of standards is for guidance only. The contractor shall be solely responsible to design & manufacture the PT suitable for 33 kV/11kV systems.

3 AMBIENT CONDITIONS

The PT supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as detailed in general technical requirement.

4 SYSTEM PARTICULARS

a)	Nominal System Voltage	33kV	11kV
b)	Highest system Voltage	36kV	12kV
c)	Rated Frequency	50Hz	50Hz
d)	No of phases	Three	Three
e)	System neutral earthing	---Solidly Earthed--	
f)	One minute Power Freq. Withstand voltage (rms)	70kV	28kV
g)	Lighting Impulse withstand Voltage	170kVp	75kVp
h)	System fault level	---25 kA for 3sec---	

5 TECHNICAL PARAMETERS OF PT

a)	Rated primary Voltage	36 KV	12 KV

b)	Type	Single phase potential transformer	
c)	Voltage/ Ratio(kV)	33/0.11	11/0.11
d)	Rated voltage factor	1.2continuous	1.5 – 30seconds-
e)	One minute power freq. Withstand voltage for		
	Primary Terminals	70 kV(rms)	28 kV
	Secondry winding	36 kV	12 KV
f)	Min. Creepage Distance	25 mm/kV of Highest System Voltage	
g)	Detail of secondaries	Core I	Application Metering
	Accuracy	0.5	0.5
	Burdan (VA)	100	100

Note: The ratings indicated for instrument transformer are tentative only and may be changed to meet the requirements.

6 PORCELAIN HOUSING

It shall be single piece of homogeneous, vitreous porcelain of high mechanical & dielectric strength. It will be glazed with uniform Brown or Dark brown colour with smooth surface finish. The creepage distance for the porcelain housing shall be at least 25mm per kV.

The contractor shall clearly detail in his bid the details of attaching the metallic flange to porcelain, pressure release valve and also how primary & secondary terminals shall be brought out.

7 WINDING

PRIMARY WINDING

It shall be made of insulated electrolytic copper wire. The neutral end of the winding shall be brought outside for earthing.

The primary terminal shall be of standard size of 30 mm dia x 80 mm length of heavily tinned (min. thickness 15 micron) electrolytic copper of 99.9 % conductivity.

SECONDARY WINDING

It shall be made of insulated copper wire of electrolytic grade. The terminal box shall be dust free & vermin proof. The size of the terminal box shall be big enough to enable easy access and working space with the use of normal tools.

The secondary terminals studs shall be provided with at least 3 nuts and two plain washers. These shall be made of brass duly nickel plated. The min. stud outer dia shall be 6* mm & length 15 mm. The min spacing between the centres of the adjacent studs shall be 1.5 time the outer dia of the stud.

*Amendment issued vide letter No. REC/DDUGJY/SBD/2017/2148 Dated 21.07.2017.

POLARITY

The polarity shall be marked on each PT at the primary and secondary terminals.

8 TANK & HARDWARES

It shall be fabricated of MS steel sheet of min. 3.15 mm for sides & 5 mm for top & bottom. The tank will be finished with min. 2 coats of zinc rich epoxy paint externally. The inner surface shall be painted with oil resistance white enamel paint.

All ferrous hardwares, exposed to atmosphere shall be hot dipped galvanized.

9 INSULATION OIL

The first filling of oil in PT shall be in contractor's scope. The oil shall be as per IS 335.To ensure prevention of oil leakage, the manufacturer will give following details supported by drawings:

i) Location of emergence of Primary & Secondary terminals

ii) Interface between porcelain & metal tanks

iii) Cover of the secondary terminal box

Any nut & bolt and screw used for fixation of the interfacing porcelain bushing for taking out the terminals shall be provided on flanges cemented to the bushings & not on the porcelain.

If gasket joints are used, Nitrite Butyl Rubber gasket shall be used. The grooves shall be in machined with adequate space for accommodating gasket under pressure.

The PT shall be vacuum filled with oil after processing. It will be properly sealed to eliminate breathing & to prevent air & moisture from entering the tank. The sealing methods/arrangement shall be described by the contractor & be approved by the owner.

10 OIL LEVEL INDICATOR

The PT shall be fitted with prismatic type oil sight window at suitable location so that the oil level is clearly visible with naked eye to an observer standing at ground level.

To compensate oil volume variation due to temperature variation, Nitrogen cushion or the stainless steel bellows shall be used. Rubber diaphragms are not permitted for this purpose.

11 EARTHING

Two earthling terminals shall be provided on the metallic tank of size 16 mm dia & 30 mm length each with one plain washer & one nut for connection to the station earth mat

12 Junction Box

The junction box shall be of MS sheet having thickness of 2mm, synthetic enamel painted as per procedure mentioned in General technical Requirement (Min. thickness 55 micron). The shade of junction box shall be 697 of IS: 5. Disconnecting type terminal blocks for PT secondary lead shall be provided. The junction boxes shall be weather proof type with gaskets as per section-I (Introduction and general technical requirements) conforming to IP-55 as per IS-13947 (Part-I).

One junction box shall be provided for 3 numbers of single phase CT's and PT's.

13 LIFTING & MOUNTING ARRANGEMENT

The PT shall be provided with two lifting eyes to lift the PT. This shall be so positioned so as to avoid any damage to the PT during lifting for installation or transportation purpose. This shall be detailed in General Arrangement drawing.

The PT shall be of pedestal mounting type suitable for outdoor installation on steel/cement concrete structures. All the clamps, bolts, nut and washers etc. required for mounting the PT on the structure shall be supplied along with the PT and shall be galvanized. The contractor shall supply all the terminal connectors etc. required for connection to the PT.

14 TESTING

All Type and Routine Tests shall be as per relevant IS and /or IEC.

GTP to be submitted by the Bidder

Description	Particulars	
Name of the manufacturer		
Factory address		
Equipment		
Reference Standard		
Type		
Rated voltage		
Highest voltage		
Frequency		
Basic Insulation Level		
Class of insulation		
Creepage distance		
Ratio		
Class of accuracy	Core - I : , Core - II :	
Burden	Core - I : , Core - II :	
Voltage factor		
Core identification	Core - I : , Core - II :	
Place of installation		
Material & size of Primary Stud		
Material & size of Secondary Stud		
Primary terminal connector		
Fixing hole centre distance		
Painting process		
Paint shed		
IP of Secondary Terminal Box		
Weight of oil		
Volume of oil		
Height of PT		
Total weight of PT		
Guarantee		
Type Test Report	Tested at	Date of Test
a. High voltage Power frequency wet withstand voltage test		
b. Lightning impulse voltage withstand test		
c. Temperature rise Test		
d.Determination of error.		

13. Control & Relay Panel for 33 kV Feeder with Directional or Non-directional O/C and E/F protection and 33/11 kV Transformer Panel with & without Differential Protection for various 33/11 kV Sub-Stations

1.0 Scope:

This specification covers design, manufacture, assembly, testing before supply, inspection, packing and delivery and other basic technical requirements in respect of control and relay panels for 33 kV feeders, 33/11KV Power Transformers without differential protection and 33/11KV Power Transformers with differential protection to be installed at various 33/11 kV sub-stations. The equipment to be supplied against this specification is required for vital installations where continuity of service is very important. The design, materials and manufacture of the equipment shall, therefore, be of the highest order to ensure continuous and trouble-free service over the years. The Manufacturer has to design the Schematics for protection and Control of all equipment including monitoring indications, visual and audible alarm, interlocking schemes among different equipment. Any other requirement which are not specifically covered here but which are necessary for successful commissioning of the Sub stations are also within the scope of the Contract.

The equipment manufactured should conform to the relevant standards and of highest quality of engineering design and workmanship. The equipment manufactured shall ensure satisfactory and reliable performance throughout the service life. The Schedule of requirement of the Panel is furnished separately in details.

2.0 Service Conditions:

2.1. System particulars:

Nominal system voltage	33 kV & 11 kV
Corresponding highest system voltage	36 kV & 12 kV
Frequency	50 Hz±3%
Number of phases	3
Neutral earthing	33 kV Grounded through Earthing Transformer 11 kV solidly earthed

2.2. Equipment supplied against the specification shall be suitable for satisfactory operation under the following tropical conditions:-

Max. ambient air temperature	60 ° C
Max. relative humidity	100 %
Max. annual rainfall	1450 mm
Max. wind pressure	150 kg/sq.m.
Max. altitude above mean sea level	1500 mtrs.
Isoceraunic level	50
Reference Ambient Temperature for temperature rise	50 deg C
Climatic Condition	Moderately hot and humid tropical climate conducive to rust and fungus growth

2.3. The climatic conditions are prone to wide variations in ambient conditions and hence the equipment shall be of suitable design to work satisfactorily under these conditions.

2.4. Auxiliary supplies available at the various sub-stations are as follows:-

3.2.1 Rating:

i.	A. C. Supply	230 volts, with ± 10% variation, Frequency 50Hz with ±3%
ii	D.C. Supply	30 V DC. DC system is 2(two) wire with necessary earth fault annunciation scheme. DC supply shall be normally fed from Battery charger. In case of failure of AC supply to Battery Charger, DC supply voltage will be available from Lead Acid Battery.

2.5. Unless otherwise specified all equipment and material shall conform to the latest IS applicable standards. Equipment complying with other internationally recognized standards will also be considered if it ensures performance equivalent or superior to Indian standards. In the event of supply of equipment conforming to any international \ internationally recognized standards other than the standard listed below.

2.6. The equipment provided shall also comply with the latest revisions of Indian Electricity act and Indian Electricity rules and any other applicable statutory provisions, rules and regulations.

2.7. All equipment provided under the specification shall generally conform to the latest issue of the following :-

a)	IS 12063/1987	Degree of Protection provided for enclosure of electrical equipment.
b)	IS 5/2004	Colour for ready mixed paints & enamels.
c)	IS 3231 / 1986 & 1987	Electrical relays for power system protection
d)	IEC 60255	Numerical biased protection relay
d)	IS 8686/1977	Static Protective Relays
e)	IS 1248/2003	Indicating instruments
f)	IS 14697/1999	HT Static Tri vector TOD Energy meter
g)	IS 6875 amended up to date	Control switches
h)	IS 4794/1968 & 1986	Push buttons
i)	IEC 337 &337-1	Control Switches (LV Switching devices for control and auxiliary circuit)
j)	IEC:60185	Current Transformers
k)	IEC:60186	Voltage Transformer
l)	IS 375	Marking and arrangement for Switchgear Bus
m)	IS:5578/1984	Marking of insulated conductors.

2.8. CT, PT Ratio and Transformer Details:-

CIRCUIT	**33KV CT RATIO/CLASS**
33Kv Feeder	400-200/1-1 A 0.5,5P20
33kv side of 33/11kv transformer	400-200/1-1-1A, for 10 &12 MVA 0.5/5P20/PS and 200-100/1-1A For up to 6.3 MVA Tr. 0.5/5P20
	600-400/1-1-1A, 0.5/5P20/PS at phase side (Indoor

11KV side CT for 6.3MVA & 10MVA Transformer	Panel)
11KV transformer Bushing CT for REF	600/1A, PS for 10 MVA 33/11KV transformer for both Phase & neutral. 400/1A, PS for up to 6.3 MVA 33/11KV transformer for only neutral.
33 KV PT RATIO	33KV, single phase
Electro-magnetic PT Ratio/Class	33KV/√3, 110V/√3-110V/√3 ,0.5/3P
TRANSFORMER DETAILS	33/11KV,up to 12 MVA, Dyn11

3.0 CONSTRUCTIONAL DETAILS :

3.1. CONTROL AND RELAY PANEL

The Control and Relay Panel shall be of Simplex type and the access door shall be provided at the back of each Panel where no instruments or relays shall be mounted. The indicating and signaling devices and relays etc. shall be mounted on the front side and the auxiliaries which shall be inside the Panel. The access door shall be at the back side and of double door type of height 1900 mm.

In front of Panel where relays and instruments are to be mounted shall be stretcher leveled steel plate 3 mm. thick and side panel, doors and top covers shall be of 2mm. thick steel plate. Light sections of structural steel shall be used for panel frame.

The individual panel shall be 2250 mm. in height with Channel base, 610 mm. in depth and of suitable width limited to 1000mm to accommodate the equipment at a suitable height, suitable gaps to facilitate easy workability as specified hereafter. Individual piece of Channel base of C&R Panel is to be provided to obtain the flexibility of inter-changing the Panel, if any.

The complete panel shall incorporate all necessary instruments, meters, relays, auxiliary relays, control switches, indicating lamps, mimic, annunciator, audible alarms, horizontal and vertical wiring trough, wiring supports, interior lighting system, terminal blocks , fuses and links etc.

3.2. CONSTRUCTIONAL FEATURES

a. The Control and Relay Panel frame shall be suitable for erection of flush concrete floor and secured to it by means of evenly spaced grout bolt projecting through the base channels from members of the frame.

b. The manufacturer shall ensure that the equipment specified and such unspecified complementary equipment required for completeness of protection/control scheme be properly accommodated in the panels without congestion and if necessary to provide panels with larger width. No price increase at a later date on this account shall be allowed.

c. Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof for tropical use. The enclosure shall provide a degree of protection not less than IP-41 in accordance with IS-2147. Type test report in this respect shall be furnished with offer.

d. Panels shall be free standing, floor mounting type and shall comprise structural frames enclosed completely with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of panels such as base frame, front sheets and door frames and not less than 2mm for sides, door, top & bottom portions. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation and installation.

e. Design, material selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, rivets or bolt head apparent front outside, with all exterior surfaces tune and smooth.

f. All holes and extension windows in the Panel shall be blanked and access doors shall be lined with compressible liners at the edges. The EMPLOYER will shut off the bottom crevices with cream cement, the Cable Entry holes with weak concrete and the cable trench with present R.C. Slabs or checker plate. All control and supply cables will be laid in a distribution trench running under the panel . The Cable will branch off into each cubicle through entry holes in the concrete floor opening in the bottom cubicles. Necessary Drawings for concrete floor and trench shall be supplied by the manufacturer to enable the EMPLOYER to construct the foundation floor for these panels. The drawings shall show details of the distributing trench, cable entry holes, glands and positions of grouting bolts. The EMPLOYER will prepare foundation with pocket for grouting bolts. The manufacturer shall supply channel base, suitable grouting bolts, lock nut and washers.

g. Control Cable entries to the panel shall be from the bottom. Bottom plates of the panels shall be fitted with detachable gland plates to allow cable entries from the bottom. Gland plates shall be suitable for fixing the cable glands at an elevated height of at least 100 mm above the ground level. Terminal Connectors and Test terminal blocks for cables shall be fixed at an elevated height of at least 200 mm above the Bottom plate. Side blocks cut out to be arranged at the top of both sides of panel for inter panel bus wires. Dimensions of the cut out will be 300 mm X 50 mm , 255 mm from the top.

3.2.1 General :

a. Materials shall be new; the best quality of their respective kinds and such as are usual and suitable for work of like character. All materials shall comply with the latest issues of the specified standard unless otherwise specified or permitted by EMPLOYER.

b. Workmanship shall be of the highest class throughout to ensure reliable and vibrations free operations. The design, dimensions and materials of all parts shall be such that the stresses to which they may be subjected shall not cause distortion, undue wear, or damage under the most severe conditions encountered in service.

c. All parts shall conform to the dimensions shown and shall be built in accordance with approved drawings. All joints, datum surfaces and meeting components shall be machined and all castings shall be spot faced for nuts. All machined finishes shall be shown on the drawings. All screw, bolts, studs and nuts and threads for pipe shall conform to the latest standards of the International Organization for Standardization covering these components and shall all conform to the standards for metric sizes.

d. All materials and works that have cracks, flaws or other defects or inferior workmanship will be rejected by EMPLOYER.

3.2.2 Assembly :-

Necessary items of equipment shall be assembled in the factory prior to shipment and routine tests shall be performed by the manufacturer as per the requirements of the latest issue of IEC/IS as specified under each equipment in these specifications to demonstrate to the satisfaction of EMPLOYER that the switchgear panels comply with the requirements of the relevant IEC/IS standards.

3.2.3 Casting :-

Casting shall be true to pattern, of workmanlike finish and of uniform quality and condition, free from blowholes, porosity, hard spots, shrinkage defects, cracks or other injurious defects, shall be satisfactorily cleaned for their intended purpose.

3.2.4 Welding:-

Wherever welding is specified or permitted, a welding process, including stress relieve treatment as required if necessary, conforming to an appropriate and widely recognized professional standard shall be used. All welders and welding operators shall be fully qualified by such a standard.

4.0 Mounting

9.1 All equipment on and inside the panels shall be mounted and completely wired to the terminal blocks ready for external connection.

9.2 Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking shall be clearly visible and of permanent nature.

9.3 The manufacturer shall carry out cutout, mounting and wiring of the bought out items which are to be mounted in the panel in accordance with the corresponding equipment manufacturer's drawings.

9.4 The centre line of switches, push buttons and indicating lamps shall be not less than 750 mm from the bottom of the panel. The centre line of relays and meters and recorders shall be not less than 450 mm from the bottom of the panel.

9.5 The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Likewise the top of all meters, relays and recorders etc. shall be in one line.

9.6 The control switches for circuit breakers shall be located on the mimic diagram corresponding to their exact position of the controlled equipment in the single line drawing. The location of the switches shall be within working height from the floor level for easy and comfortable operation.

9.7 No equipment shall be mounted on the doors.

9.8 All the equipment connections and cabling shall be designed and arranged to minimise the risk of fire and damage.

The constructional details and mounting arrangement for various front mounted equipments shall be as per the enclosed drawings. The center lines of any relays, if additionally provided, shall not be less than 450 mm from ground level.

5.0 WIRING

5.1 All wiring shall be carried out with 1100 volts grade single core, multistrand flexible tinned copper wires with PVC insulation which has provided its utility in tropical region against hot and moist climate and vermin (Misc. white ant and cockroaches etc.) Rubber insulated wiring will not be accepted. Wire numberings and colour code for wiring shall be as per IS:5578/1984. The wiring should be encased in suitable width PVC casing. The wiring diagram for various schematics shall be made on thick and laminated durable white paper in permanent black ink and same should be pasted on the inside surface of the door.

5.2 The sizes of wiring in different circuit shall not be less than these specified below:

TABLE-I

Circuit	**Permissible size of wire**
Metering and Relaying Circuits connected Current Transformer	2.5 mm²
Potential Circuits for metering and Relaying, Control, Visual Audible Alarms and Signalling Circuit	1.5 mm²

The following colour schemes shall be used for the Wiring:

TABLE – II

Circuit where used	**Colour of Wire**
Red Phase of Instrument Transformer	Red

Circuits	
Yellow Phase of Instrument Transformer Circuits	Yellow
Blue Phase of Instrument Transformer Circuits	Blue
Neutral connection, earthed or not earthed in the instrument Transformer Circuit	Black
A.C. Control Wiring Circuits using auxiliary supply and	Black
D.C. Control Wiring Circuit using Battery Supply	Grey
Earth Connection	Green

5.3

a) All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & trough shall be used for this purpose.

b) Longitudinal troughs extending throughout the full length of the panel shall be used for inter panel wiring. Inter connections to adjacent panels shall be brought out to a separate set of terminal blocks wires. All bus wiring for inter panel connection shall preferably be provided near the top of the panels running throughout the entire length of the panels.

c) Wiring connected to the space heaters in the cubicles shall have porcelain beaded insulation over a safe length from the heater terminals.

d) Wire termination shall be made with solder less crimping type and tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided to all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected for any purpose. Termination shall be such that no strand of a conductor shall left loose or overhanging. Conductor termination shall be secured to the holding nuts/screws, terminal blocks etc. with washers interposed between the terminals/holding nuts/screw heads. The terminals shall be so connected that no conductor ferrule code gets masked due to overlay of conductors.

e) All spare contacts of relays shall be wired up to terminal blocks.

f) Each wire shall be continuous from end to end and shall not have any joint within itself individually.

g) Wires shall be connected only at the connection terminals or studs of the terminal blocks, meters, relays, instruments and other panel devices.

Terminal Ends of all wires shall be provided with numbered Ferrules. At point of inter-connection where a change of number is necessary, duplicate Ferrules shall be provided with the appropriate numbers on the changing end.

h) At the terminal connection, washers shall be interposed between terminals, wire terminals and the holding nuts. All holding nuts shall be secured by locking nuts. The connection stud shall project at least 6 mm from the lock nut surface. Wire ends shall be so connected at the terminal studs that no wire terminal numbered ferrule gets masked due to succeeding connections. All wires shall be suitable for bending to meet the terminal stud at right angles with the stud axis, and they shall not be skewed.

i) All studs, nuts, bolts screws etc. shall be threaded according to the British Standard practice unless EMPLOYER's prior approval to any other practice of threading is obtained.

6.0 TERMINAL BLOCK CONNECTION

Terminal blocks shall be of clip-on design made out of non-trackable insulating material of 1100 V grade. All terminals shall be stud type, with all current carrying and live parts made of tinned plated brass. The studs shall be of min 4 mm dia brass. The washers, nuts, etc. used for terminal connectors shall also be of tinned plated brass. All blocks shall be shrouded by easily removable shrouds made of transparent die-electric materials.

The terminal connector/blocks shall be disconnecting type terminal connectors for PT and same with automatic shorting of C.T. secondary terminals shall be provided in CT secondary circuit. All other terminal connectors shall be Non-disconnecting type. Terminal should be shock protected in single moulded piece. Terminal block should have screw locking design to prevent loosening of conductor. Provision shall be made on each pillar, for holding 10% extra connection (5% incoming + 5% outgoing).

At least 20% spare terminals for each type shall be provided. All terminals shall be provided with ferrules indelibly marked or numbered and identification shall correspond to the designations on the relevant wiring diagrams. The terminals shall be rated for adequate capacity which shall not be less than 10 Amps for control circuit. For power circuit it shall not be less than 15 Amps.

7.0 SPACE FOR CONTROL CABLES AND CABLE GLANDS

Sufficient space for receiving the Control Cables inside the Panel at the bottom of the cubicles and mounting arrangement for the terminal cable glands shall be provided. Removable type separate cable entry plate (may be two) shall be fixed with bottom plate. The specification does not cover supply of control cables and cable glands for which the EMPLOYER will make separate arrangement.

8.0 SPACE HEATERS

240 V, 50 HZ Tubular Space Heaters suitable for connection to the Single Phase A.C. Supply complete with On-Off Switches located at convenient position shall be provided at the bottom of the Panel to prevent condensation of moisture. The Watt loss per Unit surface of heater shall be low enough to keep surface temperature well below sensible heat. A thermostat control unit with variable temperature shall be installed to control the heater. The 240 V AC supply for the heater shall be controlled by a suitably rated single pole miniature circuit breaker compartment to be mounted on an insulator. One AC Ammeter with 0-1.0 Amp range shall be provided in series with the heater to monitor the current drawal of the Heater.

9.0 DISTRIBUTION AND CONTROL OF AUX. POWER CIRCUIT

9.1. D.C. CIRCUIT

There shall be only one 30V D.C. for the entire Control and Relay Panel fed from a D.C. Distribution Panel. A continuous D.C. Bus shall be provided in the Control and Relay Panel and D.C. supply for control, protection, indication and supervision of circuit breaker and other equipment shall be teed off from D.C. bus through a set of 20 Amp rated H.R.C. Fuse on positive and negative side. D.C. supply to be teed off shall be distributed within the Panel as below:

(a) Control DC scheme both positive and negative side with 16 Amp fuse

(b) Close/Trip Ckt 1 and Trip Ckt 2 without fuse; closing circuit with 10A fuse.

(c) Indication Circuit through a set of 6 Amp. HRC Fuse both at +ve and –ve side

(d) Protective relay circuits through 6A fuse both at +ve and –ve side

(e) Annunciation ckt with 6Amp fuse on both at +ve and –ve side

(f) DC Emergency Lamp with 6Amp fuse both at +ve and –ve side

Three nos. of D.C. operated no-volt auxiliary relay(self reset type) provided with hand reset type flag with inscription — Main D.C. Fail , ±Control Dc fail & Protection DC fail with 4NO+4NC in each relay. 2 NC contact for ±DC fail' alarm and Indication, 1NO wired upto SCADA TB and 1NO wired upto spare TB.

One Push button having N/C Contact used in Series with the above relay for ±D.C. Fall Test'
purpose.

9.2. A.C. CIRCUITS

230 Volts, Single Phase A.C. Aux. Supply to the Control and Relay Panel will be fed from A.C. Distribution Panel through a 16Amp MCB provided there. One 16 Amps rated HRC Fuse shall be provided at the Control & Relay Panel for the Incoming A.C. Supply. Two A.C. operated no volt auxiliary relay (self reset type) rated for 230V shall be provided with hand reset flag with inscription – ±A.C. Fail & DC Fail Accept with 4NO+4NC contacts for each relay. One push button having N/C Contact used in Series with above relay for–A.C. Fail Tes' purpose.

9.3. P.T. SECONDARY CIRCUIT

There may be two nos. 33KV bus PT, one in each bus section. P.T. supply shall be available from selected 33 KV Bus P.T through suitable PT selection scheme by switch. Two sets of Fuse and link of suitable rating shall be provided for the Incoming P.T supplies and two sets, one for each PT of 3 nos. coloured LED indicating lamps shall be provided for supervision of the Fuse. Lamps shall be connected between respective phases and neutral. The arrangement of distribution of P.T. Secondary Circuit shall be as follows:

(a) Potential supply to the protective relay circuit for Feeder where necessary shall be fed from selected Bus P.T. supply bus.

(b) Potential supply to meters, Energy meters and indicating instrument of each

panel shall be fed from selected Bus P.T. supply bus.

(c) Selected P.T. secondary supply to the protective relays of each panel shall be fed through 4 poles - MCB and link in neutral in each panel where necessary with two change over contacts for annunciation.

d) Selected P.T. secondary supply for metering and indicating instruments of each panel shall be fed through 4 pole MCB in each phase and link in neutral in each panel of
33KV system voltage.

e) Two position (PT-1/PT-2), minimum 4(four) way PT selector switch (stay put type), minimum
16A rating shall be provided in each panel for metering ckt. Additional 4 way PT selector switch is required for protection wherever applicable. The no. of way may increase during detailed engineering.

9.4. FUSE AND LINK

Fuses shall be of cartridge type. Carrier and base for the fuse and links for all D.C. and A.C. Circuits shall have imprint of rating, voltage and circuit designation.

9.5. MIMIC DIAGRAMS

a) Provision shall be made for 10 mm. wide painted and overall drawing mimic diagram by the EMPLOYER on the exterior of the front panel to represent the single line arrangement of the station equipment. Provision shall be made in such a way that centre line of the mimic bus shall be at a suitable height from the bottom of the C&R Panel.

b) Colour scheme for mimic diagram as follows:-

KV Class	Colour	Shade Index as per ISS
33 KV	Brilliant green	221
11 KV	Air Craft blue	108
400/230 V	Black	309
Earth	White	-
110 V	Canary yellow	-

c) In 33 KV simplex type C&R panels, Symbol marking for the position indication of isolators, earth switches etc, ON/OFF indication for Circuit breaker, PT supply indication, CB spring charge, auto trip, trip ckt healthy etc. shall be mounted along the mimic diagram at appropriate location. Non-Discrepancy type control switch for the C.B. shall be mounted within the mimic, indicating the C.B. ON/OFF status.

10.0 Labeling

All front mounted as well as internally mounted items including MCBs shall be provided with individual identification labels. Labels shall be mounted directly below the respective equipment and shall clearly indicate the equipment designation. Labelling shall be on aluminium anodised plates of 1 mm thickness, letters are to be properly engraved.

11.0 Earth Bus

Each panel shall be provided with two earth bus of size 25 x 6 mm (min) each. The earth bus shall be of tinned plated copper, and all metallic cases of relays, instruments etc. shall be connected to this earth bus independently for their effective earthing. The wire used for earth connections shall have green insulation.

12.0 Circuit breaker Control Switch:

19.1 PISTOL GRIP TYPE Non- discrepancy T-N-C spring return type switch shall be provided for remote operation of circuit breaker to ensure that manual pumping of closing solenoid not possible. The switch shall be mounted in the mimic diagram itself such that the stay-put ('N') position will render the continuity of the mimic. One green LED for 'breaker open' indication and one red LED for 'breaker closed' indication shall also be provided adjacent to the T-N-C switch.

19.2 Switches should have finger touch proof terminals. For the convenience of maintenance, screw driver guide should be from top/bottom of the switch and not from the side. Terminal wire should be inserted from the side of the switch terminal.

19.3 Terminal screws must be captive to avoid misplace during maintenance.

19.4 Switch shall be with 48 mm x 48 mm escutcheon plate marked with Trip & Close.

19.5 Trip-neutral-close, with pistol grip handle must be pushed in to spring return to either trip or close position from Neutral position for safety and not just turn to

trip.

19.6 One contact to close in each position of Trip and Close. Contact rating shall be 12A at 30 V DC.

19.7 One spare contact is required in off & on position.

13.0 Local/Remote switch:

Local/Remote switch should be 4-pole, 2 way Lockable and stay put type.

14.0 INDICATING LAMPS & CONTACT MULTIPLIER

i) INDICATING LAMPS

L.E.D. Type Indicating Lamps shall be provided on the Control Panel to indicate the following:

S.No.	Functions	Quantity	Colour of Lamp
1	C.B. Spring charged indication	1 No.	Blue
2	C.B. trip Coil/Circuit healthy indication	2 No.	White
3	C.B. Auto tripped indication	1 No.	Amber
4	Panel D.C. Fail indication	1 No.	Amber
5	P.T. Supply indicating Lamp	2 sets	Red/Yellow/Blue
6	C.B. —ON indication	1 No.	Red
7	C.B. —OFF indication	1 No.	Green

All the lamps shall be connected to the auxiliary D.C. supply of the Sub-Station except Sl. No. (4) & Sl. No. (5) which should be connected to the auxiliary A.C. supply and P.T. Secondary supply respectively. The Lamp shall be suitable for Panel purpose and shall be Low Watt consumption. All indicators shall have bright LEDs having long life. Conventional bulbs are not acceptable. The indicating LEDs with resistors shall withstand 120% of rated voltage on a continuous basis. However, the specification of indicating lamps may likely to be changed/ modified as per requirement

of EMPLOYER.

Lamps for circuit breaker "ON", "OFF", "TRIP CKT HEALTHY" and "AUTO TRIP" indications. LED indicating lamp complete with static circuits and features should be supplied with Low voltage protection circuit (LVGP) and surge suppressor circuit having LED indication. Lamp assembly should be of fire – retardant glass epoxy PCB , industrial heat resistant, fire resistant, non hygroscopic DMC material, chrome – plated corrosion resistant solid brass bezel, polycarbonate lens in desired colour shades of Red, Green , Amber, Yellow etc. the intensity of light should be minimum 100 mcd at 20 mA . Indication lamp should be suitable to operate on 30 V direct current supply source. Acceptable make are BINAY Opto Electronic Private Ltd. or equipment.

ii) Contact Multiplier

230 Volts, Single Phase, 50 hz A.C.. Supply operated Contact Multiplier to be provided, if required.

15.0 TERMINAL BLOCK / TTB

1. Terminal Blocks for incoming A.C and D.C. Circuit and C.T., P.T. & SCADA Circuit should be located on the left hand side and Transformer supervision, breaker control and spare in right hand side of the wall of the Panel seen from back side respectively.

2. 3-Phase, 4-Wire Link type Test Terminal Block having sealing provision shall be provided in
Metering Circuit of each Panel.

16.0 SAFETY EARTHING

1. Earthing of metallic parts or metallic bodies of the equipment on the Panel shall be done with soft drawn single conductor bare Copper Tail connections shall have minimum area of 16 sq, mm. and the main earthing connection 60 sq.mm. These wires shall be connected by suitable terminals and clamps junction. Soldered connections shall not be employed.

2. The neutral point of star connected LV winding of instrument transformers and one corner of the open delta connected LV side of instrument transformers shall be similarly earthed by tail connected with main earth wire of Panel Earthing

System. Multiple earthing of any instrument transformer circuit shall be avoided.

17.0 PANEL LIGHTING

1. The Panel interior shall be illuminated by CFL lamps connected to 230 Volt Single Phase A.C. The illumination of the interior shall be free from shadows and shall be planned to avoid any strain or fatigue to the wireman likely to be caused due to sub-normal or non-uniform illumination. One emergency D.C. light shall be provided for each panel with individual switch with proper identification mark.

2. A toggle switch or door operated switch shall be provided for control of A.C. lighting in each panel.

3. One combined 15 Amps. 3-Pin and 5 Amps. 2-Pin Power Socket outlet together with Plus
Pins shall be provided at convenient points in each Panel for A.C. Supply.

18.0 ANNUNCIATOR

A. ELECTRONIC ANNUNCIATOR

1. Suitable Multi-way Microprocessor based electronic Annunciator for the visual and audible alarm on the control panel using bright LEDs shall be provided in each panel to indicate over current and earth fault protection operated. In addition to above, each electronic annunciator of Transformer Control Panel shall have provision to indicate Transformer trouble trip/alarm function operated. Also one window of the Annunciator shall have to be used for Non-Trip A.C. Fail Alarm Indication and one window for Trip Circuit unhealthy indication. Each Electronic Annunciator shall have provision for connection with accept/reset/lamp test/mute Push buttons for proper functions. Electronic annunciator shall have provision for connection with Electronic Buzzer/Electronic Bell for Trip & Non-Trip Audio Alarm of common annunciation scheme. Electronic Annunciation shall have provision for flashing illuminating display with inscription for operation of respective Protection Relay. The Micro-Processor based Electronic Annunciator should have separate coloured windows for Trip & Non-Trip Annunciation for easy detection.

2. Annunciator fascia units shall have translucent plastic windows for each

alarm point.

3. Electronic Annunciator shall have first Fault Indication Facilities & System Watch Dog

4. Annunciator facia plate shall be engraved in black lettering with respective alarm inscription as specified. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall be about 5 mm. The inscriptions shall be visible only when the respective facia LED will glow.

5. Annunciator facia units shall be suitable for flush mounting on panels. Replacement of individual facia inscription plate and LED shall be possible from front of the panel.

6. Unless otherwise specified, one alarm buzzer meant for non-trip alarms and one bell meant for trip alarms shall be provided in each control panel (mounted inside).

7. Each annunciator shall be provided with 'Accept', 'Reset' and 'Test' push buttons, in addition to external PB.

8. Special precaution shall be taken by the manufacturer to ensure that spurious alarm conditions do not appear due to influence of external magnetic fields on the annunciator wiring and switching disturbances from the neighbouring circuits within the panels.

9. In case 'RESET' push button is pressed before abnormality is cleared, the LEDs shall continue to glow steadily and shall go out only when normal condition is restored.

10. Any new annunciation appearing after the operation of 'Accept' for previous annunciation, shall provide a fresh audible alarm with accompanied visual alarm, even if the process of "acknowledging" or "resetting" of previous alarm is going on or is yet to be carried out.

B. Provision for testing healthiness of visual and audible alarm circuits of annunciator shall be available.

16 Window Annunciation Scheme for 10 MVA & 12 MVA Transformer (individually controlled) to indicate following functions:-

1	Differential protection(87) operated	1 no.
2	Non-directional protection (O/C+E/F) operated	1 no.
3	Oil Temp./Winding Temp/MOG Alarm for transformer	1 no.
4	Oil Temp./Winding Temp Trip for transformer	1 no.
5	REF 64R(HV side) tripped	1 no.
6	REF 164R(LV side) tripped	1 no.
7	Buchholz Alarm for transformer	1 no.
8	Buchholz Trip for transformer	1 no.
9	OLTC Buchholz/ Main Tank PRV Trip for transformer	1 no.
10	AC fail	1 no.
11	Trip Circuit/Coil 1or Trip Circuit/Coil 2 Unhealthy	1 no.
12	Non-directional O/C & E/F Relay Trouble	1 no.
13	Differential relay trouble	1 no.
14	Spare	1 no.
15	Spare	1 no.
16	Spare	1 no.
	Mounting	Flush
	No. of facia windows	16
	Supply voltage	30 V DC
	No. of LEDs per window	2
	Lettering on facia plate	Properly engraved

12 Window Annunciation Scheme for up to 6.3 MVA Transformer (individually controlled) to indicate following functions:-		
i)	Non-directional protection (O/C+E/F) operated	1 no.
ii)	Oil Temp./Winding Temp/MOG Alarm for	1 no.

	transformer	
iii)	Oil Temp./Winding Temp Trip for transformer	1 no.
iv)	REF 64R (HV side) tripped	1 no.
v)	REF 164R (LV side) tripped	1 no.
vi)	Buchholz Alarm for transformer	1 no.
vii)	Buchholz Trip for transformer	1 no.
viii)	OLTC Buchholz/ Main Tank PRV Trip for transformer	1 no.
ix)	Panel AC fail	1 no.
x)	Trip Circuit/Coil 1 or Trip Circuit/Coil 2 Unhealthy	1 no.
xi)	Panel AC fail	1 no.
xii)	Non-directional O/C & E/F Relay Trouble	1 no.
xiii)	Spare	1 no.
	Mounting	Flush
	No. of facia windows	12
	Supply voltage	30 V DC
	No. of LEDs per window	2
	Lettering on facia plate	Properly engraved

	12 Window Annunciation Scheme for Feeders to indicate following functions :-	
i)	Non-directional O/C operated	1 No
ii)	Non-directional E/F operated	1 No
iii)	Panel D.C. Fail	1 No
iv)	Trip Circuit Coil 2 Unhealthy	1 no.
v)	Panel AC fail	1 no.
vi)	Trip Circuit/Coil 1 Unhealthy	1 no.
vii)	Non-directional O/C & E/F Relay Trouble	1 no.
viii)	PT MCB Tripped	1 No
ix)	Spare	1 no
x)	Spare	1 no.

xi)	Spare	1 no.
xii)	Spare	1 no.
	Mounting	Flush
	No. of facia windows	12
	Supply voltage	30 V DC
	No. of LEDs per window	2
	Lettering on facia plate	Properly engraved

	12 Window Annunciation Scheme for Parallel Feeders to indicate following functions:-	
i)	Directional O/C operated	1 no.
ii)	Directional E/F operated	1 no.
iii)	Panel DC Fail	1 no.
iv)	Trip Circuit/Coil 2 Unhealthy	1 no.
v)	Panel AC fail	1 no.
vi)	Trip Circuit/Coil 1 Unhealthy	1 no.
vii)	Directional O/C & E/F Relay Trouble	1 no.
viii)	PT MCB Tripped	1 no.
ix)	Spare	1 no.
x)	Spare	1 no.
xi)	Spare	1 no.
xii)	Spare	1 no.
	Mounting	Flush
	No. of facia windows	12
	Supply voltage	30 V DC
	No. of LEDs per window	2
	Lettering on facia plate	Properly engraved

C. PANEL D.C. FAIL ALARM SCHEME

Control & Relay Panel shall have a common — Panel D.C. Fail Alarm Scheme operated by 230 V Single phase A.C. Aux. Supply for audible as well as visual alarm in case of failure of D.C. incoming supply to the Panel.

Another Single Element Relay without Flag and 1 no. self-reset type N/O & 1 no. N/C contact having inscription Panel D.C. fail' alarm accept Relay shall be provided. Besides above, 1 no. Indicating Lamp, 1 no. A.C. Operated Electric Hooter and 2 nos. Push Button, one having 1 no. N/C contact, the other having 1 no. N/O contact shall also be provided for successful operation of the scheme. All auxiliary relays required to render Annunciation System operative and shall be considered to be within the scope of the tender.

AC fail, DC fail scheme shall be operated by relay not contactor.

19.0 INDICATING INSTRUMENT AND METERS

a. All instruments shall be flush mounted, back connected type and provided with dust tight cases for tropical use with dull black enamel finish. All fixing screws, nuts and threaded parts shall be designed to Indian Standards.

b. All instruments shall be of class 0.5 type. The calibration of the instruments shall function satisfactorily when mounted on steel panels or alternatively magnetically shielded instruments shall be used.

c. Instruments shall be capable of indicating freely when operated continuously at any temperature from 0 to 50 degree C.

d. All circuits of instruments shall be capable of withstanding applied load of 20% greater than the rated capacity for a period of eight hours.

e. The instruments shall be capable of withstanding the effect of shock vibration and a di- electric test of 2000 Volts r.m.s. to ground for one minute as per relevant ISS.

19.1 Ammeters:

All ammeters shall be provided with direct reading scale. Full Scale Value of the Ammeters shall be 100% of the nominal current of maximum C.T. ratio. The ammeters shall be connected to measuring C.T. Core. Ammeters shall be suitable for R.Y.B. Phase measurements. However, the ammeters to be supplied shall be of type –DIGITAL‖. The auxiliary power of the ammeters should be 230V AC.

19.2 Voltmeters

Volt Meter shall be provided with direct reading scale. The maximum value of the volt-scale be
15% in excess of the normal Circuit Voltage. The rated voltage of the Volt Meter shall be 110V A.C. However, the voltmeters to be supplied shall be of type –DIGITAL‖. The auxiliary power of the voltmeters should be 230V AC.

a. Voltmeter Selector Switch:

One Voltmeter selector switch having 7 position 6 way stay-put type shall be provided.

b. PT Selector Switch:

One PT selector switch, 2 position, stayput type shall be provided.

19.3 Energy Meters

Tariff Metering Equipments

(a) Three element Tri-vector Meters shall be supplied by the EMPLOYER. But Panel Wiring for the Meters along with Test Terminal Block and space for the Tri-vector Meters are to be provided for the Panels.

20.0 NAME OF IDENTITY PLATES

a) All instruments, relays and such other similar electrical devices mounted on the control and relay panel shall be provided with name plates bearing the manufacturer's name, serial identifying number and the Electrical rating data.

b) 3mm thick and 25mmX150mm brass or plastic plates bearing suitable

identification marks shall be fixed under the terminal wiring at the test blocks, at the fuse blocks and at the cable terminals. Similar plates shall be fixed on the exterior of the panel in appropriate places to indicate function of control switches, push button etc. such as isolator control switch, breaker control switch, DC fail test, accept reset etc. Suitable identification marks shall be provided for individual casing part of the relays and other equipment. Plates should be screwed and riveted to the Panel.

c) 50mm wide brass or plastic plate bearing suitable circuit description (which will be furnished after order is placed) etched in 30 mm size letters shall be provided for each panel and mounted on the top of both outer of the front panels. These plates shall be removable type.

d) Schematic Diagram of CT, PT, CB circuitry & AC, DC Ckt, Indication and Annunciation Ckt along with protection circuitry giving the terminal nos. and Bus wire details shall be printed in laminated durable stickers and pasted inside the panel Door page wise of the respective panel.

e) Each unit of control and relay panel shall be provided with a label located at the bottom on the front and shall contain the following details :

i) Manufacturer's name
ii) P.O.no. and date
iii) Drg. ref. no. pertaining to the panel.

21.0 PAINTING

Panel painting shall be done by the modern process of painting. All unfurnished surface of the steel panel and frame work shall be sand blasted or suitably cured to remove rust, scale, foreign adhering matter or grease. A suitable rust resisting primer shall be applied on the interior and exterior surface of steel, which shall be followed by application of an undercoat suitable to serve as base and binder forth finishing coat.

Details of Painting:-

Surface treatment	by seven tank process
Paint type	Powder coated. Pure polyester base grade A structure finish
Paint shade	RAL 7032 for external & internal surface

Paint thickness	Minimum 80 microns

22.0 RELAYS:

A. GENERAL REQUIREMENT

The main protective relays SCADA Compatible Numerical Directional/Non Directional O/C & E/F Relays shall be of panel manufacturers own make. However, multinational company manufacturing panel in India may import required/desired relays from their foreign counterpart with same brand name at their own risk, cost and responsibility without hampering the stipulated delivery schedule as stated in the tender notification.

All numerical relays shall be provided with 'Relay Failure Annunciation contact'.

B. SCADA COMPATIBLE NUMERICAL DIRECTIONAL/NON DIRECTIONAL O/C & E/F RELAYS

The primary requirements of the relays are to protect the respective single circuit or double circuit feeders and 33/11KV Power Transformers in the event of fault. The Directional/Non Directional E/F relays shall provide suitable sensitivity for limited earth fault current.

The relay should be suitable for substation automation, primary circuit breaker operation through SCADA from remote control room.

THE DETAILED SPECIFICATION OF Non-Directional O/C and E/F RELAY IS AS PER ANNEXURE-I OF SPECIFICATION

THE DETAILED SPECIFICATION OF Directional O/C and E/F RELAY IS AS PER ANNEXURE-II OF SPECIFICATION

C. OTHER PROTECTIVE RELAYS

- Differential relay shall be of numerical type
- REF relay etc. may be of static type.

D. OTHER PARTICULARS RELATED TO ALL RELAYS

1) All shall conform to the requirement of IS: 3231 / IEC 255 and shall be suitable for operation within a temperature range 0ºC to 55ºC and 95% relative humidity. Relays shall be suitable for flush / semi flush mounting on the panel with connections from the rear, protected with dust tight cases for tropical use and with transparent cover removable from the front.

2) All A.C. relays shall be suitable for operation at 50Hz. The current coils shall be rated for a continuous current of 1 amp and the voltage coil for 230V normal. The contacts of the relays shall be properly designed to prevent or minimise damage due to arcs which have to be broken successfully against 30V +/- 10% volt DC. When open, the contacts shall withstand a voltage of 115% of the normal circuit voltage. The relays shall be designed for satisfactory operation between 70% to 110% of rated D.C. voltage of the sub-station. The voltage operated relays shall have adequate thermal capacity for continuous operation.

3) Timers shall be of static type. Pneumatic timers are not acceptable.

4) The Relays shall preferably be provided with suitable Seal-in-Devices. Relays should be immune to all types of external influences like Electro static, Electromagnetic, Radio interference, shock etc.

5) All the numerical relay should have provision for setting all the features available in the relay and viewing those setting as well as different other parameters through both built in display unit as well as through PC. All numerical relays shall have self monitoring feature with watch dog contact. The supply of relay should be inclusive of necessary software and hardware for interfacing with a PC, to be supplied by the manufacturer.

E. PROTECTION SCHEMES

E-1 <u>PROTECTION SCHEMES FOR 33 KV FEEDER</u>

NON-DIRECTIONAL OVER CURRENT AND E/F PROTECTION :

This relay shall be used for 33KV radial feeder. The relay shall

a) be three O/C & one E/F element type.

b) have IDMT characteristics with time current characteristics of 3 sec at 10 times current setting.

C) have variable current setting of 50% to 200% of rated current and adjustable time setting.

d) have high set unit with current setting 500%-2000% for protection and 33 KV feeder protection, with very low transient overreach.

e) Definite Time Sensitive Earth Fault Protection may be inbuilt function of Numerical over- current Relay and shall have a variable current setting range minimum 1% to 40% in very small steps of CT secondary current and wide range of definite time setting range minimum. 0.1 to 10 Sec. This relay shall be used in 33 KV feeder for detection of line to ground fault current of both very low and high magnitude where the 33 KV system is grounded through earthing transformer.

f) LED indication for numerical relays of different type of faults including phase identification.

E-2 PROTECTION SCHEMES FOR 33 KV PARELLEL FEEDERS AT RECEIVING ENDS

DIRECTIONAL PROTECTION

Directional O/C & Directional Instantaneous E/F Relays shall be required for 33 KV parallel feeders as specified in the schedule of requirement. Each Feeder shall be provided with 3 elements IDMT Voltage polarized O/C Relays and single element voltage polarized E/F Relay. The O/C Relays shall be IDMT type with high set element. The E/F Relay shall have directional sensitive E/F setting having wide range of setting (1-40%) & wide range of definite time setting range minimum. 0.1 to 10 Sec. The relay shall also have instantaneous unit. The relay shall have necessary P.T. fuse failure monitoring scheme.

Characteristics:-

O/C Element: IDMT with High Set Unit	Current Settings & Operating time	IDMT-50-200%, 0-3 sec, Inst.- 500-2000%or 400-1600%
MTA	Selectable MTA for Directional Relay should cover 1st quadrant in a non-effectively grounded system	
Polarized P.T. Voltage	110 V A.C.	
E/F Element		
Current Setting	1-40% (minimum.) in	
	very small steps	
Operating Time of Relay	Instantaneous	
Operating Time of Timer	0.1 to 10 Sec in very small steps	
MTA	Selectable MTA for Directional Relay should cover 1st quadrant in a non-effectively grounded system	
Open Delta P.T. Voltage	63.5 V A.C.	

The numerical directional relay shall have in-built feature for derivation of zero sequence voltage internally. If separate IVT is required for derivation of zero sequence voltage for directional earth fault element, the particulars shall be as per following Technical Parameters:-

1	Insulation Level	1.1KV
2	Over Voltage Factor	1.2 Cont./1.9 for 8 Hrs.
3	Transformation	110 V/√3 / 110/√3

	Ratio	
4	VA Burden/Phase	7.5
5	Accuracy Class	3P
6	No. of Phase	Single
7	Type	Epoxy Cast Resin Indoor Single Phase Voltage Transformer
8	Formation	3 nos. Single Phase P.T. shall be connected in primary as Star and Secondary as Open Delta with neutral of Primary and one end of Open Delta earthed.

E-3 PROTECTION OF 33 KV INDIVIDUAL TRANSFORMERS

For protection of H.V. Side of the Transformers, following main protective relays are required

i) Numerical O/C protection.

ii) 2 sets Restricted E/F Relay shall be provided for HV and LV side of individual control transformer panel.

iii) 1 set Differential Relay in addition to above, shall be provided for 10 MVA 33/11KV transformer panel.

Differential Relay shall be

a) Provided at 33KV panel of the transformers to be protected. It shall be numerical adjustable/variable percentage biased type differential relay.

Necessary software, cables, connectors and other accessories as required for download, analyze data etc. shall be within the scope of successful manufacturer.

b) The relay shall be very fast in operation with an operating time less than 40 millisecond at 5 times setting.

c) The relays shall be inherently stable for external through fault conditions without affecting the speed of operation for internal faults.

d) The relay shall have either a built in facility of ratio and phase angle correction or necessary interposing Auxiliary current transformers of universal type, shall be provided in the respective panel.

e) The relay shall be provided with 2nd harmonic restraint or any other inrush proof feature to prevent operation due to magnetizing in rush current when the transformer is charged either from HV or LV side. But this shall not affect the speed of operation for internal fault.

f) It shall be provided with 5th harmonic restraint features to prevent operation due to possible over excitation of the transformer. This shall also not affect the speed of operation for internal fault.

g) The relay shall have adjustable bias setting range 20% to 50% and adjustable operating setting range of 10% to 50% at zero bias.

h) It shall have three instantaneous high set over current units for clearing heavy internal fault.

i) The relay shall be with 2-bias winding.

j) The relay shall be such that there will not be any necessity of changing the setting of the relay whenever the transformer taps are changed from +5% to-10%.

k) The manufacturer has to furnish the type test report from CPRI/NABL accredited Govt. recognized
Test House and performance certificate from Power Utilities in India.

l) Differential relay shall have facility for setting, parameterization, downloading the storage data, data captured by disturbance recorder etc. locally through PC. The necessary PC, Windows based Licensed software for establishing the facility to be considered in the scope of the supply by the Manufacturer.

m) The relay shall have disturbance recording (with time stamping) function with suitable no. of analog and digital channels, Memory size and number of disturbances stored in the relay shall be clearly indicated in the offer. No. of site selectable BI, BO and watchdog contact details, communication port details (front, rear) along with necessary hardware and software details shall be furnished.

E-4 RESTRICTED EARTH FAULT PROTECTION

The above protection shall be provided for 33/11 KV transformers at HV and LV side. The Relay shall be:

a) Single pole type.
b) Current/voltage operated high impedance type with a suitable setting to cover the maximum portion of transformer winding. Necessary calculation to prove the above winding coverage shall be furnished along with the tender.
c) Tuned to the system frequency.
d) Have suitable nonlinear resistor to limit the peak voltage and stabilizing resistance.
e) Operating time shall be less than 40 ms.
f) Shall be standalone type.
g) Have suitable stabilizing resistor to prevent mal operation during external faults if necessary.

E-5 A set of D.C. Voltage Operated Aux. Relays with coil cut-off arrangement and 4No and 4 NC contacts, hand reset with flag indicator type shall be provided for each Transformer for

(a) Buchholz Alarm
(b) Buchholz Trip
(c) Winding Temp. Trip & winding temp. alarm
(d) Oil Temp trip & Oil Temp. Alarm
(e) Low Oil Level Alarm
(f) Pressure Release Device Trip
(g) OSR for OLTC trip

Each Transformer Panel shall be provided with a High Speed Tripping Relay with coil cut- off arrangement having 6 NO and 4 NC electrical reset with flag indicator type.

E-6 AUXILIARY RELAYS, TRIP RELAYS and TRIP COIL/ CIRCUIT SUPERVISION RELAYS

Auxiliary Relays- D.C. Voltage operated auxiliary relays provided with mechanically operated hand reset indicator and sufficient no. of hand reset contacts shall be provided for protection and supervision against transformer internal trouble/faults. No of elements and number of relays shall be as per requirement of individual

transformer.

For Trip Circuit Supervision Relays - All Panels should be provided with D.C. Voltage operated Trip Circuit Supervision Relay having provisions for pre & post close supervision of Trip Circuit with set of self-reset contacts provided for Trip Circuit Healthy Indication and Trip Circuit unhealthy indication& Alarm in respect of Trip Coil/circuits of respective Breakers.

Tripping Relays- All Panels should be provided with D.C. Voltage operated High Speed Tripping Relays having self reset contacts capable to make, carry and break trip coil current. Sets of Trip Contacts shall be provided for Inter-tripping function of corresponding 11
KV Incoming Switchgear and closing blocking function of 33 KV & 11 KV Breakers in respect of Transformer Control Panels. Each set of trip relay shall have minimum two nos. NO and 1No. NC contact as SPARES. The operating time of master trip relay shall be less than 40 ms and electrical reset type.

E-7 TRIP CIRCUIT/COIL SUPERVISION SCHEME :

Trip circuit supervision scheme shall be such that testing of trip circuit healthiness is possible irrespective of whether the C. B. is in the closed or open position. The Trip Circuit Healthy LED should glow continuously in CB ‗ON' Position and on demand in C.B. ‗OFF‖ position. The rating of dropping resistance in series with Trip Circuit Healthy LED shall be such that the Trip Coil should not get damaged because of continuous current flowing through it.

E-8 Principal requirements of protective relays, metering equipments, auxiliary relays breaker control switches etc. are as follows:

E-8-1 Ammeter:

Each circuit one ammeter shall be provided with the following :

Mounting	Flush
Size	96 x 96 mm. case
Response Time	1 second
Operating Temperature	Up to 55°C
Dielectric Strength	2 kV RMS for 1 minute
Auxiliary Supply	230 volt A.C, 50 Hz

Operating Current	1 A from CT Secondary.
Type	Panel Mounting with $3\frac{1}{2}$ Digital Display.

E-8-2 Volt Meter :-

Mounting	Flush
Size	96 x 96 mm. Case
Response Time	1 second
Operating Temperature	Up to 55°C
Dielectric Strength	2 kV RMS for 1 minute
Auxiliary Supply	230 V A.C., 50 Hz
Frequency	50 Hz
Operating Voltage	110 V from PT Secondary.
Type	Panel Mounting with $3\frac{1}{2}$ Digital Display.

E-8-3 Buzzer

One DC buzzer shall be provided in the panel for non-trip alarm. One DC Bell shall be provided for Trip alarm and one AC Bell for Panel DC fail alarm.

E-8-4 High speed tripping relay electrically resettable type confirming to IS – 3231

Aux. voltage	30 V or 110 V D.C to be decided during detailed engineering stage
Coil rating	30V D.C., voltage band for satisfactory operation : 50 to 120% of rated voltage
Operating Time	40 m. seconds nominal at rated voltage
Burden of relay coil watts (Max)	Low burden 40 Watt at rated voltage
Operating temp	-10 deg C to 55 deg C.
Operational indication for each element	Mechanical red colour Flag : Electrical Reset Type
	6 NO + 4 NC combination with additional hand

Contact Configuration	reset coil cut of contact (Seal in contact)

Contact ratings:

Make and carry	A.C. 1250 VA with max 5 amp & 660 Volts D.C. 1250 W dc with max 5 amp & 660 Volts
Make and carry for 3 sec.	A.C. 7500 VA with max 30 amp & 660 Volts D.C. 7500 W dc with max 30 amp & 660 Volts
Break	A.C. 1250 VA with max 5 amp & 660 Volts D.C. – 100 W resistive 50 watt inductive with max 5 amp & 660 Volts
Insulation	2 KV RMS, 50Hz for 1 min. 2.5 KV/1 sec between all terminals & case as per IS 3231. 1 KV RMS, 50Hz for 1 min. across open contact
Type of mounting	Flush

E-8-5 Numerical based differential protection relay with inbuilt current amplitude & vector group compensation feature & also with differential high set element for two winding power transformer compliant to IEC 60255.

Aux. voltage	30 V or 110 V D.C to be decided during detailed engineering stage
C.T. secondary	Selectable 1 amps / 5 amps for both HV & LV sides
Online display of HV & LV phase currents & differential current	
Adjustable bias setting	10 to 50% In.
Operation based on fundamental frequency	
Programmable HV/LV CT ratio of T/F vector group	
Inbuilt REF protection	
Inbuilt HV & LV side over current & earth fault protection	
Inbuilt transformer trouble auxiliary relay	
Backlit LCD display	
Harmonic restrain feature	
Storing facility of latest 5 fault events with real time clock	

Password protection	
DC burden	Quiescent condition – approx 4 watt Under trip condition – 30 Volt - approx 4 watt, 110 Volt - approx 7 watt.
AC burden	Through current only – approx 0.15 VA for 1 amp & 0.30 VA for 5 amp (per bias circuit) Bias & differential Ckt only: 2.8 VA for 1 amp & 3.2 VA for 5 amp.
Contact arrangements	Two change over self reset tripping contacts & two annunciation contacts
Contact rating	Make & carry 7500VA for 0.2 sec. with max 30 A & 300 V AC or DC carry continuously 5 amp AC or DC break 1250 VA AC or 50 W DC resistive, 25 W L/R – 0.04 s subject to max. 5 amp & 300 Volts
Current Input	Six for differential & one for REF
Self diagnosis feature for healthiness of relay	
Flush mounted / draw out type	

23.0 Guarrantee:-

The panels shall be delivered to the various consignees of the EMPLOYER and shall be suitably packed to avoid damages during transit.

The C&R Panel with relays with all integral parts of the Equipment will be guaranteed for the period of five years from the date of last dispach.
In the event of any defect in the Equipment, relay, any integral part of the Equipment arising out of faulty design, materials, workmanship within the above period, the supplier shall guarantee to replace or repair to the satisfaction of EMPLOYER.
If the supplier fails to do so, within one month of receipt of intimation, EMPLOYER reserves the right to effect repair or replacement by any other agency and recover charges for repair or replacement from the supplier.

24.0 TESTS :-

24.1 Type Test :

24.1.1 The Manufacturer should submit the Type test report including functional test for all the protective relays and C&R panels carried out within five years from the due date of submission of tender from CPRI/NABL accredited Laboratory/ Govt. Recognized test house or Laboratory on the tendered Items as per relevant Standard & Tender Specification with the purchase order failing which the lot shall be rejected. The Type tests for Numerical Relays is to be submitted as specified in Annexure-I & II of Relays specification.

24.1.2 Test at Factory:

The following Tests shall be carried out 6 copies of Test certificates shall be submitted for approval. The Equipments shall only be dispatched after approval of the test certificates.

1. Checking of wiring of circuits and the continuity.
2. One minute applied voltage test. All Equipment on panel and small wiring shall be tested for withstand voltage of 2000Volts to earth & between different voltage circuits.
3. Insulation resistance of the complete wiring, circuit by circuit with all equipments mounted on the Board before and after H.V. test mentioned under 2 above.
4. Routine tests according to relevant National standard are on the Instruments, relays & other devices.

25.0 INSPECTION:

25.1 Acceptance test at manufacturer's works in presence of purchaser's representatives shall be carried out. The supplier shall give at least 15 days notice of the date when the tests are to be carried out. Purchasers shall give the right to select any quantity of the item wise offered lot for testing, offered for inspection and in the event of failure in test(s), the purchaser shall have the right to reject the offered equipments.

25.2 All relays, meters & annunciators provided in the control & relay panels are to be accepted only after successful hundred percent performance testing at testing department of EMPLOYER.

25.3 The inspection may be carried out by the EMPLOYER at any stage of manufacturing. The successful Manufacturer shall grant free access to the EMPLOYER's

representative/s at a reasonable notice when the work is in progress. Inspection and acceptance of any equipment under this specification by the EMPLOYER, shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective.

25.4 The manufacturer shall keep the EMPLOYER informed in advance, about the manufacturing programme so that arrangement can be made from stage inspection.

25.5 The EMPLOYER reserves the right to insist for witnessing the acceptance/routine testing of the bought out items. The supplier shall keep the EMPLOYER informed, in advance, about such testing programme.

26.0 SPARES:

The manufacturer shall quote item-wise Unit Prices for all type of relays and other consumable spares recommended by him. Such spare shall include Fuse Holders, Fuses, Indicating Lamps, essential spare parts of Relays, Instrument, extra Control Switches etc. EMPLOYER may procure these items from the successful manufacturer.

27.0 DRAWING & LITERATURE

Triplicate copies of the following drawings and literature shall be submitted along with the
order copy:-

(a) Principal dimension details of each unit cubicles, complete assembly of panel and proposed arrangement of the Panel in a Control Room.

(b) Front and rear views of the Panel with instrument and device positions marked.

(c) Pictorial views of the Control Switches Terminal Blocks, Indication Instruments, Test Blocks and exploded views of draw out type instructions and Fuse Blocks.

(d) Schematic Wing Diagram for Test Terminal Block.

(e) Illustrative, descriptive literature, General Technical Data & Specification of Devices.

f) make, type, particulars, literatures of each and every relay (protective & auxiliary), meters, annunciators, switches, lamps, TBS, TTBS etc. along with bill of material in

line with specification.

28.0 CONTRACT DRAWINGS & LITERATURE

In the event of an order materializing, the Supplier also submit four prints of each drawing for approval of the EMPLOYER along with 2 sets of literature as mentioned in the spec.
The Contract drawings shall cover the followings:-

(a) Details of construction and dimensions of a cubicle and of the complete Panel.

(b) Template for foundation and details of Cable Trench and Cable Entry Holes in the
Foundation Platform.

(c) Elementary diagrams of all controls, metering, protection annunciation and other circuits. All devices shall be numbered according to ASA or international usage, which shall be separately coded.

(d) Cabling and wiring diagram of the cubicles and inter-connections between them. Ferrule numbers, device number and grouping for cable take off shall be distinctly shown.

(e) Dimensional outline drilling diagram and special mounting arrangement if any, of such type of various devices on the Panel.

(f) Inter-connection diagram between Control Panel and C.B. power and instrument transformer etc.

(g) Wiring Schedule for Control & Relay Panel.

(h) Internal wiring diagram of all devices and elementary wiring diagram of relays where internal wiring is in triplicate. Construction details of switches, terminal blocks and test blocks etc.

(i) After approval, 10 sets of the final contract drawing for each set of Control & Relay Panels are to be supplied by the Manufacturer. One set reproducible tracing of the above drawings in soft format shall also be supplied.

In the event of contract being awarded, 4 copies of the following literatures shall be

supplied along with the drawings as mentioned:-

(a) Literature describing construction, operation, adjustment and rating specifications of all the protective and auxiliary relays, recording instruments, metering instruments and control switches.

(b) Literature giving rating data, details and adjustments for calibration of the indicating instruments.

(c) Calibration instruments for the metering instruments.

(d) List of spare parts, identification number of renewable parts of relays, instruments and switches etc. with the help of which the EMPLOYER will be able to procure spare parts from the manufacturer at any subsequent time.

(e) It is desired that the complete schematic drawing is provided on a permanently laminated/engraved plate of suitable thickness which has to be bolted/riveted at the four corners on the inside face of rear door. In addition, one more plate of similar type and dimension shall be provided on the outside of the rear door providing guidelines and instructions for operation. The guidelines and schematic to be provided on the plates shall be as per approved drawings.

29.0 DOCUMENTS TO BE SUBMITTED ALONGWITH THE OFFER:

The manufacturer shall invariably submit the following documents failing which the offers are liable for rejection:-

29.1 Bill of Material (schedule-IA/IB/IC).

29.2 Documents supporting the qualifying requirements/past performance reports schedule-III).

29.3 Undertakings from relay manufacturer regarding (Schedule-IV) :

29.3.1 Non-phasing out of the relays for at least 10 years from the date of supply

29.3.2 For extending technical support and back-up guarantee

29.4 Detailed catalogue/technical literature in respect of all components/accessories including bought-out items.

29.5 Names of supplier of bought out item.

29.6 List of testing equipment available with the Manufacturer.

30.0 QUALITY ASSURANCE PLAN

30.1 The Manufacturer shall invariably furnish QAP as specified in Annexure-III along with his offer the QAP adopted by him in the process of manufacturing.

30.2 Precautions taken for ensuring usages of quality raw material and subcomponent shall be stated in QAP.

31.0 GUARANTEED TECHNICAL PARTICULARS:

Manufacturer shall furnish Guaranteed Technical Particulars of equipment offered mentioning thereon Make & Technical particulars of each device as per schedule specified. Performance Guarantee will be based on the Guaranteed Technical Particulars.

Schedule-II -- GTP for C&R Panel

Schedule-V—GTP for Non Directional/ Directional O/C & E/F Relay

Schedule-VI—GTP for Master Trip Relay

Schedule- VII – GTP for Differential Protection Relay

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

32.0 Bus Configuration and Bill of material

32.1 33/11KV delta star individual control transformer panel having HV side control and protection. Single main bus with bus section isolator scheme.

2 nos.	Circuit label engraved suitably at front and inner side
1 no.	Section of painted and overlaid mimic diagram
1 no.	Circuit breaker control switch.
6 nos.	Indicating lamps for circuit breaker ON/OFF, spring charged, trip circuit 1 & 2 healthy and auto trip indication.
2 nos.	Trip circuit supervision relay to supervise the TC 1 & 2 both under pre close and post close condition.
3 nos.	96 mm x 96 mm ammeter scaled suitably.
1 no.	volt meter of 96 mm x 96 mm
1 no.	Suitable space and wiring for non-tariff TVM for energy management.
1 set	Three phase 4 wire test terminal block for above.
1 no	Auxiliary relay with test push button for panel DC supervision relay.
16	Fascia window type annunciator complete with accept reset and test PB but without audible bell.
1 no	Triple pole, IDMTL, non-directional over current relay with setting range 50% - 200% for IDMTL units and 500% - 2000% for high set unit.
2 nos	Restricted Earth Fault Relay current operated having setting range 10% to 40% both for HV & LV side of the Transformer.
1 no	High speed master tripping relay with contacts as required with lock out and coil supervision scheme complete.
1 set	Two bias Transformer differential relay (for 10 MVA only) with Interposing auxiliary CTs

	(universal type) where ever necessary.
1 no.	PT selector switch, two position PT-1/PT-2 switch, stay put type (16 A)
1 no.	Space heater with On/OFF switch and thermostat.
1 no.	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for transformer Buchholz trip and Buchholz alarm function. Each element with 4NO+2NC Contact.
1 no.	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for transformer winding temp. trip and alarm function. Each element with 4NO+2NC Contact.
1 no.	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for transformer Low Oil Level(Main Tank) and OSR(OLTC) alarm function. Each element with 4NO+2NC Contact.
1 no. .	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for transformer Oil Temp. Trip and alarm function. Each element with 4NO+2NC Contact.
1 no.	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for transformer Main tank PRV trip and OLTC PRV Trip function. Each element with 4NO+2NC Contact.
1 no	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for OLTC Buchholz trip and spare. Each element with 4NO+2NC Contact.
1 no.	DC operated emergency lamp with switch.
1 no.	Cubicle illumination lamp operated from door switch.
1 no.	15A, 3 phase plug & socket with switch.
1 set	Panel accessories as necessary.
1 set	Other equipment, relays etc. as required to fulfill the scheme Requirement.
1 no	Local/Remote switch

32.2 33KV single feeder line C&R Panel with Non directional O/C & E/F protection

and 33KV parallel feeder line C&R Panel with directional O/C & E/F protection. Single main bus with bus section isolator scheme.

2 no.	Circuit label engraved suitably at front and inner side
1 no.	Section of painted and overlaid mimic diagram
1 no.	Circuit breaker control switch.
6 nos.	Indicating lamps for circuit breaker ON/OFF, spring charged, trip circuit 1 & 2 healthy and auto trip indication.
2 nos.	Trip circuit supervision relay to supervise the TC 1 & 2 both under pre close and post close condition.
3 nos.	ammeter of 96 mm x 96 mm scaled suitably.
1 no	Voltmeter of 96 mm x 96 mm scaled suitably
1 no.	Suitable space and wiring for non-tariff TVM for energy management.
1 no.	Three phase 4 wire test terminal block for above.
1 no.	Auxiliary relay with test push button for panel DC supervision relay.
12 way	Fascia window type annunciator complete with accept reset and test PB but without audible bell.
1 no	Triple pole, IDMTL, non-dir- over current relay as per clause 23
1 no.	Single pole definite time sensitive E/F relay current operated having wide setting range for single circuit line.
1 no	Triple pole, IDMTL, directional over current relay with setting range 50% - 200% for IDMTL units and instantaneous high set unit -500% - 2000% applicable for parallel line feeder as per schedule
1 no	Single pole directional definite time sensitive E/F relay current operated having wide setting range for single circuit line. NECESSARY IPTs ARE WITHIN THE SCOPE OF MANUFACTURER
1 no.	High speed master tripping relay with contacts as required with lock out and coil supervision scheme complete.
1 no.	PT selector switch, two position PT-1/PT-2 switch, stay put type (16 A)
1 no.	Space heater with On/OFF switch and thermostat.
1 no.	DC operated emergency lamp with switch.
1 no.	Cubicle illumination lamp operated from door switch.
1 no.	15A, 3 phase plug & socket with switch.
1 set	Panel accessories as necessary.
1 no	Local/Remote switch
1 set	Other equipment, relays etc. as required to fulfill the scheme Requirement.

32.3 Common items:(where ever mentioned)

1 no.	96 mm x 96 mm voltmeter scaled suitably.
3+3nos	PT supply Indicating lamps, red-yellow-blue for each PT.
1 no	Voltmeter selector switch, 4-position, RY—YB—BR—OFF.
1 set	Audible bell and hooter for trip and non-trip fascia annunciation.
1 no	AC operated single element, auxiliary relay having only self reset contacts and with reverse flag for incoming AC supply supervision with test push button.
1 no	DC operated, two element, auxiliary relay having only self reset contact and with reverse flag for incoming DC and alarm bus DC fail supervision.
2 nos.	Test push button for above.
1 no	Single element AC operated auxiliary relay having self reset contact only for incoming DC and alarm bus DC fail alarm cancellation.
1 no	Push button for incoming DC and alarm bus DC fail alarm accept.
1 no	Indicating lamp for incoming DC and Alarm bus DC fail indication.
1 no	AC operated buzzer for incoming DC and Alarm bus DC fail audible alarm.

Annexure - IV

Standard Make of Relay and Fitments

1.	**Relays**	**Schneider, ABB, Siemens, Alstom**
2.	**Breaker Control Switch/ Local- Remote switch**	**Kaycee/Recom/Switron**
3.	**Ammeter/Voltmeter Selector switch**	**Kaycee/ Recom**
4.	**Static Ammeter/ voltmeter**	**AE/RISHAV/Secure**
5.	**Push Buttons**	**Vaishno/Teknic/Lumen/STS**
6.	**Indicating Lamps with lenses**	**Vaishno/Teknic/Lumen/STS**
7.	**Panel wiring**	**Finolex/Havvels/ KEI/ R. R. kables**
8.	**Hooter/Buzzer/Bell**	**Vaishno/STS/JVS/Bharani**
9.	**Annunciator**	**MINILEC/ALAN/ INSTALARM/EAPL**

Annexure-V

Legend of Devices associated with 33kV C & R Panel

Symbol Reference	**Description**	**Particulars**
A1-A2-A3, Ah	Ammeter	As specified
V	Voltmeter	As specified
VS	Manual Voltmeter Selector Switch	As specified
EM	Tri-Vector Meter	As specified
CS	Control switch T-A/T-N-A/C-C spring return type	As specified
L/R	Local/Remote switch	As specified
IL-R	CB „ON" Indication Red lamp	As specified
IL-G	CB „OFF" Indication Green lamp	As specified
IL-W	„Trip /Close signal received from Remote Indication white lamp	As specified
IL-B	"Spring charged" Indication Blue lamp	As specified
IL-A	CB " Auto trip" Indication Amber lamp	As specified
PB	Push Button	As specified
ANN	DC operated electric Buzzer and Microprocessor based Electronic annunciator with built in watch dog and first fault indication facility. The annunciator shall have provision for trip and non trip alarm functions and Accept/Test/Reset/Mute Push buttons	As specified
H,HS,TH	Heater, Heater Switch, Thermostat	As specified
FS	Fuse	As specified
LK	Link	As specified
MCB1	MCB 2 pole 32 A for DC supply	As specified
MCB2	MCB 2 pole 16 A for AC supply	As specified
MCB3	MCB 2 pole for spring charging motor supply	As specified
MVS	Manual PT selector switch	As specified
IR-I	Remote inter tripping contact from 33 kV Transformer Control and	As specified

	relay Panel	
TC	Tripping Coil	As specified
CC	Closing Coil	As specified
86	Tripping Relay for Tripping function	As specified
52	Vacuum Circuit breaker	As specified
52a,52b	NO and NC contacts of Breaker Auxiliary switch respectively	As specified
PT	Potential Transformer	As specified
CT	Current Transformer	As specified
TTB	Test Terminal Block	As specified
51/50 R-Y-B-N	O/C and E/F protection	As specified
67 R-Y-B-N	Directional O/C and E/F protection	As specified
64	Restricted Earth Fault Protection	As specified
87	Differential Protection	As specified

SCHEDULE-I A

(To be submitted, duly filled in, along with the offer) Bill of materials for 33 KV feeder C&R panels

Sr. No	Description	Quantity	Make, Type & design
1	Circuit label	1 No.	
2	Mimic section(Brilliant green paint to shade No.221 of IS 5 to be used)	1 No.	
3	T-N-C type control switch for circuit breaker.	1 No.	
4	Indicating LEDs for Spring charge indication(Blue) Trip circuit healthy indication(white) one each for Trip ckt 1 and Trip Ckt 2 Breaker 'ON' indication(Red) Breaker 'OFF' indication(Green)	 1 No. 2 Nos. 1 No. 1 No.	
5	Push button for Trip circuit test Alarm Accept/Reset/Test/Mute	 1 No. 4 Nos.	
6	Numerical non-directional IDMT over current and earth fault relay with high set instantaneous trip feature	1 No.	
7	High speed Master tripping relay (Electrically resettable)	1 No.	
8	12 window annunciation scheme with accept, reset and LED test push button with self resetting audible alarm.	1 Set	
9	Ammeter (96 mm x 96 mm.)	3 Nos.	
10	Voltmeter (96 mm x 96 mm.) & selector switch.	1 Set	

11	Local / Remote switch	1 Set	
Internally mounted			
1	Space heater and control switch	1 Set	
2	Cubical illumination lamp and door switch	1Set	
3	Power Plug, socket and control switch	1 set	
4	Alarm bell for trip	1 No.	
5	Alarm cancellation relay	1 No.	
6	Alarm buzzer for non trip with auto-stop feature (with variable time setting 0-60 seconds)	1 No.	
7	MCBs	As required	
8	Fuse and Links	As required	
9	Control wire	As required	

SCHEDULE-I B

Bill of materials for 33/11KV Transformer C&R panels with differential protection

Sr. No	Description	Quantity	Make ,Type and design
1	Circuit label	1 No.	
2	Mimic section (Brilliant green paint to shade No. 221 of IS 5 to be used)	1 Set	
3	T-N-C type control switch for circuit breaker.	1 No.	
4	Indicating LEDs for		
	Spring charge indication(blue)	1 No.	
	Trip circuit healthy indication(white)) one each for Trip	1 No.	

	ckt 1 and Trip Ckt 2		
	Breaker 'ON' indication(Red)	1 No.	
	Breaker 'OFF' indication(Green)	1 No.	
5	Push button for Trip Circuit Healthy Test, Alarm accept/Reset/Test/Mute	5 NoS.	
6	Trip circuit Healthy test	1 No.	
7	Numerical non-directional IDMT over current and earth fault relay with high set instantaneous trip feature	1 No.	
8	High speed master tripping relay (electrically resettable)	1 No.	
9	Space for HT Static TOD Tri-vector Energy meter and TTB.	1 No.	
10	Ammeter (96 mm x 96 mm.)	3 Nos. and 1 No.	
11	Voltmeter (96 mm x 96 mm.) & selector switch.	1 Sets	
12	Transformer differential numerical relay	1 No.	
13	16 window annunciation scheme with accept, reset and LED test push button with self resetting audible alarm.	1 No.	
14	Auxiliary relay for main tank Buchholz Alarm/trip (2- element)	1 Set	
15	Aux. relay for winding temp Alarm/trip (2-element)	1 Set	
16	Aux. relay for OLTC Buchholz Alarm/trip (2-element)	1 Set	
17	Aux. relay for low oil level alarm(Main Tank) & OSR(OLTC) Trip (2-element)	1 Set	
18	Aux. relay for oil temp alarm/trip (2-element)	1 Set	
19	Aux. relay for Main tank PRV & OLTC PRV Trip (2- element)	1 Set	
Internally mounted			
1	Space heater and control switch	1 No.	
2	Cubicle illumination lamp with door switch.	1 No.	
3	Power plug with control switch	1 No.	
4	MCB.	As required	

5	Fuse and Links	As required	
6	Control wire	As required	

SCHEDULE-IC

(To be submitted duly filled in alongwith the offer)

Bill of materials for 33/11KV Transformer C&R panels without differential protection.

Sr.	Description	Quantity	Make and Type desig
1	Circuit label	1 No.	
2	Mimic section (Brilliant green paint to shade No.221 of IS 5 to be used)	1 Set	
3	T-N-C type control switch for circuit breaker	1 No.	
4	Indicating LEDs for		
	Spring charge indication(blue)	1 No.	
	Trip circuit healthy indication (white) one each for Trip Ckt 1 and Trip Ckt 2	2 Nos.	
	Breaker 'ON' indication (Red)	1 No.	
	Breaker 'OFF' indication (Green)	1 No.	
5	Push button for Annunciation AC/RE/TEST/MUTS & Trip Circuit Healthy	5 Nos	
6	Numerical non-directional IDMT over current and earth fault relay with high set instantaneous trip feature.	1 No.	
7	High speed tripping relay (electrically resettable)	1 No.	
8	Space for HT TOD Tri-vector Energy meter and TTB.	1 No.	
9	Ammeter (96 mm x 96 mm.)	3 Nos. & 1No	
10	Voltmeter (96 mm x 96 mm.) & selector switch.	1 Set	
11	16 window annunciation scheme with accept, reset and LED test push button with self resetting audible alarm.	1 No.	
	Auxiliary relay for main tank Buchholz Alarm/trip (2-element)	1 Set	
	Aux. relay for winding temp Alarm/trip (2-element)	1	

		Set	
	Aux. relay for OLTC Buchholz Alarm/trip (2-element)	1 Set	
	Aux. relay for low oil level alarm(Main tank) /OSR(OLTC)Trip (2-element)	1 Set	
	Aux. relay for oil temp alarm/trip (2-element)	1 Set	
	Aux. relay for Main tank PRV / OLTC PRV Trip (2- element)	1 Set	
	Internally mounted		
1	Space heater and control switch	1 No.	
2	Cubicle illumination lamp with door switch.	1 No.	
3	Power plug with control switch	1 No.	
4	MCBs, fuses, links, control wiring, etc.	As required	
5	Fuse and Links	As required	
6	Control wire	As required	

NOTE: THE MANUFACTURERS MUST HAVE TO SUBMIT SEPARATE BILL OF MATERIAL FOR DIFFERENT TYPE OF PANELS WITH THE GUIDELINE AS MENTIONED ABOVE, FURNISHING THE TYPE AND MAKE OF EACH ITEM.

SCHEDULE - II

DETAILS OF RELAYS, METERS, EQUIPMENT& DEVICES AS OFFERED IN SCHEDULE OF 33 KV SIMPLEX TYPE CONTROL AND RELAYS PANEL – TO BE FILLED UP BY THE MANUFACTURERS ALONGWITH SUBMISSION OF SUPPORTING DOCUMENTS

Sl. No.	**Description**	**Make And Country Of Manufacture**	**Type (Catalogue to be enclosed)**	**Brief Description, with CT/PT details, contact configuration, Input/Output details, characteristics, range, suitability etc. for clear perspective.**
A	**SURFACE MOUNTING DEVICES**			
1	**Circuit Level**			
2	**Mimic Diagram**			
3	**Circuit Breaker Control Switch Spring return lost motion type**			
4	**Ammeter 96 mm sq. for C.T. Secondary rated Current 1A Scale 0-100/0-200A Scale 0-200A / 0-400A**			
5	**Voltmeter 96 mm Sq. for P.T. Secondary 110 VAC (L/L) Scale 0-40 KV**			
6	**Voltmeter Selector Switch 6 way & off position having break before make contact**			

7	**Test Terminal block suitable for 3 phase 4 wire system with wire rear connecting studs having provision of sealing arrangement**			
8	**Multi way micro processor based Electronic Annunciator with building- system watchdog first fault indications and red & yellow coloured windows with inscription for Trip & Non Trip Alarm functions**			
9	**Indicating Lamps led type 63.5 VAC for P.T. Supply indication with RED/YELLOW/ BLUE Colours**			
10	**Indicating Lamp LED type 230 VAC for Panel D.C. Fail Common Indication**			
11	**Indicating Lamp LED type 30 VDC for CB ON/OFF Auto up Spring Charge Trip Circuit Healthy Indication with RED/GREEN/ AMBER /BLUE Colours**			
12	**Push Button for Panel DC fail test**			
13	**Push Button for including AC fail test**			
14	**Push Button for non trip Panel DC**			

	fail Alarm Accept			
15	**Push Button for Annunciator Alarm Test / Mute/Accept/Reset**			
16	**3 Element normal IDMTL over current Relay with instantaneous high set unit**			
17	**Single Element Instantaneous sensitive Earth Fault Relay with Timer**			
18	**Triple Pole Directional Voltage polarized Over Current Relay with Directional High Set Unit on all Element**			
19	**Single Pole Directional Voltage polarized Instantaneous sensitive E/F Relay with timer**			
20	**Hi balance Instantaneous Restricted Earth Fault Circulatory Current Fault Relay** **(a) HV side of Power Trf. (b) LV side of Power Trf.**			
21	**Single Element High Speed Tripping Relay with electrically reset Contact & H/R flag/indication with required numbers of contracts**			

22	**Two Element 30 V DC Voltage Actuated Auxiliary Relay with HR Contacts & HR/LED Flag/indication for Transformer Internal Trouble functions**			
23	**Single Element 30V DC Voltage Actuated Auxiliary Relay with self Reset Contact & Reverse Flag indication for Panel DC Supply fail function**			
24	**Single Element 230V AC Voltage Actuated Auxiliary Relay with self Reset Contacts & Reverse Flag indication for incoming AC Supply fail function**			
25	**30 V DC Voltage operated Relay for Trip Circuit supervision purpose with self reset contact**			
26	**Single Element 230V AC Voltage Actuated Auxiliary Relay with self Reset Contacts without Flag indication for panel DC fail Alarm, Accept**			
27	**Additional Involvement of Single Element 30V DC Voltage Actuated Auxiliary Relay**			
28	**Extra Involvement of Auxiliary Relay**			

	for not having sufficient contacts to achieve required functions			
29	**Space & wiring for housing purchaser's projection mounting type Energy meter(not within the scope of manufacturer**			
30	**Common Electronic DC bell/Buzzer Trip & Non-Trip Alarm functions**			
31	**Common Electronic AC Ball for Panel DC fail Alarm functions**			
32	**Biased differential relay for 10 MVA Trf. Control & Relay Panel**			
B	**Inside Mounting Devices**			
1	**230V AC Cubicle illuminating lamp with door operated Switch/Toggle Switch**			
2	**30V DC Emergency Lamp with Toggle Switch**			
3	**230C AC 60W space heater with thermostat & Toggle Switch**			
4	**15A Double V AC Combined 2/3 pin plug and socket with Switch**			
5	**15A Double Pole MCB for Incoming AC Supply**			
6	**Fuse**			

7	**Links**			
8	**Terminals**			
9	**Earthing Arrangement**			
10	**Interposing P.T. for Directional Relay if required**			
11	**Interposing Universal type CT for Differential Relay if required**			

Note: All surface mounting devices excepting Energy meter,TTB & Bells are flush mounting type As per Schedule requirement.

Schedule-V

GTP for Numerical Feeder Protection Relay

Sl. No.	**Feature and Function**	**Supplier's details**
1.1	Make, Type, Model No and Version No and Ordering Code	
1.2	Conformance to i. IEC255-4	
	ii. IEC 61850	
1.3	No. of CT inputs for O/C and E/F Protection	
1.4	Type test report submitted(y/n)	
1.5	Relay shall be of Numeric Design	
1.6	Relay designed for bay protection and Control	
1.7	Size of Relay LCD screen	
1.8	Relay is equipped with CB close and open key/push buttons	
1.9	Relay has following protection functions: a. Three phase over current b. Earth fault c. Thermal overload function d. Broken conductor protection function e. Circuit Breaker Maintenance function	
2.	a. One time delayed element and	

	two high set elements b. Setting range and step for IDMT element for both current and Time Multiplier Setting	
	c. Selectable Current/Time Curve for IDMT element	
	d. Setting range and step for high set elements for both current and time delay	
10.	Sampling rate and frequency of analog signal	
11.	Whether remote controllable from SCADA	
12.	a. No. of Digital Inputs b. Voltage rating of Digital Inputs c. Provision of testing without current injection	
13.	Supervision for CB open and Closed status	
14.	No. of programmable LEDs and no. of Latched LEDs	
15.	Analog Measurement and display supported	
16.	Fault Record storage capacity	
17.	Event storage capacity	
18.	Disturbance record storage capacity	
19.	MMI with keypad and LCD provided	

20.	Rated DC Supply and tolerance	
21.	Rating of CT/PT secondary	
22.	Rated frequency	
23.	a. Operating ambient temperature & humidity	
	b. Withstanding capability of Electromagnetic Interference as per relevant part of IEC 61850	
24.	Mounting	
25.	Watchdog	
26.	a. Nominal Feeder current	
	b. CT Ratio setting	
	c. Earth fault current with time delay IEC Curves, 2nd stage for instantaneous trip(less than 50 ms)	
	d. High set with delay	
	e. IEC Curves for all O/C and E/F have user selectable?	
27.	a. No. of Digital Output Contacts	
	b. Contact rating	
28.	Mode of Time Synchronization	
29.	Type of Lugs and terminators	
30.	MTBF	
31.	Lifespan	
32.	Compliance to Type Test	
33.	Communication Port a. Rear port- details b. Front port-details	
34.	Whether Communication Ports are native to the Relay	
35.	Protocol supported for Rear Port	

36.	Protocol supported for Front port	
37.	Start and trip output contacts are freely programmable	
38.	Cable for connection of Relay to laptop(USB port) along with converter and power supply if required for relay local setting	
39.	Basic application software for setting change, parameterisation	
40.	CD with software(licensed) to download disturbance recorder, event log and evaluation of those records	
41.	Graphical configuration tool for I/P, O/P and functional building block for protection and control	
	Any other software required for integration with SCADA.	

Schedule-VI

GTP for Master Trip Relay

Sl. No.	Description	Manufacturer's Response
01.	Manufacturer Name	
02.	Type and designation	
03.	Electrical reset	
04.	Mounting	
04.	High Burden relay	
05.	Operating Time	
06.	Rated DC supply and tolerance	
07.	No. of NO Contact	
08.	No. of NC Contact	

Schedule-VII

GTP for Numerical Based Differential Relay

Description	Manufacturer's Response
Manufacturer Name	
Type and designation	
Rated DC supply and tolerance	
C.T. secondary current	
Adjustable bias setting	
Operation philosophy	
Whether Programmable HV/LV CT ratio of T/F vector group provided	
Inbuilt REF protection provided	
Inbuilt HV & LV side over current & earth fault protection provided	
Inbuilt transformer trouble auxiliary relay provided	
Display Type and details	
Whether Harmonic restrain feature available	
Details of Event Recording and storing facility	
Password protection	
DC burden	
AC burden	
Contact arrangements	
Contact rating	
Current Input	
Self diagnosis feature provided	
Mounting Arrangement	

Communication port Details	

ANNEXURE-I

Technical specification for IEC 61850 compliant non- Directional O/C and E/F Relay with Bay control features

Sl. No.	Feature and Function	Technical requirement
1	Purpose and application	It is intended to automate the Switchgears specified in the scope of supply and use Communicable Numeric relays for Protection, Control, Metering and Status monitoring. This specification is based on the understanding that an integrated Automation System along with protections shall be provided and same shall have provisions for Integration with SCADA system. All the feeders shall be remote controlled from EMPLOYER's SCADA and from the local console of the numerical relays. Numerical multifunctional combined Microprocessor based Feeder protection and management relay to protect the 33kV Feeder from all electrical and other faults along with reporting system, Disturbance record for fault analysis. Manufacturer should comply with any especial requirement or feature asked for retrofitting the relays. Relay should be IEC 61850 compliant. Relay should have 4 CT input for O/C and E/F protection. There should be option for derivation of E/F internally.
2.	Main Protection Feature	1. Relay should have minimum two group of setting. Setting group changeover required from digital status input. 2. Electrical over load protection with selectable IEC curves with two stage, first stage to be used as Definite Time / IDMT and second stage to be used as high set for short circuit protection. 3. Earth fault protection in two stages with IEC characteristics. First stage to be used as IDMT/Definite

		Time and second stage to be used as instantaneous elements. Earth fault element should be suitable for both CBCT and residual type CT connection. 4. Negative phase sequence Protection with IEC Curves. 5. CB Fail Protection & time settable as per user. 6. The relay should be immune to DC switching while carrying current i.e. no spurious trip should be generated if relay DC is made On and Off 7. The relay should conform to the IEC255-4 or BS 142 for Inverse time characteristics. 8. The relay should have features to monitor for broken conductor and CB opening time
3.	Processor feature	Relay shall be completely Numerical with protective elements having software algorithm based on sampling of Analog inputs. Sampling Rate of Analog Signal: The sampling rate should be 1000 Hz for 50 Hz signal or better for each analog channel. Hardware based measurements shall not be acceptable.
4.	Operational Philosophy	The operation of Relay shall be possible both locally from the Switchgear and remote & Local Work station. The local position shall be displayed in remote / local workstation and remote operation shall be blocked if the switch is in Local. Clear control priorities shall prevent initiation of operation of a single switch at the same time from more than one of the various control levels and there shall be interlocks among various control levels. The priority shall always be with the lowest enabled control level. Relay accuracy shall not be affected by system frequency fluctuation.
5.	Status/Optical Inputs/Digital inputs	1. Minimum 7 number status inputs are required 2. All status inputs should be 30 V DC/110 V DC (will be mentioned during detailed Engineering as per requirement). 3. Setting group is required to be changed with any Digital input status. 4. Trip circuit supervision with DI status 5. The digital inputs shall be acquired by exception

		with 1ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state. 6. Relay should have comprehensive self diagnostic feature with remote indication of relay failure and alarm shall be generated without tripping of circuit 7. Provision of Testing output relays without any current injection. 8. No. of programmable LEDs - at least 4 nos. with latching option.
6.	Main measuring and reporting feature	All measurements should be in primary quantities. Minimum following displays are required in alpha numeric:- 1. Three phase (Positive sequence) current 2. Neutral(zero sequence) current 3. All the trips should have clear indication on the relay terminals 4. Resetting should be selectable as hand reset or auto reset. 5. The default relay LCD shall be user defined to display primary circuit loading.
7.	Memory and Recording Feature	1. The relay setting and programming should be stored in EEPROM so that during Aux. Power failure the said data is not lost. 2. Relay should have event log, trip log and DR record. All logs should go in to history. 3. All tripping of relay should initiate DR in auto without extra binary input. Triggering of DR with binary input should be user configurable.
		4. The last 2 fault DR records should be in flash memory and DR will not erase in case of DC supply fail for more than 2 days. 5. Should be able to record at least 5 Oscillographic disturbances and 5 fault records and 250 event records. 6. Minimum Four no. of latest trip log with cause of trip should be stored in memory along with date and time stamping. The memory should not be lost with the switching off of DC. 7. The relay should have fault-recording feature

		with current waveform and Digital Input status. The fault waveform should consist of minimum four current waveforms of three phase current and zero sequence current and DI status. Triggering time for Pre and Post should have user selectable. This record should be in flash memory for minimum 7(seven) days even after switching off the DC supply. 8. The fault should be date and time stamped. 9. Communication protocol IEC 61850.
8.	Auxiliary Supply	30 V or 110 VDC (will be mentioned during detailed Engineering as per requirement) to - 25% to + 10%, 2 wire unearthed system. Necessary software shall be in-built for proper shutdown and restart in case of power failure. Auxiliary supply burden will be around 20Watt.
9.	Rated CT/PT secondary	5/1 Amp(User selectable) , CTs used to be protection class
10.	Rated frequency	50 HZ +/- 5%
11.	Ambient condition	1. Operating ambient temperature upto 55 Deg C 2. Operating Humidity upto 100 % 3. Relay shall meet the requirement for withstanding electromagnetic interference according to relevant parts of IEC 61850. Failure of single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.
12.	Module and Mounting	1. Relay should be flush mounted type 2. If module is drawout type then it should have CT shorting facility of make before break type. 3. Mounting in switchgears located in non AC rooms. 4. Galvanic isolation between field connection and relay hardware should be there.
13.	Watchdog and self monitoring	The relay should have facility to monitor the healthiness of its circuits and components by own monitoring system. In case of any problems, the alarm should be generated by one of the output contacts. The alarm as soft signal to be sent to SCADA system as well. Necessary support
		documentation explaining the self diagnostic feature shall be furnished Watch dog contact shall be provided

		in addition to required 7BI and 7 BO.
14.	Settings	Approximate settings possible should be as follows:- 1. Nominal Feeder current 2% to 110 % 2. CT Ratio setting 10-1000(approx.) 3. Earth fault current 5 to 40% with time delay IEC Curves, 2nd stage for instantaneous trip(less than 50 ms) 4. Over current trip- 50% to 200% of 1/5 Amp with time delay as per IEC Curves. 5. High set with delay 200% to 2000% 6. IEC Curves for all O/C and E/F have user selectable.
15.	Output Relays	Minimum 7 number output relays are required out of which 1. One potential free change over contact should be provided for start inhibit of relay. 2. All o/p contact should be freely programmable. 3. Rating of trip contacts:- a) Contact durability>10K operation b) 15 Amp make and carry for 3 sec for trip contact c) Make and carry for trip contacts L/R<=40ms Rating of Alarm contacts:- a) 8 Amp make and carry continuously for 5 sec. Testing of Output relays through keypad on relay fascia and relay HMI software. Output relay dwell time shall be user programmable or fixed at 100ms.
16.	Relay software and Man Machine Interface	1. The relay should have native IEC 61850 Communication Protocol. 2. Should have password protected key padlock. 3. Necessary software for relay setting , retrieving DR, event log, trip log should be supplied by the Manufacturer. Necessary License is to be issued for EMPLOYER, if required. 4. Manufacturer has to supply communication hardware

		for relay setting, DR downloading from front port. This device should be compatible to USB/Ethernet port. 5. It shall be possible to transfer the data stored in the DFR to computer on IEEE/COMTRADE format. The data format shall be compatible for dynamic protection relay testing on relay test kit. COMTRADE data viewing software to be provided. 6. Multiuser/Corporate license for installation on minimum 7 nos. of PCs.
17.	Date and time	Date and Time stamping with faults and record. The clock should be powered from internal cell and should not required setting after every DC switching. The internal cell life minimum 5 years. Time synchronization by IRIG-B or SNTP. For time synchronization through SNTP is to be provided from clock signal coming from RTU. In case of IRIG-B, time synchronization will be done with GPS clock signal from GPS receiver located at substation.
18.	Lugs and terminators	All CT and PT terminals shall be provided as fixed (screwed) type terminals on the relay to avoid any hazard due to loose connection leading to CT opening or any other loose connection. Necessary amount of lugs should be supplied along with each relay for CT connection and control wiring.
19.	Manuals, Drawings and Literature	1. The relays should be supplied with manuals with all technical and operating instructions. 2. All the internal drawings indicating the logics and block diagram details explaining principle of operation should be given at the time of supply. 3. Mapping details shall be submitted in IEC format.
20.	Standard documentation per Relay, according to IEC 61850	1. MICS document (model implementation conformance statement) 2. PICS(protocol implementation conformance statement 3. Conformance Test certificate from KEMA/CPRI. 4. PIXIT document All the above mentioned certificates shall be submitted. 5. ICD file

		6. SCD file
21.	Extendibility in Future	The Manufacturer shall provide all necessary software tools along with source codes to perform addition of bays in future and complete integration with SCADA by the User. These software tools shall be able to configure relay, add analog variable, alarm list, event list, modify interlocking logics etc. for additional bays/equipments which shall be added in future.
22.	Lifespan	The supplier should mention following:- 1. Product maturity: The Manufacturer should mention the time period for which the product is in the market 2. Expected production life 3. Hardware/Firmware change notification process. Upgrades to be provided free of cost within the Guarantee period/5 years whichever is later, if needed. 4. Lifespan of standard tools and processes for relay configuration, querying and integration.
23.	Standards	The relay should conform to the IEC255-5 or equivalent BS / ANSI for following:- 1. Overload withstand test 2. Dielectric withstand: 2kV in common, 1 kV in differential mode 3. Impulse Voltage: 5kV in common, 1kV in differential mode 4. Insulation resistance>100 M-ohm. 5. Vibration: Shock and bump and Seismic 6. Storing and transportation 7. Radio Interference: IEC 61000 for high frequency disturbance, Transient disturbance, Electrostatic discharge 8. KEMA Certification for the particular model offered with respect to IEC61850 Protocol.
24.	Communication Port	1. Two nos. IEC 61850 protocol compliant Ethernet RJ45/F.O port for communication with SCADA system through two managed Ethernet Switches operating in

		redundant mode. The communication shall be made in 1+1 mode between individual IED to Switch, such that failure of one set of LAN shall not affect the normal operation of SCADA. However, it shall be alarmed in SCADA. 2. Functioning of Relay shall not hamper to fault occurring any interconnected relay. 3. One Front port Ethernet RJ45/USB 2.0 for relay parameterization and configuration etc. with the help of PC. In case RS-232 port offered, suitable interfacing cable with one end having RS 232 port and other end USB 2.0 to be provided to connect with PC free of cost. 4. Relay should generate GOOSE message as per IEC 61850 standard for interlocking and also ensure interoperability with third party relays.
25.	Name Plate and marking	Each IED shall be clearly marked with manufacturer's Name, type, serial no. and electrical rating data. Name plates shall be made of anodized aluminium with white engraving on black surface.
26.	Performance Guarantee	Relays will be guaranteed for the period of five years from the date of last dispach. Any problem in the said period should be attended free of charge inclusive of repair/replacement of relays/ component (both H/W, S/W).
27.	Type Test	|| Dielectric Withstand Test—IEC 60255-5 || High Voltage Impulse Test, class III --- IEC 60255-5(5kV peak, 1.2/50
		micro Sec;3 Positive and 3 negative shots at interval of 5 Sec.) || DC Supply Interruption ---- IEC 60255-11 || AC Ripple on DC supply ---- IEC 60255-11 || Voltage Dips and Short Interruptions --- IEC 61000-4-11 || High frequency Disturbance ---- IEC 60255-22-1, Class III || Fast Transient Disturbance ---- IEC 60255-22-4, Class-IV

		⁞⁞ Surge withstand capability ---- IEEE/ANSI C 37.90.1(1989) ⁞⁞ Degree of Protection ⁞⁞ Electromagnetic compatibility ⁞⁞ Mechanical stress/vibration test ⁞⁞ Temperature withstand Type test reports for the above tests shall be submitted for the approval of EMPLOYER along with Tender, failing which order may be rejected. Wherever the above mentioned standards and IEC 61850 overlap, the latter will prevail.
28.	Training	Suitable training to be imparted to employer persons on the following items:- 1. Relay setting and parameterization 2. Relay configuration with respect to I/P, O/P and functional block for protection. 3. GOOSE configuration. 4. Configuration and Interfacing required for third party SCADA System Integration. 5. Diagnostic features The details of syllabus to be finalized with EMPLOYER.
29.	Service Charge for Commissioning Engineer	Firm rate shall be quoted separately for commissioning and integration of Relay with SCADA as per format. This rate shall be valid for three years from due date of submission of tender. However, the above cost will not be considered for evaluation.

Inter-operability test:-

After fulfilment of the above Q.R. inter-operability test of the offered relay (other than Make & Model used in EMPLOYER) with the existing relay in EMPLOYER Network will be tested in EMPLOYER Distribution Testing Department, EMPLOYER for which due intimation for supply of sampled of offered relay will be given to the Manufacturer. The Manufacturer needs to submit the said relay to Distribution Testing Department, EMPLOYER within one week from the said intimation.

The offered relay will only be accepted after fulfilment of above Q.R. & successful inter-operability test at EMPLOYER system.

Checklist for Bill of Material for supply

Sl. No.	Material	
1.	Relay (Model No.)	Qty as per Tender
2.	Lugs suitable for current and control, wiring	Qty as per Tender X Number of TBs in relay + 20% extra.
3.	Cable for connection of Relay to laptop(USB port). Along with converter and power supply if required for relay local setting	10 set
4.	Manual, Hard copy in good quality paper properly bounded	10 set
5.	Copy of Type Test certificate along with manual	With offer
6.	Basic application software for setting change,	10 nos.
7.	CD with software(licensed) to download disturbance recorder, event log and evaluation of those records	10 nos.
8.	Graphical configuration tool for I/P, O/P and functional building block for	10 nos.

	protection	
9.	Any other software required for integration with SCADA.	10 nos.

N.B All the above tools/ Software should be compatible to WINDOWS XP/WINDOWS NT/WINDOWS 7 Operating System.

ANNEXURE-II

Technical specification for IEC 61850 compliant Directional O/C and E/F Relay with Bay control features

Sl. No	Feature and Function	Technical requirement
1	Purpose and application	It is intended to automate the Switchgears specified in the scope of supply and use Communicable Numeric relays for Protection, Control, Metering and Status monitoring. This specification is based on the understanding that an integrated Automation System along with protections shall be provided and same shall have provisions for Integration with SCADA system. All the feeders shall be remote controlled from EMPLOYER's SCADA and from the local console of the numerical relays. Numerical multifunctional combined Microprocessor based Feeder protection and management relay to protect the 33 kV Parallel Feeder from all electrical and other faults along with reporting system, Disturbance record for fault analysis. Manufacturer should comply with any especial requirement or feature asked for retrofitting the relays. Relay should be IEC 61850 compliant. Relay should have 4 CT input, 3 input for O/C and residual E/F protection will be derived internally. One CT input may be used for unbalanced current protection. Relay should have 4 voltage input , 3 input for VT element for directional O/C protection with internally derived residual voltage for E/F protection. Another VT input will be used for residual voltage protection. Relay should have two stage over voltage and under voltage protection.
2	Main Protection Feature for directional O/C & E/F relay.	1. Electrical over load protection with selectable IEC curves with two stage, first stage to be used as Definite Time / IDMT and second stage to be used as high set for short circuit protection. 2. Earth fault protection in two stages with IEC characteristics. First stage to be used as IDMT/Definite Time and second stage to be used as instantaneous elements. Earth fault element should be

		suitable for both CBCT and residual type CT connection. 3. Negative phase sequence Protection with IEC Curves. 4. CB Fail Protection & time settable as per user. 5. The relay should be immune to DC switching while carrying
		current i.e. no spurious trip should be generated if relay DC is made On and Off 6. The relay should conform to the IEC255-4 or BS 142 for Inverse time characteristics. 7. VT fuse fail detection on NPS current/NPS Voltage or zero sequence current/voltage based logic and blocking of under voltage protection by VT fuse fail detection. 8. Three phase VT fuses fail detection on current based logic. 9. The relay should have features to monitor for broken conductor and CB opening time. 10. The relay shall be designed for application in EMPLOYER's distribution network where the system is non-effecively earthed through earthing transformer emanating at 33kV bus of 132/33 kV substation. 11. Relay should have minimum two group of setting. Setting group changeover required from digital status input.
3.	Processor feature	Relay shall be completely Numerical with protective elements having software algorithm based on sampling of analog inputs. Sampling Rate of Analog Signal: The sampling rate should be 1000 Hz for 50 Hz signal or better for each analog channel. Hardware based measurements shall not be acceptable.
4.	Operational Philosophy	The operation of Relay shall be possible from both locally from the Switchgear and remote and Local Work station. The local position shall be displayed in remote / local workstation and remote operation shall be blocked if the switch is in Local. Clear control priorities shall prevent initiation of operation of a single switch at the same time from more than one of the various control levels and there shall be interlocks among various control levels. The priority shall always be with the lowest enabled control level. Relay accuracy shall not be affected by system frequency fluctuation.

5.	Status/Optical Inputs/Digital inputs	1. Minimum 7 number status inputs are required 2. All status inputs should be 30 V DC/110 V DC (will be mentioned during detailed Engineering as per requirement) 3. Setting group is required to be changed with any Digital input status. 4. Trip circuit supervision with DI status 5. The digital inputs shall be acquired by exception with 1ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state. 6. Relay should have comprehensive self diagnostic feature with remote indication of relay failure and alarm shall be generated without tripping of circuit 7. Provision of Testing output relays without any current injection. 8. No. of programmable LEDs- at least 4 nos. with latching option.
6.	Main measuring and reporting feature	All measurements should be in primary quantities. Minimum following displays are required in alpha numeric:- 1. Three phase (Positive sequence) current, Three phase voltage 2. Neutral (zero sequence) current, MW, MVAR, Frequency, Pf, MVA etc. 3. All the trips should have clear indication on the relay terminals 4. Resetting should be selectable as hand reset or auto reset.
7.	Memory and Recording Feature	1. The relay setting and programming should be stored in EEPROM so that during Aux. Power failure the said data is not lost. 2. Relay should have event log, trip log and DR record. All logs should go in to history. 3. All tripping of relay should initiate DR in auto without extra binary input. Triggering of DR with binary input should be user configurable. 4. The last 2 fault DR records should be in flash memory and DR will not erase in case of DC supply fail for more than 2 days. 5. Should be able to record at least 5 Oscillographic

		disturbances and 5 fault records and 250 event records. 6. Minimum Four no. of latest trip log with cause of trip should be stored in memory along with date and time stamping. The memory should not be lost with the switching off of DC. 7. The relay should have fault-recording feature with current waveform and Digital Input status. The fault waveform should consist of minimum four current waveforms of three phase current and zero sequence current and DI status. Triggering time for Pre and Post should have user selectable. This record should be in flash memory for minimum 7 days even after switching off the DC supply. 8. The fault should be date and time stamped. 9. Communication protocol IEC 61850.
8.	Auxiliary Supply	30 V or 110 VDC (will be mentioned during detailed Engineering as per requirement) to - 25% to + 10%, 2 wire unearthed system. Necessary software shall be in-built for proper shutdown and restart in case of
		power failure. Auxiliary supply burden will be around 20Watt.
9.	Rated CT/PT secondary	5/1 Amp(site selectable) , CTs used to be protection class. 3PT input rated 110 Volt (L-L)
10.	Rated frequency	50 HZ +/- 5%
11.	Ambient condition	1. Operating ambient temperature up to 55 Deg C 2. Operating Humidity up to 100 % 3. Relay shall meet the requirement for withstanding electromagnetic interference according to relevant parts of IEC 61850. Failure of single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.
12.	Module and Mounting	1. Relay should be flush mounted type 2. If module is draw out type then it should have CT shorting facility of make before break type. 3. Mounting in switchgears located in non AC rooms. 4. Galvanic isolation between field connection and relay hardware should be there.
13.	Watchdog and self monitoring	The relay should have facility to monitor the healthiness of its circuits

		and components by own monitoring system. In case of any problems, the alarm should be generated by one of the output contacts. The alarm as soft signal to be sent to SCADA system as well. Necessary support documentation explaining the self diagnostic feature shall be furnished. Watch dog contact shall be provided in addition to required 7BI and 7 BO.
14.	Settings	Approximate settings possible should be as follows:- 1. Nominal Feeder current 2% to 110 % 2. CT Ratio setting 10-1000(approx.) 3. Earth fault current 5 to 40% with time delay IEC Curves, 2nd stage for instantaneous trip(less than 50 ms) 4. Over current trip- 50% to 200% of 1/5 Amp with time delays as per IEC Curves. 5. High set with delay 200% to 2000% 6. IEC Curves for all O/C and E/F have user selectable. 7. Selectable MTA for Directional features for O/C relay should cover 1st quadrant for effectively grounded system/ impedance grounded system/solid grounded system.
15.	Output Relays	Minimum 7 number output relays are required out of which 1. One potential free change over contact should be provided for start inhibit of relay. 2. All o/p contact should be freely programmable. 3. Rating of trip contacts:- a) Contact durability>10K operation b) 15 Amp make and carry for 3 sec for trip contact c) Make and carry for trip contacts L/R<=40ms Rating of Alarm contacts:- d) 8 Amp make and carry continuously for 5 sec. Testing of Output relays through keypad on relay fascia and relay HMI software. Output relay dwell time shall be user programmable or fixed at 100ms.
16.	**Relay software and Man Machine**	1. The relay should have native IEC 61850 Communication

	Interface	Protocol. 2. Should have password protected key padlock. 3. Necessary software for relay setting, retrieving DR, event log, trip log, and downloading waveform should be supplied by the Manufacturer. Necessary Licensed is to be issued for EMPLOYER, if required. 4. Manufacturer has to supply communication hardware for relay setting, DR downloading from front port. This device should be compatible to USB/Ethernet port. 5. It shall be possible to transfer the data stored in the DFR to computer on IEEE/COMTRADE format. The data format shall be compatible for dynamic protection relay testing on relay test kit. COMTRADE Data viewer software is to be provided. 6. Multiuser/Corporate license for installation on minimum 7 nos. of PCs.
17.	**Date and time**	Date and Time stamping with faults and record. The clock should be powered from internal cell and should not required setting after every DC switching. The internal cell life minimum 5 years. Time synchronization by IRIG-B or SNTP. For time synchronization through SNTP is to be provided from clock signal coming from RTU. In case of IRIG-B, time synchronization will be done with GPS clock signal from GPS receiver located at substation.
18.	**Lugs and terminators**	All CT and PT terminals shall be provided as fixed (screwed) type terminals on the relay to avoid any hazard due to loose connection leading to CT opening or any other loose connection. Necessary amount of lugs should be supplied along with each relay for CT connection and control wiring.
19.	**Manuals, Drawings and Literature**	1. The relays should be supplied with manuals with all technical and operating instructions. 2. All the internal drawings indicating the logics and block diagram details explaining principle of operation should be given at the time of supply.

		3. Mapping details shall be submitted in IEC format.
20.	**Standard documentation per Relay, according to IEC 61850**	1. MICS document (model implementation conformance statement) 2. PICS(protocol implementation conformance statement 3. Conformance Test certificate from KEMA/CPRI. 4. PIXIT document All the above mentioned certificates shall be submitted along with Order copy 5. ICD file 6. SCD file
21.	**Extendibility in Future**	The Manufacturer shall provide all necessary software tools along with source codes to perform addition of bays in future and complete integration with SCADA by the User. These software tools shall be able to configure relay, add analog variable, alarm list, event list, modify interlocking logics etc. for additional bays/ equipments which shall be added in future.
22.	**Lifespan**	The supplier should mention following:- 1. Product maturity: The Manufacturer should mention the time period for which the product is in the market 2. Expected production life 3. Hardware/Firmware change notification process. Upgrades to be provided free of cost within the Guarantee period/5 years whichever is later, if needed. 4. Lifespan of standard tools and processes for relay configuration, querying and integration.
23.	**Standards**	The relay should conform to the IEC255-5 or equivalent BS / ANSI for following:- 1. Overload withstand test 2. Dielectric withstand: 2kV in common, 1 kV in differential mode 3. Impulse Voltage: 5kV in common, 1kV in differential mode 4. Insulation resistance>100 M ohm 5. Vibration: Shock and bump and Seismic 6. Storing and transportation

		7. Radio Interference: IEC 61000 for high frequency disturbance, Transient disturbance, Electrostatic discharge 8. KEMA/CPRI Certification for the particular model offered with respect to IEC61850 Protocol
24.	**Communication Port**	1. Two nos. IEC 61850 protocol compliant Ethernet RJ45/F.O port for communication with SCADA system through two managed Ethernet Switches operating in redundant mode. The communication shall be made in 1+1 mode between individual IED to Switch, such that failure of one set of LAN shall not affect the normal operation of SCADA. However, it shall be alarmed in SCADA. 2. Functioning of Relay shall not hamper to fault occurring any interconnected relay. 3. One Front port Ethernet RJ45/USB 2.0 for relay parameterization and configuration etc. with the help of PC. In case RS-232 port offered, suitable interfacing cable with one end having RS 232 port and other end USB 2.0 to be provided to connect with PC free of cost. 4. Relay should generate GOOSE message as per IEC 61850 standard for interlocking and also ensure interoperability with third party relays.
25.	**Name Plate and marking**	Each IED shall be clearly marked with manufacturer's Name, type, serial no. and electrical rating data. Name plates shall be made of anodized aluminium with white engraving on black surface.
26.	**Performance Guarantee**	Relays will be guaranteed for the period of five years from the date of last dispach. Any problem in the said period should be attended free of charge inclusive of repair/replacement of relays/ component (both H/W, S/W).
27.	**Type Test**	⁞⁞ Dielectric Withstand Test—IEC 60255-5 ⁞⁞ High Voltage Impulse Test, class III --- IEC 60255-5(5kV peak, 1.2/50 micro Sec;3 Positive and 3 negative shots at interval of 5 Sec.) ⁞⁞ DC Supply Interruption ---- IEC 60255-11 ⁞⁞ AC Ripple on DC supply ---- IEC 60255-11

		❙❙ Voltage Dips and Short Interruptions --- IEC 61000-4-11 ❙❙ High frequency Disturbance ---- IEC 60255-22-1, Class III ❙❙ Fast Transient Disturbance ---- IEC 60255-22-4, Class-IV ❙❙ Surge withstand capability ---- IEEE/ANSI C 37.90.1(1989) ❙❙ Degree of Protection ❙❙ Electromagnetic compatibility ❙❙ Mechanical stress/vibration test ❙❙ Temperature withstand Type test reports for the above tests shall be submitted for the approval of EMPLOYER along with Tender. Wherever the above mentioned standards and IEC 61850 overlap, the latter will prevail.
28.	**Training**	Suitable training to be imparted to employer's persons on the following items:- 1. Relay setting and parameterization 2. Relay configuration with respect to I/P, O/P and functional block for protection. 3. GOOSE configuration. 4. Configuration and Interfacing required for third party SCADA System Integration. 5. Diagnostic features
29.	**Service Charge for Commissioning Engineer**	Firm rate shall be quoted separately for commissioning and integration of Relay with SCADA as per format. This rate shall be valid for three years from due date of submission of tender. However, the above cost will not be considered for evaluation.
30.	Credential as pre- requisite of Tender	1. Copies of performance certificate for two years successful operation as on the due date of bid opening for the offered relay in respect to implementation of IEC 61850 protocol to any SCADA/substation automation system from reputed Power Sector Utility in India shall have to be furnished along with the Bid. Copies of Purchase Orders and corresponding Delivery Challans /Stores Receipt vouchers/ Excise Duty Invoice, etc., i.e. Proof of Execution of the Purchase Orders. OR

		Successful testing and operation of minimum one year in EMPLOYER network.. 2. Documentary evidence for being manufacturers like registration Certificate issued by SSI/NSIC/Directorate of Industries/DGS&D, etc. for Qualifying requirement. 3. The manufacturer should have testing facilities of all functional tests or should have arrangement of all functional tests at government approved testing laboratories. **Inter-operability test:-** After fulfilment of the above Q.R. inter-operability test of the offered relay (other than Make & Model used in EMPLOYER) with the existing relay in EMPLOYER Network will be tested in EMPLOYER Distribution Testing Department, EMPLOYER for which due intimation for supply of sampled of offered relay will be given to the Manufacturer. The Manufacturer needs to submit the said relay to Distribution Testing Department, EMPLOYER within one week from the said intimation.

Checklist for Bill of Material for supply

Sl. No.	Material	
1.	Relay (Model No.)	Qty as per Tender
2.	Lugs suitable for current and control, wiring	Qty as per Tender X Number of TBs in relay + 20% extra.
3.	Cable for connection of Relay to laptop(USB port). Along with converter and power supply if required for relay local setting	10 set
4.	Manual, Hard copy in good quality paper properly bounded	10 set
5.	Copy of Type Test certificate along with manual	With offer
6.	Basic application software for setting change,	10 nos.
7.	CD with software(licensed) to download disturbance recorder, event log and evaluation of those records	10 nos.
8.	Graphical configuration tool for I/P, O/P and functional building block for protection	10 nos.
9.	Any other software required for integration with SCADA.	10 nos.

N.B All the above tools/ Software should be compatible to WINDOWS XP/WINDOWS NT/WINDOWS 7 Operating System.

QUALITY ASSURANCE PLAN (Annexure-III)

The manufacturer shall invariably furnish following information along with his offer.

(1) Statement giving list of important raw materials including but not limited to

(a) Contact material
(b) Insulation
(c) Sealing material
(d) Contactor, limit switches, etc. in control cabinet.

Name 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 Manufacturer's representative, copies of test certificates.
2) Information and copies of test certificates as in (i) above in respect of bought out accessories.
3) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
4) Special features provided in the equipment to make it maintenance free.

5) List of testing equipment available with the Manufacturer for final testing and associated combinations vis-à-vis, the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in the relevant schedule i.e. schedule of deviations from specified test requirements. The supplier shall, within 15 days from the date of receipt of Purchase Order submit following information to the EMPLOYER :-
i) List of raw materials as well bought out accessories and the names of sub-suppliers selected from those furnished along with offer.
ii) Necessary test certificates of the raw material and bought out accessories.

iii) Quality Assurance Plan (QAP) with hold points for EMPLOYER's inspection. The quality assurance plan and hold points shall be discussed between the EMPLOYER and supplier before the QAP is finalized.
iv) The supplier shall submit the routine test certificates of bought out items and raw material, at the time of routine testing of the fully assembled Panel.

14. Batteries and Charger

Lead Acid or Ni-Cd, any one of these two can be used by contractor. Both the specification along with specification for their charger are given below:

I. Ni-Cd ALKALINE BATTERIES (PARTIAL RECOMBINATION TYPE) WITH CHARGERS FOR 33/11 kV AND 66/11 kV SUB-STATIONS

Part-A :Ni-Cd ALKALINE BATTERIES (PARTIAL RECOMBINATION TYPE) FOR 33/11 kV AND 66/11 kV SUB-STATIONS

1) SCOPE

This specification covers the requirements and tests for 24 V, 30 V 110 V, 220V partial recombination type Nickel-Cadmium alkaline batteries with chargers, for use in 33/11 kV and 66/11 kV sub-stations.

The batteries covered in this specification are for indoor use. For out-door application a suitable enclosure shall be provided, preferably made of an insulating material like FRP/SMC/DMC/Poly carbonate plastic material, heat/alkali/humidity/UV resistant, confirming to S1 or D1 grade of IS: 13410/IS: 13411 or other relevant international standard, in order to have rust free enclosure. The enclosure shall have rainproof ventilating louvers backed with fine brass wire mesh & suitable canopy. The enclosures shall confirm to IP: 52 degree of protection.

2. APPLICABLE STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. Unless otherwise modified in this specification, the Ni-Cd batteries shall comply with latest version of IEC 62259.

All work shall be carried out as per the following standards and codes.

Sl .No.	International Standards	Indian Standards	Description

Sl .No.	International Standards	Indian Standards	Description
1	IEC: 62259	-	Secondary cells and batteries containing alkaline or other non-acid electrolytes-Nickel-cadmium prismatic secondary single cells with partial gas recombination
2	IEC: 60623	IS: 10918	Secondary cells and batteries containing alkaline or other non-acid electrolytes-vented Nickel_Cadmium prismatic rechargeable single cells
3		IS: 1146	Rubber & Plastic container for lead acid storage batteries
4	IEEE: 1106		Recommended practice for maintenance, testing & replacement of Ni-Cd storage batteries for generating stations & substations
5	IEEE: 1115		Recommended practice for sizing of Ni-Cd batteries for stationary applications
6		IS 13410	Glass reinforced Polyester sheet moulding compounds.
7		IS: 1248	Voltmeter

3. STANDARD RATING

The recommended voltage ratings of batteries, for use at 33/11 KV and 66/11 KV sub-stations, shall be 24 volts or 30 volts. The batteries for the above application shall

have a rating of 45 Ah (Minimum) in case of 24 V battery system or as per the load requirement of the substation.

Note: Utilities may specify 110 or 220 V DC system if so required. For batteries intended for use with individual or groups of breakers or with higher DC System voltage, lower Ah ratings can be used depending upon the requirements.

4. CELL VOLTAGE

The nominal voltage of a single cell shall be 1.2 V

Nominal Voltage Rating of battery	**Nominal single cell voltage**	**Float cell voltage**	**Number of cells (to be finalized)**	**Permissibe D.C. System voltage variation**	**End of discharge cell voltage (Min.)**
(V)	(V)	(V)	(V)	(V)	(V)
24	1.2	1.4 to1.42	19	21.7 to 27	1.14
30	1.2	1.4 to1.42	23	26.2 to 32.7	1.14
110	1.2	1.4 to 1.42	87	99.2 to 123.5	1.14
220	1.2	1.4 to1.42	170	193.8 to 241.4	1.14

Note: As the nominal cell voltage is 1.2 V, nominal battery bank voltage may not exactly match nominal DC system voltage.

5. CAPACITY AT 20^0C TEMPERATURE

Battery capacity shall be decided based on the following load cycle:-

(a) 800W for 1/2 minuteto end cell voltage of not less than 1.14 V per cell considering loads (i) to (iv) below.

(b) 300 W for 1 hour to end cell voltage of not less than 1.14 V per cell considering loads (iii) & (iv) below.

(c) 100W for 05 hrs to end cell voltage of not less than 1.14 V per cell considering loads (iv) below.

The load cycle has been decided based on the following considerations:-

(i) Tripping of 03 Nos. circuit breakers simultaneously with battery for which a total load of 500 W has been considered.

(ii) Closing of 3 circuit breakers one after the other for which a load of 500 W per circuit breaker has been considered.

(iii) Emergency lighting load of 200 W for 01 hour.

(iv) 100 W load for panel indication lamps, relays, PLCC/ VHF communication systems, computer etc. for a period of 06 hours.

6. BATTERY SIZING

The supplier shall carry out battery sizing calculations based on the load cycle specified in line with IEEE 1115 and submit the same to the owner justifying the type/number of cells considered against the requirement.

Following factors shall be considered while carrying-out battery sizing calculations:-

a) Ageing factor – 1.25
b) Design margin –1.0
c) State of charge –0.9

The number of cells shall be determined as per load cycle and the battery system voltage level. The owner, if required for the battery system, may specify provision for the number of spare cells.

7. CONSTRUCTION

The cells shall have prismatic, spill-proof type of construction with partial recombination feature. The cells shall be flooded type containing sufficient reserve electrolyte. Battery shall be equipped with nickel-plated inter-cell connectors and terminals. The cells shall be housed in high-strength impact resistant & alkali-resistant containers and should be transparent / translucent to facilitate checking of electrolyte level. Container and Lid should bewelded and should not cause leakage of electrolyte/gases during operation even in case of normal mechanical/electrical abuses. O-rings of nitrile rubber with Epoxy sealing shall be used to ensure proper sealing of bushings etc. Flip-top vent plugs/ valves with flame arrester feature shall be provided. The regulating valve type design shall be of self-resealing type. Construction of cells shall be so as to ensure proper air circulation between the cells for heat dissipation/ ventilation (by providing either insulated button separators integral with the outer surface of the cell container or by suitably designing the inter cell connectors). The containers shall be strong enough, so that excessive bulging of container does not occur during service. Cells shall be supplied in filled & charged state or otherwise electrolyte in dry form & battery water separately or electrolyte in liquid form shall be shipped as desired by the owner.

Battery shall have provision for water top up to ensure electrolyte level does not fall below recommended level.

8. ELECTRODES

Electrodes shall be deigned for maximum durability under all service conditions. + ve and –ve electrodes shall be made by encapsulating/impregnating active material in order to ensure that the battery is able to perform reliably over its life. +ve and –ve electrodes shall be separated by micro porous separators. The structure of electrodes shall be elastic enough to absorb mechanical stresses & volume changes during charge/discharge cycles.

9. ELECTROLYTE

The electrolyte shall be prepared from battery grade potassium hydroxide (KOH) confirming to IEC 60993. The cells shall contain sufficient reserve electrolyte for efficient heat dissipation &to reduce water topping up interval. Reserve electrolyte shall not be less than 06 ml/Ah.

10. CONNECTORS

Nickel-plated copper inter-cell connectors shall be used forconnecting up adjacent cells and rows. Bolts, nuts and washers shall be nickel-plated steel/stainless steel. All terminals and cell inter-connectors shall be fully insulated or have insulation shrouds.

11. TERMINALS

Separate terminals shall be provided on the end cell for connecting load through DCDB and for connecting charger leads. All terminals shall be of suitably sized nickel-plated steel. Suitable nickel-plated copper lugs shall be provided by the supplier for use of the purchaser for connecting up the load wiring. All connectors and leadsshall be suitable for carrying 30-minute discharge current continuously and rated for short circuit duty of 4kA for 01 second.

12. MANUAL OF INSTRUCTIONS

The manufacturer shall supply a copy of the instruction manual for commissioning & initial treatment of the battery and maintenance during service with every battery bank ordered.

13. RECOMBINATION EFFICIENCY

In order to reduce topping-up frequency, recombination of Hydrogen & Oxygen gases evolved during charging/discharging shall be achieved by using safe and reliable technology such as catalytic conversion/valve regulation technique or both. Minimum recombination efficiency shall be 80%. Recombination efficiency test shall be done in

accordance with IEC 62259. In case the batteries are operated at high temperatures & are frequently boost charged the water consumption may be higher & topping-up frequency may increase.

14. BATTERY RACKS

Suitable corrosion resistant battery racks and cable supports shall be provided. Metallic racks shall be properly earthed. The bottom tier of stand shall have a ground clearance of 150mm minimum above the floor. Racks shall be made of alkali resistant powder coated steel or stainless steel or FRP to ensure corrosion resistance.

15. TEMPERATURE RANGE

Battery must be capable of continuous operation in temperatures range of -15^{o}C to +50^{o}C for prolonged periods. No Air-conditioning shall be provided where batteries are to be installed.

16. ACCESSORIES

The following accessories (BIS certified) shall be supplied with each set of battery:-

i) Clamp-on type digital multi-meter of AC/DC current range having ISI mark.
ii) Pair of gloves
iii) 10" Slide insulated wrench for opening terminal nuts
iv) Plastic/glass syringe
v) Alcohol thermometer
vi) Hydrometer for use while filling electrolyte.

17. CHARGE RATE

Fully discharged batteries should be able to get recharged in 7 hours maximum to 90% of capacity with charging current in the range of 0.1 to 0.4CmA rate at 20ºC. At higher temperatures, the charging time may be more. The trickle charge rate shall be 1-2 mA/Ah.

18. CELL DESIGNATION

The practice as per IS: 10918 (latest version) shall be followed.

19. POLARITY MARKING

The polarity of the terminals shall be marked for identification. Positive terminal may be identified by 'P' or a (+) sign or red colour mark and negative terminal may be

identified by 'N' or (-) sign or blue colour mark. Marking shall be permanent and non-deteriorating.

20. WARNING MARKING

The battery shall be furnished with a warning plate located at conspicuous place specifying the use of 'ALKALINE ELECTROLYTE ONLY' (in block letters) and specifying proper filling level of the electrolyte. Marking shall be permanent and non-deteriorating.

21. PACKING

The batteries shall be securely packed in wooden crates suitable for handling during transit by rail/road and secured to avoid any loss or damage during transit. Carton boxes duly palletized shall also be acceptable.

22. TESTS

The batteries shall be tested for type, acceptance and routine tests in line with IS: 10918 & IEC: 62259 (latest versions). The owner may at their discretion to accept the batteries based on type tests already carried-out. In such cases, Type test reports for tests carried out not earlier than 05 years from bid opening date from NABL accredited labs shall be acceptable.

Note : In case Type tests are repeated, life cycle test may not be insisted upon Ni-Cd battery of the specific ratings to be ordered, as this test takes a long time (2-3 years). However, satisfactory evidence is to be furnished for having made this test on cell of any other Ah capacity of the same design.

23. BUYBACK OF USED/UNSERVICEABLE BATTERIES

Manufacturer shall buyback used/unserviceable batteries from the substations where batteries are replaced. The owner shall confirm the following particulars of used/unserviceable batteries to enable the bidder to quote buyback rates:

i) Type & number of cells for disposal
ii) Make
iii) Year of make/purchase
iv) Capacity
v) Condition of cells

The bidder should quote their rates for buyback considering the salvage value of the above cells.

24. SAFE DISPOSAL OF UNSERVICEABLE BATTERIES

The bidder shall have facilities for proper treatment & disposal of used/unserviceable batteries that are bought back from the users, in line with the environmental protection rules & regulations of the country.

25. GUARANTEE

The batteries shall be guaranteed for a period of 36 months from the date of commissioning.

Part B : CHARGER FOR Ni-Cd BATTERY (RECOMBINATION TYPE)

1. SCOPE

This specification covers the requirements and tests for Battery charger for partial recombination type Nickel-Cadmium alkaline batteries for use in 33/11 KV and 66/11 KV sub-stations.

2. CODES AND STANDARDS

2.1. All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards and codes.

2.2.

Sl. No	International standards	Indian standards	Description
1		IS:5	Colours for ready mix paints.
2		IS : 1248	Direct acting indicating analogue electrical measuring instruments.
3	IEC : 947-1	IS : 13947 Prt-1	Low voltage switchgear and control gear - General.
4	IEC : 947-2	IS : 13947 Prt.-2	Low voltage switchgear and

			control gear - Circuit Breaker
5	IEC : 947-3	IS : 13947 Prt-3	Specification for low voltage switchgear and control gear – Switches, Disconnectors, Switch disconnectors & Fuse combination units.
6	IEC : 947-4	IS : 13947 Prt-4	Specification for low voltage switchgear and control gear – Contactors
7		IS : 13947 Prt-5	Specification for low voltage switchgear and control gear – Control Circuit Devices & Switching Elements
8	IEC: 439	IS:8623	Low voltage switch-gear and control-gear assemblies
9		IS:8686	Static protective relays
10	IEC:225	IS : 3231	Electrical relays for power system protection.
11		IS : 3842	Application guide for Electrical relays for AC System
12	IEC 146	IS : 3895	Mono-crystalline semi-conductor Rectifier Cells and Stacks.
13	IEC 146	IS : 4540	Mono crystalline semi-conductor Rectifier assemblies and equipment.
14		IS:6619	Safety Code for Semi-conductor Rectifier Equipment.
15		IS : 9000	Basic environmental testing procedures for electronic and

			electrical items.
16	IEC: 60269	IS:13703 Prt-4	Low voltage fuses for protection of semiconductor devices.
17		IS:1901	Visual indicating lamps
18		IS:6005	Code of practice for phosphating of Iron and Steel.
19	IEC: 227	IS:694 /IS: 1554	PVC Insulated Cable for working voltages upto and including 1100 V.

2.3. Equipment complying with other internationally accepted standards such as IEC, BS, VDE. etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

3. EQUIPMENT DESCRIPTION

3.1. a) The Battery Chargers as well as their automatic regulators shall be of static type. Battery chargers shall be capable of continuous operation at the respective rated load in Float mode, i.e. Float charging the associated Ni-Cd Batteries (partial recombination type) while supplying the D.C. loads. The Batteries shall be Float charged at 1.4 to 1.5 Volts per cell. All chargers shall also be capable of Boost Charging the associated Batteries at 1.42 to 1.7 Volts per cell at the desired rate. The Chargers shall be designed to operate, as mentioned above, up-to an ambient air temperature of 50°C. Tapping arrangement in the battery bank shall be provided to limit the over-voltage for supplying load within allowed voltage range under boost charge conditions. The charger should automatically switchover to float charge & to boost charge when the specified limit of voltage is approached. However, necessary timer circuit shall be used to allow a finishing charge before switching over to float mode, as recommended by battery manufacturer in order to ensure that battery gets fully charged. Recommended values of charger rating, tapping cell and specified

voltages for automatic changeover to float/boost mode are given in table below, however, the manufacturer may suggest any changes in the recommended values with justification at the time of supply :

Rating of Charger	**Charger Rating during Float Charging at 1.4 to 1.45 V per cell**	**Charger Rating during Boost Charging at 1.42 to 1.7 V per cell**	**Tapping to be provided at ---th cell**	**Switching Voltage to Boost Mode**	**Switching Voltage to Float Mode**
Volt	**Ampere**	**Ampere**	**n**	**Volt**	**Volt**
24	10	25	15	22	32
30	10	25	18	26	38
110	5	5	69	94	146
220	5	5	136	194	285

Note : Charger rating shall be arrived at with charger in boost mode and also supplying 100% float load i.e. charger current shall be sum of float & boost rating.

b) Battery Chargers shall automatically select the appropriate mode of operation i.e. Float or Boost. Means shall be provided to avoid current/voltage surges of harmful magnitude/nature, which may arise during changeover.

c) Soft start feature shall be provided to build up the voltage to the set value slowly within fifteen seconds. The chargers shall have load limiters, which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the load limiter setting of the Charger. The load limiter characteristic shall be such that any sustained overload or short circuit in DC system shall neither damage the Charger nor shall it cause blowing of any of the charger fuses. The Charger shall not trip on overload or external short circuit. After clearance of fault, the Charger voltage shall build up automatically when working in automatic mode.

During external short circuit, output of the charger shall be automatically reduced to near zero volt till it is not isolated/disconnected & normal output voltage shall be restored by charger circuit on isolation with out any harm to source transformer/protection/ regulator circuit

d) During Float charging, the Charger output voltage shall remain within ±1% of the set value for AC input voltage variation of 230 +10% -15%, frequency variation of ±5%, a combined voltage and frequency (absolute sum) variation of 10% and a continuous DC load variation from 5% to full load. Uniform and stepless adjustments of voltage setting shall be provided on the front of the Charger panel covering the entire Float charging output range specified. Stepless adjustment of the load limiter setting shall also be possible from 80% to 100% of the rated output current for Float charging mode.

e) During Boost charging, the Battery Chargers shall operate on constant current mode with maximum current limiter setting (When automatic regulator is in service).

f) Energising the Charger with fully charged battery connected plus 10% load shall not result in output voltage greater than 110% of the voltage setting. Time taken to stabilise, to within the specified limits in clause 3.1 (d), shall be less than five seconds.

g) Momentary output voltage of the Charger, with the Battery connected shall be within 90% to 110% of the voltage setting during sudden load Change from 80% to 20% of full load or vice-versa. Output voltage shall return to, and remain, within the limits specified in clause 3.1 (d) in less than 1 second after the above-mentioned change.

h) The Charger manufacturer may offer an arrangement in which the voltage setting device for Float charging mode is also used as output voltage limit setting device for Boost charging mode, and the load limiter of the float charging mode is also used as Boost charging current setting device.

i) Suitable filter circuits shall be provided in all the Chargers to limit the ripple content (peak to peak) in the output voltage to 3% irrespective of the DC load, even when they are not connected to a battery.

j) The DC System shall be ungrounded and float with respect to the ground potential when healthy.

k) Battery shall be isolated in case of short circuit on the load side.

l) Battery test circuit shall be provided with suitable resistance for discharging the battery for 30Sec at 5 hr rate.

m) All potentiometers shall be electronically locked to contain the various parameters within allowable limits even if the setting position of potentiometers is changed to extreme positions.

n) Insulation resistance shall be 5 M Ohm min.

3.2. MCB

AC MCCB shall be provided at the incomer. DC MCCB with provision of auxiliary contacts shall be provided at the output of the battery charger.

3.3. Rectifier-Transformers and Chokes

The rectifier transformer and chokes shall be dry and air cooled (AN) type. The rating of the rectifier-transformers and chokes shall correspond to the rating of the associated rectifier assembly. The rectifier-transformers and chokes shall have class-B insulation as per IS : 4540. Rectifier transformer shall confirm to all type tests as specified in IS 4540/IS 2026. Type test & routine test reports shall be submitted to the owner.

3.4. Rectifier Assembly

The rectifier assembly shall be full wave bridge type and designed to meet the duty as required by the respective Charger. The rectifier cells shall be provided with their own heat dissipation arrangement with natural air-cooling. The rectifier shall utilise diodes/thyristors with heat sinks rated to carry 130% of the load current continuously and the temperature of the heat sink shall not be permitted to exceed 85°C absolute duly considering the maximum temperature inside charger panel with ambient temperature of 50°C. The Contractor shall submit calculations to show what maximum junction temperature will be and what the heat sink temperature will be when operating at 130% and 100% load current continuously duly considering the maximum surrounding air temperature for these devices inside the charger panel assuming ambient temperature of 50°C outside the panel. Necessary surge protection devices and rectifier type fast acting fuses shall be provided in each arm of the rectifier connections. Static silicon controlled rectifiers and diodes complete with resistor/capacitor network for surge protection shall be provided

Design having IGBT or superior technology shall also be acceptable for which full justification & experience shall be required for acceptance.

3.5. Instruments

Analog or digital D.C. voltmeter, D.C. ammeter and A.C. voltmeter with 96 mm square display shall be provided for all Chargers. The instruments shall be flush mounted type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustments. The instruments shall be of 1.5 accuracy class.

3.6. Control and Selector Switches

Control and selector switches shall be of rotary stayput type of reputed make, confirming to relevant IS with escutcheon plates showing the functions and positions. The switches shall be of sturdy construction and suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred. The contact ratings shall be at least the following :

i) Make and carry continuously - 10 Amps.

ii) Breaking current at 220 V DC - 0.5 Amp. (Inductive)

iii) Breaking current at 230 V AC - 5 Amp. at 0.3 p.f.

3.7. Fuses

Fuses shall be of HRC cartridge fuse link type. Fuses shall be mounted on fuse carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on fuse carriers, they shall be directly mounted on plug in type bases. In such cases one insulated fuse pulling handle shall be supplied for each charger. Suitable fuse fail detector circuits with alarm contacts shall be provided for all D.C. fuses.

3.8. Indicating Lamps

The indicating lamp shall be of panel mounting, LED type and capable of clear status indication under the normal room illumination. The lamp covers shall be preferably screwed type, unbreakable and moulded from heat resistant material.

3.9. Blocking Diode

Blocking diode, wherever required, with full redundancy shall be provided in the output circuit of each Charger to prevent current flow from the D.C. Battery into the Charger.

3.10. Annunciation System

Visual indications through indicating lamps/LEDs or annunciation facia shall be provided in all Chargers for the following:

i. A.C. supply failure
ii. Rectifier fuse failure
iii. Surge circuit fuse failure
iv. Filter fuse failure
v. Load limiter operated
vi. Input AC MCCB trip
vii. Output DC MCCB trip
viii. Battery on Boost
ix. Load-side DC under-voltage & over-voltage alarm
x. Battery side DC over-voltage alarm
xi. AC available – Battery discharge (Mains available battery discharge) alarm
xii. Potential free NO contacts shall be provided for following remote alarms:
   a) Battery on boost
   b) Charger trouble (this being a group alarm initiated by any of the faults other than 'Battery on Boost')

3.11. Name Plates and Marking

The nameplates shall be made of non-rusting metal/3 ply Lamicoid and shall have black background with white engraved letters and secured by screws. These shall be provided near top edge on the front as well as on rear side of Charger. Nameplates with full and clear inscriptions shall also be provided on and inside the panels for identification of various equipment.

3.12. Detailed dimensional drawings, commissioning and operating instructions and Test Certificates of the manufacturer shall be supplied with the equipment.

3.12.1. CONSTRUCTION

3.13. The Chargers shall be indoor, floor mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Charger shall be fabricated using cold rolled sheet steel not less than 1.6 mm thick. The panel frame shall be fabricated using cold rolled sheet steel of thickness not less than 2.0 mm. Removable un-drilled gland plates of at least 3.0 mm sheet steel and lugs for all cables shall be supplied by the Contractor. The lugs for cables shall be made of electrolytic copper with tin plating. Cable sizes shall be advised to the Contractor at a later date for provision of suitable lugs and gland

plates. Ventilating louvers shall be backed with fine brass wire mesh. All doors and covers shall be fitted with nitrile/neoprene/PU rubber gaskets. The Chargers shall have hinged double leaf doors provided on front and/or backside for adequate access to the Charger internals. All the Charger cubicle doors shall be properly earthed. The degree of protection of Charger enclosure shall be at least IP-42. The construction shall meet the requirements of IS 6619. All equipment mounted in the cabinet shall be provided with individual labels with equipment designation engraved.

3.14. In case of outdoor mounting, the charger shall be provided with double doors on both front & back and shall pass IP-42 requirement with one door open on both sides. The enclosure shall be provided with a canopy.

3.15. The layout of Charger components shall be such that their heat losses do not give rise to excessive temperature within the Charger panel. Location of the electronic modules will be such that temperature rise, in no case, will exceed 10°C over ambient air temperature outside the Charger.

3.16. Each Charger panel shall be provided with an illuminating lamp (CFL or tube-light) and one 5 Amp. socket. Switches and fuses shall be provided separately for each of the above.

3.17. Locking facilities shall be provided as following:

a) For locking Float/Boost selector switch in the float position only.

b) The Charger enclosure door shall have provision for padlocks. Padlocking arrangement shall allow ready insertion of the padlock shackle but shall not permit excessive movement of the locked parts with the padlock in position.

4.6 WIRING

3.17.1. Each Charger shall be furnished completely wired upto power cable lugs and terminal blocks, ready for external connection. The power wiring shall be carried out with 1.1 kV grade PVC insulated cables conforming to IS:1554 (Part-I). The control wiring shall be of 1.1kV grade PVC insulated stranded copper conductors of 1.5 sq.mm. minimum, conforming to IS:694. Control wiring terminating at electronic cards shall not be less than 0.75 sq. mm. Control terminal shall be suitable for connecting two wires of 1.5 sq.mm. stranded copper conductors. All terminals shall be numbered for ease of connections and identification. At least 20% spare terminals shall be provided for circuits.

3.17.2. Power and control wiring within panels shall be bundled separately. Any terminal or metal work which remains alive at greater than 415 V, when panel door is opened, shall be fully protected by shrouding.

An air clearance of at least ten (10) mm shall be maintained throughout all circuits, except low voltage electronic circuits, right upto the terminal lugs. Whenever this clearance is not available, the live parts should be insulated or shrouded.

3.18. Painting

Pre-treatment & phosphating with 7 tank process shall be provided as per IS: 6005. The phosphate coating shall be 'class-C' as specified in IS: 6005. Electrostatic powder painting with final shade – 692 (smoke grey) of IS: 5 shall be provided. The thickness shall not be less than 50 microns.

3.19. PACKING & DISPATCH

The equipment shall be dispatched securely packed in wooden crates suitable for handling during transit by rail/road so as to avoid any loss or damage during transit.

4. QUALITY ASSURANCE PLAN

4.1. The vendor shall furnish the following information along with his bid; failing which the bid shall be liable for rejection. Information shall be separately given for individual type of material offered.

i) The structure of Organization
ii) The duties and representatives assigned to staff ensuring Quality of work
iii) The system of purchasing, taking delivery and verification of materials
iv) The system for ensuring quality of workmanship
v) The quality assurance arrangements shall conform to the relevant requirement of ISO 9001 or ISO 9002 as applicable
vi) Statement giving list of important raw materials/components, list of sub-suppliers, list of standards according to which the raw materials are tested.
viii) List of manufacturing facilities available.
ix) Level of automation achieved and list of areas where manual process exists.
x) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
xi) Lists of testing equipment 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.

4.2. The contractor shall also submit following information after award of contract:

i) Sub-suppliers of raw materials as well as bought out accessories & components. The equipment supplied shall adhere to the list of components submitted & as per type-tested equipment.
ii) Type test certificates of the raw materials and bought out accessories as required by the owner.
iii) Manufacturing Quality Plan (MQP) shall be submitted. The owner hold points for stage inspection shall be discussed between the owner and contractor at the time of award of contract before the MQP is finalized.

4.3. Makes of the following components (not restricted to) shall be subject to owner's approval.

i) Relays
ii) Instruments
iii) SCR/IGBT
iv) Diodes
v) Annunciator

5. TESTS

Battery chargers including the components shall confirm to all type tests including heat run test as per relevant Indian standards. Performance test on the chargers as per specification shall also be carried out on each charger.

5.1. TYPE TESTS

5.1.1. Following type tests, in addition to the requirement of IS : 4540, should have been carried out on each rating and type of Battery Charger for which reports are to be submitted.

i. Complete physical examination.
ii. Temperature rise test at full load (at highest voltage & highest current).
iii. Insulation resistance test.
iv. High voltage (power frequency) test on power and control circuits except low voltage electronic circuits.
v. Ripple content test at
vi. No load
vii. Half load
viii. Full load

ix. Automatic voltage regulator operation test at specified A.C. supply variations at

a) No load
b) Half load
c) Full load

x. Load limiter operation test

xi. Short circuit test at full load and at no load for sustained short circuit of 1-minute minimum shall be carried out. The charger shall not trip, no fuse shall blow and charger current shall be limited to 150% of the rated current.

xii. Efficiency and power factor measurement.

xiii. **Environmental Tests**

Steady state performance tests (clause 7.2.2 (f) and (g)) shall be carried out before and after the following tests.

i) Dry heat, Damp Heat, Vibration, Low temperature, Transportation, shock as per IS : 9000.
ii) Degree of protection test (IP-42).

xiv. Rectifier transformer – As per IS 4540.

5.1.2. If type tests are carried out against the contract, minimum 15 days notice shall be given by the contractor. The contractor shall obtain the owner's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type tests to be carried out.

5.1.3. In case the contractor has carried out the type tests within last five years as on the date of bid opening, he may submit the type test reports from NABL accredited laboratory to the owner for waival of conductance of such type tests. These reports should be for the tests conducted on the equipment with identical design to that proposed to be supplied under this contract. The owner reserves the right for conducting any or all of the specified type tests under this contract.

5.2. ROUTINE TESTS :

5.2.1. Following routine tests shall be carried out on all Rectifier transformers in addition to tests required as per IS-4540.

a) Insulation resistance test.
b) High voltage (power frequency) test.

5.2.2. Following routine tests shall be carried out on all Battery Chargers in addition to tests required as per IS-4540 :

a) Complete physical examination.

b) Short circuit test at full load and at no load for sustained short circuit of 1-minute minimum shall be carried out. The charger shall not trip, no fuse shall blow and charger current shall be limited to 150% of the rated current.

c) Insulation resistance test.

d) High voltage (power frequency) test.

e) Ripple content test at

i) No load
ii) Half load
iii) Full load

f) Automatic voltage regulator operation test at specified A.C. supply variations at

i) No load
ii) Half load
iii) Full load

g) Load limiter operation test

h) Checking of proper operation of annunciation system.

i) Dynamic response test Overshoot/Undershoot in output voltage of the charger as a result of sudden change in load from 100% to 20 % and 20% to 100% shall be measured.

j) Soak Test - All electronic modules shall be subjected to continuous operation for a minimum period of 72 hours. During last 48 hours, the ambient temperature shall be maintained at 50 deg. C. The manufacturer shall submit the record of carrying out this test to the owner's engineer at the time of inspection.

k) The charger shall be checked for gasketing arrangement as per drawing.

5.2.3. Following routine tests shall be carried out on annunciation system.

a) Soak test shall be carried out as per Cl. 7.2.2 (j).

5.3. ACCEPTANCE TESTS:

5.3.1. Following acceptance tests and checks shall be carried out by the owner at the manufacturer's works:

a) Complete physical examination.

b) Checking of proper operation of annunciation system.

c) Temperature rise test at full load.
d) Insulation resistance test.
e) Automatic voltage regulator operation.
f) Load limiter operation.
g) Dynamic response test.
h) Ripple content test

5.3.2. Overshoot/Undershoot in output voltage of the Charger as a result of sudden change in load from 100% to 20% and 20% to 100% shall be measured with the Batteries connected/disconnected. Output voltage of the Charger connected with Battery shall be within 90 % to 110 % of the voltage setting in above conditions and shall return to, and remain, within the limits specified in clause 3.1 (d) in less than 2 seconds.

5.3.3. The Contractor shall furnish for inspection, the type and routine tests certificates for Chokes and transformer whenever required by the Employer.

6. GUARANTEE

The battery charger shall be guaranteed for a period of 24 months from the date of commissioning.

II. 30 VOLT 100 AH LEAD ACID BATTERY

Part A : 30 Volt 100 Ampere-Hour Lead Acid stationary Battery

1. SCOPE

This specification covers 30 Volt 100 Ampere-Hour Lead Acid stationary Battery, for use at 33/11KV substations for feeding auxiliary supply to Switchgear equipment at the time of interruption in mains supply. The battery is to be supplied along with wooden stand/rack as per description given below. Specifications of battery rack are indicated separately.

2. APPLICABLE STANDARDS

The cells of Lead Acid Battery shall conform to the requirements of IS 1651: 1991 with latest amendment thereof.

3. STANDARD RATINGS

The standards rating for 30 Volt Lead Acid Battery shall be 100 AH.

4. CELL VOLTAGE

The nominal voltage of a single cell shall be 2.1 to 2.2 Volts.

5. CAPACITY AT ROOM TEMPERATURE

The battery shall comprise of 15 cells with capacity not less than 100 AH at 10-hour rate of discharge to end voltage of 1.85 Volts per cell at room temperature not exceeding 32 degree C.

6. GENERAL DESCRIPTION

Cells shall be supplied in glass containers having ample space provided below the plate for accumulation of deposit. The glass containers shall be sufficiently robust, transparent and free from flaws. The bidder may also quote for battery with hard rubber containers, which shall conform to IS 1146: 1981.

Lead acid battery, comprising of closed type cells shall be complete with plante / tubular type positive plate assemblies, glass boxes, lids, micro porous plastic separators, polystyrene dowels and buffers, inter cell connectors and bolts & nuts. The battery shall be complete with (i) inter row connectors and bolts & nuts, acid jars and packing case, (ii) stands (iii) stand insulators (iv) cable sockets for end and tapping connections.

The sulphuric acid and water used for the preparation and maintenance of electrolyte shall conform to IS 266: 1977 and IS 1069: 1964 respectively.

The separators used shall be either wooden or synthetic. The wooden separators when used shall conform to IS 652:1960 and the synthetic separators to IS 6071: 1986.

The venting device shall be of anti-splash type with more than one exit hole and shall allow the gases to escape freely but shall effectively prevent acid particles or spray from coming out.

A suitable electrolyte level indicator indicating lower and upper limits shall be fitted to facilitate checking of electrolyte level in opaque containers. The materials used shall be acid proof and shall not deteriorate during service.

The manufacturer's identification shall be embossed/impressed on the connectors. Where it is not possible to bolt the cell terminals directly to assemble a battery, separate lead, copper or aluminium connectors of suitable size shall be provided to enable connection of the cells.

The material for bolts and nuts shall be brass. Bolts and nuts for connecting the cells shall be effectively lead-coated to prevent corrosion.

Open cells shall be provided with spray arrestors of adequate area over the plates. These may be of glass sheet at least 3 mm thick and shall be adequately supported.

7. MOUNTING STAND

The cells shall be accommodated in double tier stand constructed of "SAL" wood and painted with 3 coats of acid proof paint. Necessary paint for this purpose shall be supplied. No metal fastenings shall be used. Stand should be self-supported and free from wrap & twist. The assembled stand / rack should be suitable for bolting end to end to form continuous row. The stands shall be supported on insulators to obtain necessary insulation from earth and there shall be insulators between each cell and stand. The price of stand shall be included in the cost of the battery.

8. TERMINALS

Separate terminals shall be provided for connecting load and charger leads to the battery terminals. All terminals shall be of M 12 size. The agency shall provide suitable copper lugs for use of the owner for connecting the load wiring.

9. ACCESSORIES

The following accessories shall be supplied along with each battery and price for the same shall be included in the cost of the battery:-

1. One battery logbook
2. Two copies of printed instruction sheet
3. One no. cell testing voltmeter (3-0-3 volts) complete with leads
4. One no. floating hydrometer
5. One no. syringe hydrometer
6. One no. thermometer (0 to 100 degree C)with specific gravity correction scale
7. One set of suitable insulated spanners
8. One no. acid resisting funnel
9. One no. acid resisting jar
10. One pair of rubber gloves
11. Lead platted 2 nut – bolts and 2 washers set = 30 + 4 extra =34 Nos.
12. Cell insulators for mounting of cells = 15X4+6 extra = 66 Nos.
13. Rack insulator for mounting of battery rack = 8 Nos. minimum

10. CHARGE RATE

Fully discharged batteries should normally be recharged at 10 Amps. for 10 hours at room temperature. New batteries and old batteries at high temperatures may need more time. Trickle charge rate shall be about 50 to 100 mA,

11. CELL DESIGNATION AND MARKING

The practices indicated in relevant IS shall be followed for cell designation purpose.

The following information shall be indelibly and durably marked on the outside of the cell:-

1. Indicating the source of manufacture
2. Ah capacity at 10-hour rate
3. Upper and lower electrolyte level in case of transparent containers
4. Year of manufacture and
5. Country of origin
6. Each cell and battery may also be marked with the Standard Mark.

The polarity of the terminals shall be marked for identification. The positive terminal may be identified by "P" or (+) sign or Red colour mark and the negative terminal may be identified by "N" or (-) sign or a Blue colour mark. Terminal marking shall be permanent and non-deteriorating.

The battery shall be supplied with a warning plate located at conspicuous place specifying the use of "PARTICULAR ELECTROLYTE ONLY' (in block letters) & specifying the proper filling level of the electrolyte. Marking shall be permanent and non-deteriorating.

12. TESTS

The following tests shall be carried out in accordance with IS 1651:1991 with latest version thereof.

13. TYPE TESTS

1. Verification of constructional requirements
2. Verification of marking
3. Verification of dimensions
4. Test for capacity
5. Test for voltage during discharge
6. Ampere-hour and watt-hour efficiency tests

7. Test for loss of capacity on storage
8. Endurance test

14. ACCEPTANCE TESTS

The following shall constitute acceptance tests: -

1. Marking and packing
2. Verification of dimensions
3. Test for capacity, and
4. Test for voltage during discharge

15. ROUTINE TESTS

The battery shall be tested after manufacture as per the requirement of IS: 1651-1991 (with latest amendment, if any). Two copies of test certificates indicating the results obtained during the tests shall be submitted.

16. MANUAL INSTRUCTIONS

The manufacturer shall supply one copy of instruction manual for initial treatment and routine maintenance during service with each battery.

The following information shall be provided on the instruction cards:-

1. Designation of cell or battery
2. Ampere – Hour capacity
3. Nominal voltage
4. Manufacturer's instructions for filling, initial charging
5. Normal and finishing charging rates and
6. Maintenance instructions

17. GUARANTEE PARTICULARS

Expected life span of battery shall be minimum 10 years. Loss of capacity on storage of a fully charged battery stored for 28 days should not be more than 3%. Battery should be capable to bear under floating & over floating conditions.

The bidders shall essentially fill up the enclosed Schedule of Guaranteed Technical Particulars of Battery offered by him.

18. PACKING

The battery shall be suitably packed in wooden crates suitable for handling during transit by rail/road, and secured to avoid any loss or damage during transit.

Part B: Battery Charger

1. SCOPE

This specification covers design, manufacturing, testing at manufacturer's works before dispatch and supply of 30 Volt 10 Ampere Single Phase Battery Charger required for charging of 30 Volt 100 Ampere-Hour Lead Acid Battery and for feeding auxiliary supply to Switchgear equipments at 33/11 kV substations.

2. STANDARDS

Unless otherwise specified, the equipment shall conform to the latest applicable Indian standards and in particular to the following standards:-

1	IS: 3895	Specification for Rectifier equipment's in general
2	IS: 13947(Part II)	Specification for MCB
3	IS: 1248	Indication instruments
4	IS: 2147	Degree of protection for cubicles
5	IS: 375	Specification for wiring
6	IS: 4540	Mono crystalline semiconductor rectifiers assemblies & equipment
7	IS: 6619	Safety code for semiconductor rectifier equipment
8	IS: 2026	Transformers
9	IS: 4237	General requirement for switchgear and control gear for voltage not exceeding 1000 Volts
10	IS: 4064	Air Break switches and fuse combination units
11	IS: 6005	Code of practice for phosphating of Iron & Steel
12	IS: 5	Colour for ready mix paints

13	IS: 5921	Printed circuit Board
14	IS: 249	Printed circuit Board
15	IS: 5578	Guide for making insulated conductor

The agency shall clearly state the standards to which the equipment offered by him conforms.

3. DRAWING AND LITERATURE

The bidder shall furnish all such drawings, instruction manuals, descriptive literature etc., as may be necessary for the proper understanding of the functioning of the charger.

The write-up should include the following:-

1. Technical specification of the charger.
2. Detailed circuit description of the charger. It should also include the functions of various components, protection circuits/cards, and relays along with their individual brief write-ups/leaflets.
3. List of the main components of the charger.
4. Following details are to be clearly indicated in the circuit diagram:-
   a. Make and Rating of components used
   b. All the fuses should be numbered and individual rating should be indicated.

4. GENERAL DESCRIPTION

The Charger shall be of simple design so as to ensure its reliable functioning and ease in maintenance/repairing. Complicated circuitry shall be avoided, as for as possible. The bidder shall indicate, as to how reliable functioning of the charger is achieved. He shall also indicate the quality control adopted for the reliable product.

The battery charging equipment shall comprise of a selenium/solid state silicon rectifier suitable for operation on 230/250 Volt Single Phase AC system. Associated transformer, regulatory resistance, switches etc. shall be accommodated in a sheet steel cubicle arranged for continuous load of 3 Amps. Adjustable from 0 to 3 Amps trickle charge of the battery and manual provision to operate at a higher voltage to recharge the battery of 100 AH capacity quickly at 10 Amp rate.

The equipment shall comprise of:-

1. AC mains switch/MCB 230/250 Volt Single Phase with fuses/MCB
2. Pilot lamp/LED type to indicate AC supply ON.
3. Ballast choke
4. Single Phase Double Wound Transformer for rectifiers
5. Main transformer single phase variac with rough and fine control to charge battery in steps of 6-12, 12-18, 18-24, 24-30, 30-36, 36-42 volts.
6. Full wave bridge connected plate/solid state silicon rectifier
7. Fuses for rectifier output
8. Moving Coil Ammeter 96-mm sq. flush mounting type (0-15 Amps.)
9. Moving Coil Voltmeter 96 mm sq flush mounting type (0-50 Volts)
10. Voltmeter fuses
11. DC ON/OF switches with fuses.

The sheet steel cubicle of the rectifier unit shall also accommodate the switches for charge rate selection, incoming from battery and various apparatus for battery control.

The chargers should have in-built automatic input voltage stabilizer in the range of 180 volt to 275 volt to facilitate steady output voltage and current from the charger.

5. CABINET

The charger shall be enclosed in a cabinet made of sheet steel of not less than 1.5 mm thickness and should be suitable for mounting on a plane surface/floor with ventilation louvers on two sides and finish painted with synthetic enamel paint of white on inside and opeline green on outside. Two coat of zinc primer shall be applied before finishing synthetic enamel paint. The cabinet shall have vermin proof construction. The cabinet legs shall be of adequate height and strength and should provide minimum clearance of 100 mm from ground.

6. FRONT PANEL MOUNTINGS

The following provisions conforming to relevant ISS shall be made on the front panel:

1. Voltmeter to indicate battery/charger DC voltage
2. Voltmeter to indicate incoming AC voltage
3. Ammeter to indicate charging/load current
4. Indicating LEDs to indicate:-

    a. Supply of power;
    b. Charger on;
    c. Input voltage less than 180 Volt

5. Audio/Visual alarm to indicate:-

a. Power failure;
b. Charger failure;
c. Battery disconnection/failure;
d. Battery reverse; and
e. DC under/Over voltage.

In case of failure of charger on fault, it should give buzzer as well as LED indication. However, the buzzer alarm should be provided with a reset switch. The indicating instruments shall be of class 1.0 accuracy

7. TRANSFORMER

The power transformer rectifier unit of the battery charger shall be designed for adequate VA rating but in any case it should not be less than 700 VA and should be rated for 300 V at factor of safety of 3. The heat dissipation and power control system should be designed with a factor of safety of 8. Rating of silicon diode should not be less than 15 A.

Please note, necessary documentary evidence, showing transformer rating of 700 VA along with test certificate from manufacturer, if bought-out, shall be enclosed, for approval of the owner.

8 PROTECTION

The charger should have built-in reverse polarity protection with indication lamp so as to protect the battery from high drains. The charger should also have MCB in the output circuit for protection from short circuits.

9. LIGHT EMITTING DIODES

For the purpose of indication LED indicators shall be provided.

10. SWITCHES AND FUSES

Control and instruments switches shall be of toggle type. All fuses shall be of HRC type and of English Electric/L&T make only.

11. LABELS

All front panel mounted equipment as well as the equipment mounted inside the cabinet shall be provided with individual labels with equipment designation engraved on aluminium plate (stickers are not acceptable).

12. WIRING

The charger shall be supplied completely wired ready for external connections at the terminal blocks. All the wiring shall be carried out with 1100 V Grade PVC insulated standard copper conductor of 2.5 Sq.mm. Colour coded wires should be used to facilitate easy tracing, as under :-

A. Single Phase AC Circuit:-

1. Red for Phase
2. Green for Earthling
3. Black for Neutral

B. D.C. Circuit:-

1. Red for Positive
2. Black for Negative

C. Control Wiring:- Gray for annunciation and other control circuits.

13. FERRULES

Engraved core identification ferules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire.

14. EARTHING TERMINALS

The battery charger cabinet shall be provided with two separate suitable earthing terminals of good quality and adequate size.

15. TESTING

The manufacturers on each battery charger shall carry out the following tests and copy of the tests certificate for each charger shall be submitted:-

1. Checking of wiring and continuity of circuits and visual inspection
2. High voltage test on the equipment with accessories. (All equipment and wiring should be tested for with-standing the power frequency voltage of 2 KV r.m.s. for 20 seconds.)
3. Checking of charging current and load currents.
4. Checking of relays operation, alarm circuit operation, lamp indication, charger failure, mains failure, load fuse failure and annunciation (manufacturer's test certificate for the instruments shall also be furnished).

5. Regulation and Ripple tests.
6. Efficiency test.
7. Burn-out/Heat-run test (for 10 Hrs.)

16. CIRCUIT DIAGRAM AND WRITE-UP

It is desired that the complete schematic of the charger is provided on a permanently laminated/engraved plate of suitable thickness, which has to be bolted/riveted at the four corners on the inside face of rear door. In addition, one more plate of similar type and dimension shall be provided on the outside of the rear door providing guidelines and instructions for operation of the charger. The guidelines and schematic to be provided on the plates shall be as per our approval for which separate drawings shall furnish, after award of contract.

17. TERMINALS

Separate terminals shall be provided for connecting load and battery leads to the charger. All terminals shall be of M12 size. Suitable copper lugs for connecting the load wiring are to be provided.

It would be the bidder responsibility to prove the adequacy of its design by submitting all technical particulars and relevant graphs to show suitability of charger for supplying load on continuous basis.

18. PRINTED CIRCUTT BOARD

The printed circuit boards should be made out of glass fiber re-in forced epoxy boards and should be coated with suitable protective coating for protection against humidity and corrosion.

19. POLARITY MARKING

The polarity marking of the terminals shall be marked for identification. The positive terminal may be identified by "P" or (+) sign or red colour mark and the negative terminal may be identified by "N" or (-) or blue colour. Terminal marking shall be permanent and non-deteriorating.

20. MANUAL OF INSTRUCTIONS

The manufacturer shall supply a copy of the Instruction Manual for commissioning and initial testing of the charger and maintenance during service with every charger supplied.

21. PACKING The charger shall be securely packed in wooden crates suitable for handling during transit by rail/road so as to avoid any loss or damage during transit.

Guaranteed Technical Particulars of **30 V, 100 Ah/200 Ah Lead Acid Battery Sets and BATTERY CHARGER**		
Sr.NO	**GTP Parameters**	
1	Name of manufacturer	
2	Type of Battery (As per specifications)	
3	Reference Standard IS : 1651 / 1991 or latest version amended upto date	
4	Whether one - acid level indicating float to each cell is fitted (Yes / No)	
5	Whether batteries terminals have suitable cable lugs (Yes /No)	
6	Arrangement of Battery cells (15 nos of 2 V , 100 AH cells connected in series to form one sets of 30 V, 100 AH or 15 nos of 2 V , 200 AH cells connected in series to form one sets of 30 V, 200 AH)	
7	Whether following accessories shall be supplied with each battery set (Yes / No)	
8	i) Inter Battery connector of lead plated copper with cross section not less than 50 sq.mm : 14 nos + 2 extra (Yes /No)	
9	ii) Lead plated 2 nut bolts and 2 washers sets : 30 sets + 4 extra (Yes / No)	
10	iii) Syringe type Hydrometer with specified gravity correction scale : 1 No (yes /No)	
11	v) Thermometer : 1 No (Yes /No)	
12	v) Voltmeter of range 3-0-3 with leads or Digital voltmeter : 1 No (Yes/No)	
13	vi) Set of spanners suitable to used nutbolts (2 spanners) : 1 set (Yes /No)	
14	vii) Rubber syringe: 1 No (Yes /No)	
15	viii) Log Book : 1 No (Yes / No)	
16	ix) Inspection sheet : 1 No (Yes / No)	
17	x) Electrolyte of dilute sulphuric acid in non - returnable carboy including 10 % extra electrolyte: 1st lot (Yes /No)	
18	xi) Cell insulators of Hard rubber (for mounting) (15 + 6 extra) : 66 nos (Yes/No)	

19	xii) Stand Insulators of stand of Hard rubber not less than 6 Nos (Yes/No)	
20	xiv) Cell number indicating plates with fixing pins : 15 Nos (Yes/No)	
21	xv) Acid Resistance Funnel : 2 nos (Yes/No)	
22	xvi) Acid Resistance Jug : 2 Nos (Yes/No)	
23	xvii) Rubber aprons : 2 nos (Yes /No)	
24	xviii) Rubber Hand Gloves (Yes /No)	
25	xix) Rubber Syphons : 1 No (Yes / No)	
26	xx) Wooden stand of teak wood : 1 No (Yes /No)	
27	The expected life span of the batteries shall be minimum 10 years (Yes/No)	
28	A. Loss of capacity on storage of fully charged battery stored for 28 days shall be not be more than 3 % (Yes /No)	
	B. If Yes , State the percentage	
29	A. Ampere hour efficiency shall not be less than 97 % (Yes /No)	
	B. If yes. State the percentage	
30	Whether battery withstand under floating and over floating conditions (Yes / No)	
31	Whether the battery is capable of being maintained at a higher Electrolyte specifi Boolean gravity of 1.230 ± 0.005 without deterioration to Grid corrosion (Yes / No)	
32	Whether following type tests are performed on 2V , battery cell : (Yes /No)	
33	i) Verification of constructional requirement (Yes /No)	
34	ii) Verification of marking (Yes /No)	
35	iii) Verification of dimensions (Yes/ No)	
36	iv) Test of capacity (Yes /No)	
37	v) Test for voltage during discharge (Yes / No)	
38	vi) Ampere- hour and watt hour efficiency test (yes / No)	
39	vii) Test for loss of capacity on storage (Yes/No)	
40	viii) Endurance Test (Yes/No)	
41	Whether above type tests are carried out within 5 years (Yes / No)	
42	Whether it is agreed to perform Acceptance tests at manufacturer's site in presence of purchaser's representative from the sample selected from the lot offered for supply (Yes / No)	
43	Dimensions of wooden stand (LX BX H) in mm	
44	Material of container (Yes/ No)	

45	Overall dimensions of each cell (L X B X H)	
46	Distance between the centers of cells when erected (in MM)	
47	Weight of cell complete with Acid (in KG)	
48	Type and material of cell separator	
49	Amount and specific gravity (1.230 ± 0.005) of electrolyte at the end of full charge	
50	Loss of capacity on storage of fully charged battery stored for 28 days	

15. LT upto (1100 V) XLPE Insulated

1.0 SCOPE:

1.1 The scope of this specification covers the design, manufacture inspection and testing the finished ISI marked LT (1100 volts, 31/2 x25 Sq.mm to 400 Sq.mm stranded, compact aluminum conductor, with XLPE insulated, PVC inner sheathed, galvanized steel strip armored/unarmored and overall PVC sheathed Black colour cable conforming to IS:7098 /88 with latest amendments and as per specification detailed.

2.0 RATED VOLTAGE:

2.1 The rated voltage of the cable shall be 1100 Volts AC with the highest system voltage of 1100 Volts between phases of the effectively earthed three-phase transmission system.

2.2 The cables shall be capable of operating continuously under the system frequency variation of ± 3 Hz, voltage variation of ± 10% and a combine d frequency – voltage variation of ± 10%.

3.0 APPLICABLE STANDARDS:

i) Unless otherwise stipulated in the specifications, the latest version of the following Standards shall be applicable:

IS 7098 (Part 2)-Cross-linked Polyethylene insulation for Cables.

IS 8130-Conductors for insulated electrical cables and flexible cords.

IS 10810(series)-Methods of tests for cables.

IS 10418-Drums for electric cables.

IS 3975-Specification for mild steel wires, strips and tapes for armouring of cables.

IS 5831-Specification for PVC insulation sheath for electric cables.

IS 10462-Fictitious calculation method for determination of dimensions of protective coverings of cables Part 1 - Elastomeric and thermoplastic insulated cables.

ii) The cables manufactured to any other International Standards like BSS, IEC or equivalent standards not less stringent than Indian Standards are also acceptable. In such cases the Manufacturer shall enclose a copy of the equivalent international standard, in English language.

4.0 CONSTRUCTION:

4.1 **Conductor:** - The cable conductor shall be made from stranded aluminum to form compact sector shaped conductor having resistance within the limits specified in IS:8130/1984 and any amendment thereof. The wires shall be laid up together with a suitable right hand lay. Stranded Class 2 – as per the IS:8 130 / IEC 60228/ BS 6360 standards.

4.2 Insulation: - The insulation shall be cross linked polyethylene applied by extrusion and shall be steam (wet) cured as pre IS:7098(1)1988 and curing in hot water tank/bath is not accepted.:

Sl.No.	Properties	Requirements
1.	Tensile Strength	12.5N/mm², Min.
2.	Elongation to break	200 percent, Min
3.	Aging in air oven: a) Treatment: Temperature: Duration: b) Tensile Strength variation: c) Elongation variation:	 135±3°C 7 days ±25 percent, Max ±25 percent, Max
4.	Hot set: a) Treatment: Temperature: Time under load Mechanical stress b) Elongation under load	 200±3°C 15 min 20N/cm² 175 percent, Max

	Permanent elongation (set) after c) cooling	15 percent, Max
5.	Shrinkage: a) Treatment: Temperature Duration b) Shrinkage	 130±3°C 1 hour 4 percent, Max
6.	Water absorption (Gravimetric): a) Treatment: Temperature: Duration b) Water absorbed	 85±2°C 14 days 1 mg/cm², Max
7.	Volume Resistivity a) at 27°C b) at 70°C	 $1x10^{14}$ ohm-cm, Min $1x10^{13}$ ohm-cm, Min
8	Thermal Resistivity	350 degrees C cm/W
9	Power factor at maximum conductor temperature	0.008
10	Dielectric strength	22 kV/mm

4.3.1 The XLPE insulation should be suitable for specified 1.1 KV system voltage.

4.3.2 The manufacturing process shall ensure that insulations shall be free from voids.

4.3.3 The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions.

4.3.4 The insulation of the cable shall be high stranded quality, specified in IS:7098 (Part-II/1985). Withstand continuous conductor temperature of 90 deg C, which means higher continuous rated current carrying capacity.

4.3.5 The cables can operate even at conductor temperature of 130 deg C continuously and

250 deg C during a Short Circuit condition

4.4 SHEATH :

The sheath shall be suitable to withstand the site conditions and the desired temperature. It should be of adequate thickness, consistent quality and free from all defects. The PVC sheath shall be extruded as per IS:7098 (Part – I/1988). IEC:60502 Part– I,BS:6622, LSOH to BS:7835.

4.5 ARMOUR :

Armoring shall be applied over the inner sheath with single galvanized steel complying with the requirements of IS:3975/1979. The dimensions of the galvanized strip shall be as specified in table 4 of the IS:7098/Part-I/1988. The armour wire shall be applied as closely as practicable. The direction of the lay of the armour shall be left hand. The joints in armour wire shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any wire shall be atleast 300mm from the nearest joint in any other armour wire in the complete cable and shall be as per IS:7098 Part 1, IS: 3975.

The cable without armouring shall also be accepted of type detailed in price schedule.

4.6 OUTER SHEATH : Extruded PVC ST2, outer sheath as per IS:5831/1984, IS:7098

Part 1, IEC:60502 Part – 1, BS:6622, LSOH to BS:78 35. shall be applied over armoring with suitable additives to prevent attack by rodents and termites. Outer sheathing shall be designed to offer high degree of mechanical protection and shall also be heat, oils, chemicals, abrasion and weather resistant. Common acids, alkalis, saline solutions etc., shall not have adverse effects on the PVC sheathing material used.

4.7 The cables should be suitable for use in solidly earthed system.

4.8 The power cables shall be manufactured to the highest quality, best workmanship with scientific material management and quality control. The Manufacturer shall furnish the quality plan, giving in detail the quality control procedure / management system.

4.9 The cable shall be suitable for laying in covered trenches and/or buried underground to meet the outdoor application purposes.

4.10 **The parameters of the LT power cables to be supplied shall be as specified below**

Nom. cross	**Nom.**	**Armoured**	**Max.DC**	**AC current**

sectional area (Sq.mm)	**Thickness of XLPE Insulation mm main core**					**rating**	
		Nom. Steel Armour size (mm)	**Approx. Overall dia. (mm)**	**Approx, Weight (kg/km)**	**Conductor Resistance at 20°C (ohm/km)**	**In air (amps)**	**In Grpund (amps)**
25	0.90	4 X 0.8	22.8	821.0	1.200	95	97
35	0.90	4 X 0.8	24.9	961.0	0.868	117	116
50	1.00	4 X 0.8	28.1	1195.0	0.641	140	134
70	1.10	4 X 0.8	33.0	1569.0	0.443	176	167
95	1.10	4 X 0.8	35.8	1903.0	0.320	221	199
120	1.20	4 X 0.8	39.0	2303.0	0.253	258	227
150	1.40	4 X 0.8	42.9	2720.0	0.206	294	255
185	1.60	4 X 0.8	47.5	3276.0	0.164	339	287
240	1.70	4 X 0.8	52.7	4048.0	0.125	402	333
300	1.80	4 X 0.8	58.4	4872.0	0.100	461	375
400	2.00	4 X 0.8	65.6	6101.0	0.0778	542	426

4.11 The short circuit current of the LT cable to be as specified below

Sq.mm of LT Cable	**Short Circuit Current(KA)**
25	2.420
35	3.370
50	4.790
70	6.680
95	9.030
120	11.400
150	14.200
185	17.500
240	22.600
300	28.200
400	37.600

5.0 SYSTEM DETAILS:

General Technical particulars

Nominal system voltage (rms) (U)	0.44KV
Highest system voltage (rms) (U_m)	1.1 KV
Number of Phase	3
Frequency	50Hz
Variation in Frequency	+/- 3%
Type of Earthing	Solidly Earthed
Total relay & circuit breaker Operating time	15 – 20 cycles

6.0 CLIMATIC CONDITIONS:

(a)	Maximum ambient air temperature (in shade)	45^0 C
(b)	Maximum ambient air temperature (under sun)	50^0 C
(c)	Maximum daily average ambient air temperature	35^0 C
(d)	Maximum yearly average ambient air temperature	30^0 C
(e)	Maximum humidity	100%
(f)	Altitude above M.S.L.	Up to 1000M
(g)	Average No. of thunder storm days per annum	50
(h)	Average No. of dust storm days per annum	Occasional
(i)	Average No. of rainy days / annum	90
(j)	Average Annual Rain fall	925mm
(k)	Normal tropical monsoon period	4 months
(l)	Maximum wind pressure	150 kg/Sq.M

7.0 DESIGN CRITERIA:

i. The cables that are covered in these specifications are intended for use outdoor , under the climatic conditions and installation conditions described in the technical specification.

ii. For continuous operation of the cables, at specified rating, the maximum conductor temperature shall be limited to the permissible value as per the relevant standard, generally not exceeding 90°C under normal operation and 250°C under short – circuit conditions.

iii. The cables in service will be subject to daily load cycles, of two peaks during a day; morning peak and evening peak, with around 25% to 50% loading during the nights.

iv. The materials used for outer sheaths shall be resistant to oils, acids and alkalis.

v. The cables shall have the mechanical strength required, during handling and laying.

vi. The cables shall be designed to withstand the thermo-mechanical forces and electrical stresses during normal operation and transient conditions.

vii. The cables shall be designed to have a minimum useful life span of Thirty-five years.

viii. The detailed design drawings shall be submitted along with Purchase order.

8.0 MANUFACTURE PROCESS:

Cross-linking of the insulation materials (pre compounded polyethylene) shall be conforming to IS: 7098 (Part – II) and the proof of purchase of the above insulating material shall be submitted and is to be offered for stage inspection..

9.0 MATERIALS:

9.1 **Conductor:** -The conductor shall be of stranded construction. The material for conductor shall consist of the plain aluminum of H2 or H4 grade as per clause – 3 of IS 8130/ 1984.

9.2 The minimum number of wires shall be 53 for circular compacted 400 sq. mm aluminum conductor as per table – 2 of IS 8130/ 1984.

10.0 CORE IDENTIFICATION:

10.1. The core identification for 31/2 core cables shall be provided, by suitable means, like, by application of individual colour or colored stripes, or by numerals or by printing on the cores as per clause 13 of IS: 7098 - Part 2

10.2. For identification of different coloring of XLPE Insulation, or by using colored strips, red, yellow and blue colors respectively shall be used to identify the phase conductors.

11.0 LAYING UP OF CORES:

The cores shall be laid together with a suitable right hand lay. The interstices at the center shall be filled with a non- hygroscopic material.

12.0 INNER SHEATH (COMMON COVERING):

12.1 The laid up cores shall be provided with inner sheath applied either by extrusion. It shall be ensured that the shape is as circular as possible. The inner sheath shall be so applied that it fits closely on the laid up cores and it shall be possible to remove it without damage to the insulation.

12.2 The thickness of the inner sheath (common covering) shall be given as follows**:**

CALCULATED DIAMETER IN MM OVER LAID UP CORES [REF IS 10462 (PART 1)]		**THICKNESS OF INNER SHEATH (Min) mm**
Over	Up to and including	
_	25	0.3
25	35	0.4
35	45	0.5
45	55	0.6
55	_	0.7

12.3 When one or more layers of binder tapes are applied over the laid up cores, the thickness of such tapes shall not be construed as a part of inner sheath.

13.0 ARMOURING:

13.1 Armouring shall be single strip steel wire applied over the inner sheath as closely as practicable. The direction of the lay of the armour shall be left hand.

13.2 The armour shall consist of galvanized strip steel The dimensions of the galvanized steel wires shall be 4 X 0.8 mm (Nominal)

13.3 The joints in the armour strip shall be made by brazing or welding and the surface irregularities shall be removed. A joint in the wire shall be at least 300-mm from the nearest joint in any other wire in the complete cable.

13.4 Manufacturers shall furnish the calculation / data sheet for the short circuit carrying

capability of the Armour.

14.0 OUTER SHEATH:

14.3 The outer sheath shall be applied by extrusion. It shall be applied over the armouring shall consist of poly-vinyl chloride (PVC) compound, conforming to the requirements of type ST-2 of IS 5831. Suitable additives shall be added to give anti termite protection.

14.4 The minimum thickness of the PVC outer sheath shall be as per IS:10462 and as detailed.

Calculated diameter under the outer sheath [IS 10462 Part 1] – mm		**Nominal thickness of the outer sheath (ts) - mm**
Over	**Up to and including**	
_	15	1.24
15	25	1.40
25	35	1.56
35	40	1.72
40	45	1.88
45	50	2.04
50	55	2.20
55	60	2.36
60	65	2.52
65	70	2.68
70	75	2.84
75	_	3.0

14.5 **IDENTIFICATION**:

The outer sheath shall have the following information embossed or indented on it; ISI marking, the manufacturer's name or trade mark, the voltage grade, the year of manufacture and the letters "RDSS, Name of Employer" The identification shall repeat every 300/350mm along the length of the cable. Outer sheath of cable shall be black in permanent colour**.**

15.0 INSPECTION AND QUALITY CONTROL:

The Manufacturer shall furnish a complete and detailed quality plan for the

manufacturing process of the cable. All raw materials shall conform to relevant applicable standards and tested for compliance to quality and requirement. During the manufacturing process, at all stages, inspections shall be made to check the physical and dimensional parameters, for verification to compliance to the standards. The Manufacturer shall arrange, for inspection by the purchaser, during manufacture with one month advance notice for verifying the various stage inspections as specified in the quality assurance plan enclosed to verify the quality control process of the Manufacturer.

16.0 TYPE TESTS:

Type test certificates from Accredited NABL Testing Laboratories for 1.1 kV XLPE, shall be submitted along with Purchase order. The Type Tests should have been conducted not later than 5 years as on the date of supply.

16.1 Stage wise Inspection: The Manufacturer shall offer the stage wise inspection as detailed in the in the quality assurance plan

16.2 All acceptance tests shall be conducted in the presence of the Employer's representative.

16.3 The supplier shall give 10 days advance notice for inspections, and witnessing of tests by the Employer representative.

16.4 The following type tests shall be conducted on the cable.

Sl. No.	**Test**	**Requirement**	**Test method Ref Part no of IS: 10810**
a)	Tests on conductor i) Tensile test ii) Wrapping test iii) Resistance test	 IS:8130 IS:8130 IS:8130	 2 3 4
b)	Tests for armoured wires and strips	Clause 15.2 & IS:3975	36 to 42
c)	Test for thickness of insulation and sheath	Clause 4.3, 14.2 & 16.2	6
d)	Physical tests for insulation:	Clause 4.2	

	i) Tensile strength and elongation at break ii) Aging in air oven iii) Hot test iv) Shrinkage test v) Water absorption (gravimetric)		7 11 30 12 33
e)	Physical tests for outer sheath i) Tensile strength and elongation at break ii) Aging in air oven iii) Shrinkage test iv) Hot deformation	IS: 5831	 7 11 12 15
f)	High voltage test	Clause 22.7	45
g)	Flammability test	Clause 22.8	53

17.0 ACCEPTANCE TEST:

17.1 The sampling plan for acceptance test shall be as per IS 7098 part -II, Appendix 'A'.

17.2 The following shall constitute the acceptance test.

a. Tensile test for aluminum.

b. Wrapping test for aluminum.

c. Conductor resistance test.

d. Test for thickness of insulation.
(i) Test for thickness of inner and outer sheath.

(ii) Hot-set test for insulation.

(iii) Tensile strength and elongation at break test for insulation and outer sheath.

(iv) High voltage test.

(v) Insulation resistance (volume resistivity) test.

18.0 ROUTINE TEST:

The following shall constitute routine tests:

- Conductor resistance test.
- High voltage test.

19.0 DETAILS OF TESTS:

19.1 Unless otherwise mentioned in this specification, the tests shall be carried out in accordance with appropriate part of IS: 10810.

19.2 High Voltage Test at room temperature:

The cables shall withstand a voltage of 3KV AC (rms) at a frequency of 40 to 60 Hz or an AC voltage of 7.2kV , between conductors and between conductors and ECC (if any) for a period of 5 minutes each test connection.

19.3 Flammability test: Period of burning after removal of the flame shall not exceed 60 seconds and the unaffected (uncharred) portion from the lower edge of the top clamp shall be at least 50-mm.

Employer reserves the right to select a random sample of 1.1 kV UG cable from the Manufacturer's end which are ready to dispatch and also ongoing cable laying works and the same samples will be sent to any testing laboratory as desired by Employer. If the testing results are found to be not satisfactory Employer reserves the right to reject the entire batch of cable received and insists for replacement of material free of cost. The decision of Employer in this regard is final.

20.0 PACKING:

20.1 The cables, as per specified delivery lengths, shall be securely wound /packed in non-returnable wooden drums, capable of withstanding rough handling during transport by Rail, Road, etc. The packing should withstand storage conditions in open yards. The cable drums shall conform to IS 10418-1982 or equivalent standard. The dimensional drawings of wooden drums shall be furnished with the Purchase order. The drum shall be provided with circumferential lagging of strong wooden planks. The end of the

cable shall be sealed with good quality heat shrink sealing caps. The sufficiently required additional sealing caps shall be supplied for use of testing during laying and jointing at site and to seal spare lengths of cable. The packing should be able to withstand the rigorous of transport. The following information in bold letters in English shall be painted on the flanges.

a. Name & Address of the manufacturer, Trade name/Trade mark/Brand
b. ISI Marking

c. Size of cable (Cross section) rated voltage, standard, insulation, cable code, drum No., and year of manufacture.

d. Length of cables (Meters)

e. Direction of rolling
i) Net weight (in Kg)

ii) Gross weight (in Kg)

iii) Owners purchase order reference.

21.0 SEALING OF CABLE ENDS ON DRUMS:

21.1 The cable ends shall be sealed properly so that ingress of moisture is completely prevented. The individual core endings shall be sealed effectively with water resistant compound applied over the core and provided with a heat shrinkable or push-on or Tapex or cold shrinkable type cap of sufficient length with adequate cushion space so that the conductor does not puncture the cap in case of movement of the core during unwinding or laying. Before sealing, the semi conducting layer on the cores may be removed for about 2 mm at each end, to facilitate checking the insulation resistance from one end, without removing the sealing cap at the other end.

21.2 The three cores should have an overall heat shrinkable or push-on or Tapex or cold shrinkable type cap with adequate end clearance, and sufficient cushioning to prevent puncturing of the overall sealing cap due to stretching of the cores. The sealing cap shall have sufficient mechanical strength and shall prevent ingress of moisture into the cable. The ends of single core cables shall also be sealed on the same lines to prevent entry of moisture.

22.0 CABLE LENGTHS:

The cables shall be supplied in continuous lengths of 500 m or more with 5% tolerance and cable shall on the wooden drums only.

23.0 QUANTITY TOLERANCE:

A +3% tolerance shall be allowed on the ordered quantity including 300-m cable as spare.

24.0 MARKING:

24.1 The packed cable drum shall carry the following information, clearly painted or stenciled.

a. The letters 'RDSS, Name of Employer'

b. Reference to Standard and ISI mark.

c. Manufacturer's Name or trade mark.

d. Type of cable & voltage grade.

e. Number of cores.

f. Nominal cross- sectional area of conductor.

g. Cable code.

h. Length of cable on the drum.

i. Direction of rotation.

j. Gross weight.

k. Country of Manufacture.

l. Year of Manufacture.

m. Purchase order and date.

n. Address of consignee.

25.0 GUARANTEED TECHNICAL PARTICULARS:

The manufacturer, shall furnish the guaranteed technical particulars of the cable offered in the GTP format provided.

26.0 DRAWING & LITERATURE:

(i) The following shall be furnished along with the tender

Cross sectional drawings of the cables, giving dimensional details.

An illustrated literature on the cable, giving technical information, on current ratings, cable constants, short circuit ratings, de rating factors for different types of installation, packing date, weights and other relevant information**.**

27.0 GUARANTEE: The cable manufactured shall be guaranteed for the period of 18 months from the date of receipt at stores.

28.0 The Manufacturer shall furnish a copy of valid BIS licence for ISI marking without which the cable shall not be accepted.

GUARANTEED TECHNICAL PARTICULARS FOR 1.1 KV

	Manufacturer's Name		
	Class of Power Cable		
1	Name of the Manufacturer and country of origin		
2	Country of Manufacture		
3	Type of cable / cable code		
4	Applicable standard		
5	Voltage		
	a. Rated Nominal voltage		
	b) Rated Maximum voltage		
6	Suitability for :		
	a. Earthed system		

7	**Conductor**		
	a) Nominal cross section (sq.mm)		
	b) Material		
	c) Shape		
	d) Diameter of conductor (mm)		
	e) Number of wires per conductor (Nos.)		
	f) Nominal diameter of wire in conductor (mm)		
8	**Insulation XLPE**		
	a) Curing process (furnish details separately)		
	b) Material/Composition		
	c) Dia over insulation		
	i. Nominal (mm)		
	ii. Average (mm)		
	iii. Minimum (mm)		
9	**Inner sheath**		
	a) Type / composition		
	b) Material		
	d) Tolerance on thickness		
	e) Diameter of cable over sheath (mm)		
10	**Armouring**		
	a) Material		
	b) Dia of wire		
	Nom. (mm)		
	Min. (mm)		
11	**Outer sheath**		
	a) Type / composition		
	b) Material		
	c) Nominal thickness		
	d) Tolerance on thickness		
	e) Diameter of cable over sheath (mm)		
12	**Anti-thermite treatment to outer sheath**		
	a) Material		
	External overall dia of cable		
	Short circuit rating of conductor 90 deg. C		

	operating temperature for 1 Sec.		
13	Minimum cable bending radius (in terms of cable diameter)		
14	Permissible maximum tension		
15	Continuous current rating under specified insulation conditions at conductor temperature of 65 deg. C and 90 deg. C.		
16	Ground Temperature 30 deg. C		
17	Thermal resistivity of soil 150 deg. C CM/W		
18	Depth of laying 200 mm		
19	Ambient Air temperature 40 deg. C		
20	No. of circuits 1 OR 2		
21	Spacing between two circuits		
22	Formation		
23	Maximum permissible conductor temperature for continuous operation under specified installation conditions (deg. C)		
24	Conductor temperature at rated current (deg. C)		
25	Basic impulse level at conductor temperature of 90 deg. C (KV)		
26	Impulse wave shape		
27	Power frequency with stand voltage (KV)		
28	Tan Delta at 50 Hz (at U.KV and 90 (-5/+10) deg. C		
29	Sheath voltage at max. load		
30	Withstand voltage of sheath on spark test		
31	Permissible short circuit current ratings of conductor		
	i) 0.1 Sec KA		
	ii) o.2 Sec KA		
	iii) 0.5 Sec KA		

	iv) 1.0 Sec KA		
32	**Conductor resistance DC & AC**		
	a) at 20 deg. C (d.c)/A.C. ohm/KM		
	b) at 90 deg. C (d.c)/A.C. ohm/KM		
	c) at 105 deg. C (d.c)/A.C. ohm/KM over load temp) a.c. (ohm)		
33	**Equivalent star resistance at 50 Hz of 3 phase current**		
	a) at 20 deg. C (d.c)/A.C. ohm/KM		
	b) at 90 deg. C (d.c)/A.C. ohm/KM		
	c) at 10% continuous overload temperature (ohm/KM)		
34	**Star reactance at 50 hz (ohm/KM)**		
	Approximate impedance at 50 hz per KM		
	a. at 20 deg. C ohm/KM		
	b. at 90 deg. C ohm/KM		
	c. at 10% continuous overload temperature (ohm/KM)		
35	Self-electrostatic capacitance per phase (Micro farad/KM)		
36	Maximum power factor at charging KVA of cables when laid direct in ground at normal voltage & frequency		
	a) at ambient Temperature		
	b) at Maximum conductor Temperature		
37	**Impedance**		
	a) Positive and negative sequence impedance 37 (ohm/KM)		
	b) Zero sequence impedance (ohm/KM)		

	c) Zero sequence data		
38	**Series reactance / Resistance**		
	a) Series resistance (ohm/KM)		
	Series reactance (ohm/KM)		
	Shunt capacitive reactance (ohm/KM)		
39	Sheath resistance at 20 deg. C ohm/KM		
40	Surge impedance of cable (ohm/KM)		
41	IR value at amient temperature per KM		
	Maximum magnitude of partial discharge at 1.5 U.o		
	At Ambient Temperature (Po)		
	At High Temperature (Po)		
	Losses per Km.		
	NOTE : (i) Cable Conductor size 400 sq. mm		
	a) Total 3 phase dielectric loss		
	i. One circuit alive Kw/KM		
	ii. Both circuits alive KW/KM on each circuit		
	b) Total 3 phase resistive loss		
	i. One circuit alive Kw/KM		
	ii. Both circuits alive KW/KM on each circuit		
	c) Total 3 phase sheath / screen loss		
	i. One circuit alive Kw/KM		
	ii. Both circuits alive load KW/KM on each circuit		
42	d) Other losses due to reinforcement		

43	One circuit alive KW/KM		
44	Both circuits alive KW/KM on each circuit		
	Total losses		
	i. One circuit alive KW/KM		
	ii. Both circuits alive KW/KM		
	Charging current at rated voltage per Km (Amps)		
45	Short circuit capacity of conductor for one second at 90 deg. C prior to short circuit and 250 deg. C during short circuit (KA)		
46	Screening factor of cable for calculating interference on control and communication cables :		
	Approximate value of attenuation of carrier current signals operating over a frequency range		
	i. 50 KC/s- dB/KM		
	ii. 100 KC/s- dB/KM		
	iii. 150 KC/s- dB/KM		
	iv. 200 KC/s- dB/KM		
47	**Shipping weight and size of cable drum**		
	a) Size of Drum		
	i. Dia of Drum (M)		
	ii. Width of Drum (M)		
	iii. Gross Weight (Kgs)		
	iv. Length of cable per Drum(M)		
	v. Weight of Cable (Kg/M)		

Current Rating Factor

Particulars	**Single Point Bonded**		**Both End Bonded**	
	65 deg. C Amps	**90 deg C Amps.**	**65 deg. C Amps**	**90 deg. C Amps**
Current Rating conductor size 400 Sq. mm				
a) In Ground				
i. Of each circuits (when both the circuits alive)				

b) In Duct				
i. Of each circuits (when both the circuits alive)				
ii. Of one circuits (when other circuit is isolated)				
c) In pipe, one cable per pipe.				
i. Of each circuits (when both the circuits alive)				
ii. Of one circuits (when other circuit is isolated)				
d) In Air				
i. Of each circuits (when both the circuits alive)				
ii. Of one circuits (when other circuit is isolated)				

Derating Factors

1. VARIATION IN GROUND TEMPERATURE :							
Ground Temperature (deg. C) :	15	20	25	30	35	40	45
Rating Factor							
2. VARIATION IN DEPTH OF LAYING :							
Depth of Laying (Meters):	0.7	0.9	1.0	1.2	1.3	1.5	
Rating Factor							
3. VARIATION IN THERMAL RESISTIVITY OF SOIL							
Thermal Resistivity of Soil : (deg. C cm/watt)	100	120	150.0	200	250		
Rating Factor							

4. VARIATION IN AIR TEMPERATURE :							
Air Temperature (deg. C) :	25	30	35	40	45	50	55
Rating Factor							
5. VARIATION DISTANCE (MM) :							
Axial Distance (mm) Between circuits :	100	200	300.0	400	600	800	
Rating Factor							

16. AB CABLE

A. AERIAL BUNCHED CABLES FOR 33kV LINES

SCOPE:

This specification covers requirements of XLPE insulated, 33 kV Aerial Bunched Cables for overhead lines.

1. Qualifying Requirement of AB Cable Manufacturer/Supplier

The manufacturer should have manufactured, successfully type tested and supplied at least one hundred (100) kms of 33 kV or above voltage grade XLPE armoured and/or AB Cable in the last five (5) years as on the date of bid opening.

2. COMPOSITION OF THE CABLE

The Composite cable shall comprise three single-core cables twisted around a bare aluminium alloy messenger wire, which will carry the weight of the cable.

3. RATED VOLTAGE

The rated voltage of the cables shall be 33 kV and the maximum operating voltage shall be 36 kV.

4. APPLICABLE STANDARDS

Unless otherwise stipulated in this Specification, the following standards shall be applicable:

i) IS: 7098 (part-II) – 1985 – Cross linked Polyethylene Insulated PVC Sheathed Cables.

ii) IS:9130-1984-Conductors for Insulated Cables

iii) IS: 398 (Part-IV) – 1979 – Aluminium Alloy Conductors.

5. DETAILS OF SINGLE CORE CABLE

5.1 The cable conductors shall be or round standard and compacted aluminium, of nominal cross sectional area 95 mm2.

5.2 **Conductor Screen**

The conductor screen shall be of extruded semi-conducting cross linked polyethylene compound of thickness as per relevant IS.

5.3 **Insulation**

The Insulation shall be of extruded cross linked polyethylene (XLPE) of nominal insulation thickness as per relevant IS and its properties shall conform to IS:7098 (Part-II).

5.4 **Insulation Screen**

The insulation screen shall be as per IS:7098 (Part-II).

5.5 **Outer Sheath**

The outer sheath shall be black polyethylene.

6. **MESSENGER (NEUTRAL CONDUCTOR)**

6.1 The bare messenger wire shall be of 120 mm2 (nominal area) aluminium alloy, generally conforming to IS:398 (Part IV) – 1979, comprising multi strands and shall be suitably compacted to have smooth round surface to avoid damage to the outer insulating sheath of single-core phase cables twisted around the messenger.

6.2 There shall be no joints in any wire of the stranded messenger conductor except those made in the base rod or wire before finally drawing.

7. **TESTS**

7.1 The following tests shall be carried out on the single-core cables as per IS-7098 (Part-II).

7.1.1 Type Tests

a) Tests on conductor:
   i) Tensile test
   ii) Wrapping test
   iii) Resistance test

b) Tests for thickness of insulation and sheath

c) Physical tests for insulation:
   i) Tensile strength and elongation at break
   ii) Agency in air oven
   iii) Hot test
   iv) Shrinkage test
   v) Water absorption

d)Tests for outer sheath:
   i) Tensile strength and elongation at break
   ii) Ageing in air oven
   iii) Shrinkage test
   iv) Hot deformation
   v) Bleeding and blooming test.

e) Partial discharge test

f) Bending test

g) Dielectric Power factor test:
   i) As a function of voltage
   ii) As a function of temperature

h) Insulation resistance test

g) Heating cycle test

k) High voltage test

l) Flammability test

7.1.2 Acceptance Test

a) Tensile Test
b) Wrapping Test
c) Conductor resistance test
d) Test for thickness of insulation and sheath
e) Hot set test for insulation
f) Tensile strength and elongation at break test for insulation and sheath
g) Partial discharge test
h) High voltage test
i) Insulation resistance (volume resistivity) test

7.1.3 Routine Tests

a) Conductor resistance test
b) Partial Discharge Test
c) High voltage test

7.2 The following tests shall be carried out on the bare messenger wire in accordance with IS:398 (Part-IV).

Type Tests/Acceptance Test

a) Breaking Load Test (on finished wire
b) Elongation Test
c) Resistance Test

8. PACKING AND MARKING

8.1 Packing

Cables shall be supplied in returnable wooden drums conforming to IS: 10418. The standard length of the bunched cable in each drum shall be 250 meters (+/-) 10%. Other lengths may be acceptable subject to the approval of employer/purchaser.

8.2 Marking

The Cable drum shall carry the information as per the requirements of IS: 7098 (Part-II). However, exact details of maerking/embossing, color of outer sheath etc. will be as per the detailed purchase order.

8.3 Suitable identification marks shall be given on the outer sheath to clearly distinguish three phases of the bunched cable.

AB CABLE

B. AERIAL BUNCHED CABLES FOR 11kV LINES

SCOPE : This specification covers requirements of XLPE insulated, 11kV Aerial Bunched Cables for overhead lines.

1.0 Qualifying Requirement of AB Cable Manufacturer/Supplier

The manufacturer should have manufactured, successfully type tested and supplied at least one hundred (100) kms of 11k V or above voltage grade XLPE armoured and/or AB cable in the last five (5) years as on the date of bid opening.

2. COMPOSITION OF THE CABLE

The composite cable shall compose three single-core cables twisted around a bare aluminium alloy messenger wire, which will carry the weight of the cable.

3. RATED VOLTAGE

The rated voltage of the cables shall be 6.35 kV/11kV and the maximum operating voltage shall be 12 kV

4. APPLICABLE STANDARDS

Unless otherwise stipulated in this specification, the following standards shall be applicable:

i) IS:7098 (part-II) – 1985 – Cross linked Polyethylene Insulated PVC Sheathed Cables
ii) IS:8130-1984-Conductors for Insulated Cables
iii) IS:398 (Part-IV) – 1979 – Aluminium Alloy Conductors

5. DETAILS OF SINGLE CORE CABLE

5.1 The cable conductors shall be of round, stranded and compacted aluminium of nominal cross sectional area 35 mm2 and 70 mm2. Corresponding nominal conductor diameter and number of wires in the conductor shall be as given in clause 5.7.

5.2 Conductor Screen

The conductors screen shall be of extruded semi-conducting cross linked polyethylene compound of thickness not less than 0.5 mm.

5.3 Insulation

The Insulation screen shall be as per IS:7098 (Part II).

5.4 Insulation screen

The Insulation screed shall comprise extruded semi-conducting compound and/or semi- conducting tape. Thickness of the screen shall be not less than 0.6 mm.

5.5 Outer Sheath

The outer sheath shall be black polyethylene. The nominal thickness of sheath shall be 1.8mm and it shall conform to the technical requirements of ST-3 of EIC-502

5.6 Dimensional and Electrical Data

The Dimensional and Electrical Data for single –core cable is given below:

S.No.	Description	Nominal area of conductors	
		35 mm2	70mm2
I.	Nominal conductor diameter(mm)/No. of wires in conductor	6.8/6	10/12
II.	Approx over dia of cable (mm)	22	25
III.	Max D.C. resistance at 200c Ohm/Km	0868	.443
IV.	Max SC current for 1 Sec. KA	3.4	6.7
V.	Max continuous load (amps)	106	156

Note: Due to limitation of short circuit current rating, it is recommended that 70mm^2 cable is used the base line for the first 4-5kms from the 33/11kV substation and thereafter the lower size of cable i.e. 35mm^2 can be used depending upon the line loading .Normally the current loading of 70mm^2 cable should not exceed 145amps and that of 35mm2 cable as 95 amps .For a maximum ambient temperature of 50^{0}C.

6. MESSENGER (NEUTRAL CONDUCTOR)

6.1 The bare messenger wire shall be of 70 mm2 (nominal area) aluminium alloy, generally conforming to IS:398 (Part IV) – 1979, comprising of seven(7) strands and shall be suitably compacted to have smooth round surface to avoid damage to the outer insulating sheath of single-core phase cables twisted around the messenger.

6.2 There shall be no joints in any wire of the stranded messenger conductor except those made in the base rod or wire before finally drawing.

6.3 The technical characteristics of messenger wire shall be as follows:

i.	Nominal sectional area(mm^2)	70
ii.	Nos. of wire	7
iii.	Nominal dia of wires /compacted conductor (approx.)mm	3.5/10
iv.	Approx. Mass kg/Km	184
v.	D.C resistance at 20^oC Ohm/Km	0.493
vi.	Breaking load(KN)	20
vii.	Modulus of elasticity (approx) KN/mm^2	59
viii.	Coefficient of linear expansion	$23X10^{-6}{}_oC$

Note: the value of item v above is to be guaranteed. A tolerance of (-) 5% is permissible on the value in item vi above.

7. DESIGNATION AND PARAMETER OF FINISHED CABLES

The designation and parameter of finished cables are given in the following table:

S.No.	Designation	Complete bunched cables	
		Overall dia approx mm	Total mass(Approx.)Kg/Km
I.	3 x 35+70	53	1450
II.	3 x 70+70	59	1900

Note: the first part of the designation refers to the number and size of phase conductor and the second to the size of messenger wire .The sizes shown represent the nominal cross sectional area in mm.

8. TESTS

8.1 The following tests shall be carried out on the single-core cables as per IS-7098 (Part-II).

8.1.1 Type Tests

a) Tests on conductor:

i) Tensile test

ii) Wrapping test

iii) Resistance test

b) Tests for thickness of insulation and sheath

c) Physical tests for insulation:

i) Tensile strength and elongation at break

ii) Agency in air oven

iii) Hot test
iv) Shrinkage test
v) Water absorption

d) Tests for outer sheath:

i) Tensile strength and elongation at break

ii) Ageing in air oven

iii) Shrinkage test
vi) Hot deformation
vii) Bleeding and blooming test.

e) Partial discharge test
f) Bending test
g) Dielectric Power factor test:
   i) As a function of voltage
   ii) As a function of temperature
h) Insulation resistance test
g) Heating cycle test
k) High voltage test
l) Flammability test

8.1.2 **Acceptance Test**

a) Tensile Test

b) Wrapping Test

c) Conductor resistance test

d) Test for thickness of insulation and sheath

e) Hot set test for insulation

f) Tensile strength and elongation at break test for insulation and sheath

g) Partial discharge test

h) High voltage test

i) Insulation resistance (volume resistivity) test

8.1.3 **Routine Tests**

a) Conductor resistance test

b) Partial Discharge Test

c) High voltage test

8.2 **The following tests shall be carried out on the bare messenger wire in**

accordance with IS:398 (Part-IV).

Type Tests/Acceptance Test

a) Breaking Load Test (on finished wire
b) Elongation Test
c) Resistance Test

9. PACKING AND MARKING

9.1 Packing

Cables shall be supplied in returnable wooden drums conforming to IS: 10418. The standard length of the bunched cable in each drum shall be 1000 meters (+/-) 10%. Other lengths may be acceptable subject to the approval of employer/purchaser.

9.2 Marking

The Cable drum shall carry the information as per the requirements of IS: 7098 (Part-II). However, exact details of marking/embossing, color of outer sheath etc. Will be as per the detailed purchase order.

9.3 Suitable identification marks shall be given on the outer sheath to clearly distinguish three phases of the bunched cable.

GUARANTEED TECHNICAL PARTICULARS FOR 1.1 KV

	Manufacturer's Name		
	Class of Power Cable		
1	Name of the Manufacturer and country of origin		
2	Country of Manufacture		
3	Type of cable / cable code		
4	Applicable standard		
5	Voltage		
	a. Rated Nominal voltage		
	b) Rated Maximum voltage		
6	Suitability for :		
	a. Earthed system		
7	**Conductor**		
	a) Nominal cross section (sq.mm)		
	b) Material		
	c) Shape		
	d) Diameter of conductor (mm)		
	e) Number of wires per conductor (Nos.)		
	f) Nominal diameter of wire in conductor (mm)		
8	**Insulation XLPE**		
	a) Curing process (furnish details separately)		
	b) Material/Composition		
	c) Dia over insulation		
	i. Nominal (mm)		
	ii. Average (mm)		
	iii. Minimum (mm)		
9	**Inner sheath**		
	a) Type / composition		
	b) Material		
	d) Tolerance on thickness		
	e) Diameter of cable over sheath (mm)		
10	**Armouring**		
	a) Material		
	b) Dia of wire		
	Nom. (mm)		
	Min. (mm)		
11	**Outer sheath**		

17. XLPE Power Cables (11kV & 33 kV)

STANDARD TECHNICAL REQUIREMENT

1.0 SCOPE:

This section covers the standard technical requirements of design, manufacturing, testing, packing and dispatching of 11 kV and 33 kV XLPE HT Power Cable.

2.0 APPLICABLE STANDARDS

The materials shall conform to the latest editions of the following Indian/International Standards :

IS 7098 Part 2 : 1985 XLPE insulated PVC sheathed cables For working voltages from 3.3 kV up to and including 33 kV

IS 5831 : 1984 PVC Insulation and Sheath of electric Cables

IS 8130:1984 Conductors for insulated electric cables and flexible cords. IS 613:1984 Copper rods and bars for electrical purposes.

IS 3975:1988 Mild steel wires, formed and tapes for armouring of cable. IS 10810:1984 Method of tests for cables.

IEEE-383:1974 Standard for type test of class IE electric cables, field splices, and connections for nuclear power generating stations.

ASTM-D2843,1993 Standard test method for density of smoke from burning or decomposition of plastics.

ASTM-D2863, 1991 Standard test method for measuring minimum oxygen concentration to support candle - like combustion of plastics (oxygen index).

NEMA-WC5,1992 Thermoplastic Insulated Wire and cable for the transmission and distribution of Electrical Energy.

IEC:754 Test on gases evolved during combustion of electric cables -

(Part-1):1994 Determination of the amount of halogen acid gas evolved during combustion of polymeric materials taken from cables.

IEC:332 Test on electric cables under fire conditions

(Part I):1993 Test on a single vertical insulated wire or cable. IS 3961 Recommended current rating for cables -

(Part II):1967 PVC insulated and PVC sheathed heavy duty cables.

IS 10418:1982 Drums for electric cables.

3.0 GENERAL REQUIREMENTS

All cables shall be suitable for high ambient, high humid tropical Indian Climatic conditions. Cables shall be designed to withstand the mechanical, electrical and thermal stresses under the unforeseen steady state and transient conditions and

shall be suitable for proposed method of installation.

Conductor shall be of uniform, of good quality, free from defects Aluminium copper.

Insulation shall be Cross Linked Polyethylene (XLPE) .

For 33 kV and 11 kV cables, conductor screen and insulation screen shall both be extruded, semi-conducting compound and shall be applied along-with XLPE insulation in a single operation by triple extrusion process. Method of curing for 33 kV cable shall be "Dry curing/ gas curing " only, whereas for 11 kV and 3.3 kV cables it shall be "Dry curing/ gas curing / Steam curing".

Extruded Semi-conducting screening and metallic screening of copper tape shall be generally as per IS 7098 (Part-II) with latest amendments. The semi conducting compound shall be suitable for the operating temperature of the cable and compatible with the insulating material.

The insulation screen shall be an extruded layer of black semi-conducting compound and continuously covers the whole area of insulation. The semi-conducting screens should be effectively cross linked to achieve 90 ^{o} C cable rating. The contact surface between insulation and insulation screen shall be smooth and free from protrusion and irregularities.

The interface between insulation and insulation screen shall be free of any voids. Insulation screen shall be strippable type.

The metallic screen shall consist of a layer of copper cable applied in helical form.

Inner sheath - All armoured and multi-core un-armoured cables shall have distinct extruded inner PVC sheath of black colour.

Armouring - Material for armour for Single Core Cable shall be Aluminum wire. For Multicore cable it shall be GS wire / flat. Armouring shall be as per relevant IS and it shall have minimum 90% coverage.

Breaking Load of the joints shall be minimum 95% of the normal armour.

Outer Sheath – It shall be of black colour PVC (type ST2 as per IS 5831) with Cable size and Voltage grade embossed on it. Sequential marking shall be at every 1 (one) Meter distance. Word "FRLS" shall also be embossed on it at every 5 (Five) meter distance.

FRLS Properties - All cable shall be Flame Retardant, Low Smoke (FRLS) type. Outer sheath shall have the following properties –

Acid Gas Generation – Max 20% (as per IEC 754-1)

Smoke density rating: 60% (As per ASTMD 2843)

Flammability test - As per Swedish chimney test F3 as per SEN 4241475

As per IEC 332 part-3 (Category B)

Minimum bending radius shall be 10 D

Repaired cables shall not be acceptable.

4.0 CURRENT RATING OF CABLES

1) Normal current rating shall not be less than that covered by IS 3961. Vendor shall submit data in respect of all cables in the prescribed format.

2) Tables given de-rating factors for various conditions of cable installation including the following, for all types of cables shall be furnished.

- Variation in ambient air temperature. - Variation in ground temperature.
- Depth of laying.
- Cables laid in the ground - Cables laid in trench
- Cables laid in ducts - Soil resistivity.
- Grouping of cables.

3) The value of short circuit withstand current ratings of all cables shall be indicated for a short circuit for 1 second duration and should also specify the maximum temperature during short circuit.

4) The following factors shall also be accounted for, while specifying the maximum short circuit withstand of the cables.

5) Deformation of the insulation, due to thermo-mechanical forces produced by the short circuit conditions, can reduce the effective thickness of insulation.

6) Conductor and core screens can be adversely affected with loss of screening effect. Likewise the thermal properties of the outer sheath material can be the limitation.

7) It is essential that the accessories which are used in the cable system with mechanical and/or soldered connections are suitable for the temperature adopted for the cables.

8) Formula for calculating short circuit current for different duration or curve showing short time current v/s time for different sizes of cables shall be furnished by vendor.

5.0 CABLE DRUMS

5.1 Cables shall be supplied in non-returnable wooden, or steel drums of heavy construction and drum shall be properly seasoned, sound and free from defects. Wood preservative shall be applied to the entire drum.

5.2 All Power Cables shall be supplied in drum length of 200/300/500m as per requirement of utility/Discom.* Each drum shall contain one continuous length of cable. Owner shall have the option of rejecting cable drums with shorter lengths. The

cable length per drum is allowed a tolerance of ±5%. The tolerance allowed on total quantity of each size is as given below.

3.1 50 meters for cable length upto 10 kms.
3.2 100 meters for cable length more than 10 kms. and up to 20 kms.
3.3 150 meters for cable length more than 20 kms.

Where the ordered quantity is not multiple of 1000 m and the incremental quantity is very small, the same may be included in one of the drums. Otherwise, an additional length for the incremental quantity will be supplied.
* Amendment issued vide letter No. REC/DDUGJY/SBD/TS/2017-18D. No.3091 Dated 25.08.2017

5.3 A layer of waterproof paper shall be applied to the surface of the drums and over the outer most cable layer.

5.4 A clear space of at least 40mm shall be left between the cables and the logging.

5.5 Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of the cable, net and gross weight stenciled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wordings shall be marked on one end of the reel indicating the direction in which it should be rolled.

5.6 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

6.0 TESTS

6.1 Type Tests
The following shall constitute type tests:

i) Tests on conductor

a. Annealing test (for copper)
b. Tensile tests (for aluminum)
c. Wrapping tests (for aluminum)
d. Resistance test

ii) Tests for armouring wires/strips
iii) Test for thickness of insulation and sheath

iv) Physical tests for insulation

a. Tensile strength and elongation at break
b. Ageing in air oven
c. Hot test
d. Shrinkage test
e. Water absorption (gravimetric)

v) Physical tests for out sheath

a. Tensile strength and elongation at break
b. Ageing in air oven
c. Hot test
d. Shrinkage test

vi) Partial discharge test

vii) Bending test

viii) Dielectric power factor test

a. As a function of voltage
b. As a function of temperature

ix) Insulation resistance (volume receptivity) tests

x) Heating cycle test

xi) Impulse withstand test

xii) High voltage test

xiii) Flammability test

6.2 Acceptance tests

The following shall constitute acceptance tests:

a. Annealing test (for copper)

b. Tensile test (for aluminum)

c. Wrapping tests (for aluminum)

d. Conductor resistance test,

e. Test for thickness of insulation

f. Hot set test for insulation,

g. Tensile strength and elongation at break test for insulation and sheath

h. Partial discharge test (for screened cables only)

i. High voltage test and

j. Insulation resistance (volume resistively) test

6.3 Routine test

The following shall constitute routine tests:

i) Conductor resistance test
ii) Partial discharge test (for screened cables only) and
iii) High voltage tests.

6.4 Optional tests

Cold impact tests for outer sheath (IS:5831-1984) shall constitute the optional tests.

SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES.

1.0 **SCOPE**

This section of the specification covers project information, site condition, desired Technical parameters, and quantity of XLPE Cable.

1.1 Project Information

a. Customer:
b. Engineer/Consultant:
c. Project Location:
d. Transport facilities
   i) Nearest Railway station: /Gauge
   ii) Distance from site:
e. Access Roads:

1.2 **SITE CONDITIONS**

(i) Ambient air temp. (max.) °C :
(ii) Ambient air temp. (min.) °C :
(iii) Design ambient temp. °C :

1.2.1 Relative humidity for design : purposes
1.2.2 Height above mean sea level in : meters
1.2.3 Earth quake data

i) Seismic zone : IS:1893-84
ii) Seismic acceleration : As per IS 2.2.4

1.2.4 Wind data
Site Wind Pressure Kgf/m^2 : As per IS 2.3

1.3 System Particulars

a.	Line Voltage (kV)	11/33
b.	Highest System Voltage (kV)	12/36
c.	Number of Circuits	1
d.	Frequency	HZ50
e.	Neutral	effectively earthed
f.	Short circuit level (KA)	22.77 KA, 31.8KA / 22.5KA,45KA

1.4 **SPECIFIC TECHNICAL REQUIREMNTS**

Technical Parameters of the cable shall be as follows:

S. No.	**PARTICULAR**	**Unit**	**DATA**	**DATA**
1	Rated Voltage	kV	6.35/11	19.0/33
2	Type of Insulation	-	XLPE	XLPE
3	Single core/ Multi core	-	Single/Three core	Single/Three core
4	Armoured / Unarmoured	-	Armoured	Armoured
5	Material of Conductor	-	Aluminium/Copper	Aluminium/Copper
6	System	-	11 kV Earthed	33 kV Earthed
7	Highest System Voltage	kV	12	36
8	Conductor size	sq. mm	120, 150, 185, 240, 300	150, 185, 240, 300, 400
9	Material		Stranded Aluminium/copper	Stranded Aluminium/copper
10	Shape of Conductor		Circular	Circular
11	Short Circuit Current	kA	13.12, 18.35 for 3 secs.	13.12, 26.24 for 3 secs
12	Power Frequency	KV rms	28	70

	Withstand Voltage			
13	Lightning Impulse Withstand Voltage	kVp	75	170
14	Continuous Withstand Temperature	Deg C	90	90
15	Short Circuit withstand Temperature	Deg C	250	250
16	Oxygen Index		Min 29 (as per ASTMD 2863)	Min 29 (as per ASTMD 2863)
17	Acid Gas Generation		Max 20% (as per IEC 754-1)	Max 20% (as per IEC 754-1)
18.	Smoke Density Generation		60% (As per ASTMD 2843)	60% (As per ASTMD 2843)
19.	Flammability Test		As per Swedish Chimney test	As per Swedish Chimney test

SECTION-III

GUARANTEED TECHNICAL PARTICULARS

Sl. No.	Item Particulars	Unit
1	Manufacturers Name & Address	
2	Country of manufacturer	
3	Type of cable	
4	Applicable standards for manufacturing	
5	Applicable standards for testing	
6	Rated voltage	kV
7	Maximum service voltage	kV
8	Maximum continuous current carrying capacity per cable when lain in air at an ambient air temperature of 50 deg. (single core cables solid bonded)	A
9	Maximum continuous current carrying capacity per cale when lain in ground at a depth of 1.0 m (ground temp. 40 deg. C and soil thermal resistivity of 150 deg.c/watt/cm max. Conductor temp. 90 deg. C) (single core cables solid bonded)	A
10	Maximum continuous current carrying capacity per cable when drawing into duct./pipes (single core cables solid bonded)	A
11	Maximum continuous current carrying capacity per cable	A

Sl. No.	Item Particulars	Unit
	when lain in covered RCC trenches at an ambient temperature of 50 Deg. C laying conditions to be specified (Single core cables solid bonded)	
12	Short circuit withstand capacities for 1 second of (With a conductor temperature of 90 Deg. C at the commencement	
i)	Conductor	KA
ii)	Screen	KA
iii)	Armour	KA
13	Conductor	
i)	Material & Grade	
ii)	Nominal cross – sectional area	sq.mm
iii)	No. of strands	
iv)	Diameter of each strand (Nominal)	mm
v)	Max. DC resistance of conductor at 20 Deg. C	ohm/km
vi)	Max. AC resistance of conductor at 90 Deg. C	ohm/km
14	Reactance of cable at normal frequency (Approx)	ohm/km
15	Electrostatic capacitance at normal frequency	mircorfarads per km
16	Charging current	
17	Loss tangent at normal frequency at Uo	
18	Conductor screen	
i)	Material	
ii)	Nominal thickness	mm
19	XLPE Insulation	
i)	Composition	
ii)	Type of curing	
iii)	Thickness of insulation (nominal)	mm
iv)	Tolerance on thickness	mm
v)	Dielectric constant at normal frequency	
vi)	Specific insulation resistance at 20 deg. C	ohm/km
vii)	Min. Volume resistivity at 20 deg. C	
viii)	Min. volume resistivity at 90 deg. C	
ix)	Min. Tensile strength	kg/sq.cm
x)	Min. Elongation percentage at rapture	%
xi)	Identification of cores	
20	1.2/50 microsecond impulse wave withstand voltage	kVp
21	5 min. power frequency withstand voltage	kV

22	Max. Dielectric stress at the conductor	kV/cm
23	Max. Dielectric stress at the conductor screen	kV/cm
24	Insulation screen	
i)	Material	
ii)	Extruded/wrapped	
iii)	Nominal thickness	mm
iv)	Colour	
25	Metallic screen	
i)	Material / composition	
ii)	Nominal radial thickness / dia	
26	Nominal diameter over metallic screen	mm
27	Nominal radial clearance allowed under metal sheath	mm
28	Type and material of filler	
29	Armour	
i)	Material and type	
ii)	Dia	

18. 10kVA 1-Phase, 16 KVA (1/ 3-Phase) & 25 KVA 3-Phase L.T. Distribution Box (with MCCBs)

1. SCOPE:

This specification covers the design, manufacture, inspection, testing at manufacturer place and supply of L.T. Distribution Box with energy meter. Distribution Boxes shall be used for controlling the L.T. feeders from the L.T. side of Distribution Transformers. The system shall be A.C. 3phase, 4 wires, 433V or AC single phase 2 wire, 230V, 50 Hz with effectively grounded neutral.

2. SERVICE CONDITIONS:

The equipment to be supplied against this specification shall be suitable for satisfactory continuous operation under the climatic conditions of the State.

3. SYSTEM DETAILS:

Distribution Boxes are meant for metering, control and protection of Distribution Transformers with relevant parameters as under:

S.No.	Transformer Capacity kVA	Full Current Amps	Incoming Circuit Configuration	Outgoing Circuits Configuration
1	10 KVA (1-Phase)	43 Amp	45 A SPN MCCB	2 x 32A SP MCCB
2	16 KVA (1-Phase)	70 Amp	80 A SPN MCCB	2 x 50 A SP MCCB
3	16 KVA (3-Phase)	22 Amp	25 A TPN MCCB	6 x 16 A SP MCCB
4	25 KVA (3-Phase)	34 Amp	40 A TPN MCCB	6 x 25A SP MCCB

Each Distribution box shall have provision for fixing of three phase tri-vector energy meter/single phase meter for DT metering depending upon capacity and type of transformer, 1No. single pole Neutral (SPN)/Three Pole Neutral (TPN) MCCB at incoming and 2 & 6 Nos. single pole MCCB at outgoing circuit as per above table. Incoming and Outgoing MCCB shall be connected through insulated connectors. Cable from the Distribution Transformer shall be connected to the incoming MCCB through energy meter. Cables from the outgoing terminals of the incoming MCCB shall be connected respectively to the R-Y-B Phase and Neutral terminals of the insulated bus bars or insulated Multiple Outgoing Connectors. Cables from insulated bus bars or insulated Multiple Outgoing Connectors shall be connected to the outgoing MCCBs.

Aluminium cable of 16mm^2 for 10 KVA / 16KVA and 35mm^2 for 25KVA transformer shall be used. Cable shall be fixed with bus bar or connectors with minimum two screws of size not less than M6. Insulation provided shall be such that no live part including the screws for holding the cable shall be accessible by hand/finger.

4. MCCB:

MCCB shall be of reputed make and shall confirm to latest IS. MCCB shall be of fixed rating type. MCCB shall have rated service short circuit breaking capacity of 10 KA at 0.4 P.F. (lag) with rated insulation voltage of 660 V. The time current characteristics of MCCB shall be as per the following details:

Multiple of normal Current Setting	Tripping Time
1.05	More than 2.5 hrs.
1.2	More than 10 minutes and less than 2 hrs.
1.3	Less than 30 minutes
1.4	Less than 10 minutes
Multiple of normal Current Setting	Tripping Time
2.5	Less than 1 minute
6.0	Less than 5 Seconds

For above test, the reference calibration temperature of the MCCB shall be 50^0C.

5. ENCLOSURE:

(i) The enclosure shall be made up of CRCA MS sheet of 18 SWG sheet thickness for 10/16KVA single phase and of 16SWG for 16/26KVA three phase. The manufacturing process of Box shall be Deep Drawn Process /Sheet Bending Process.

(ii) The inside dimensions of Distribution Box shall be 300 x 500 x 160mm for 10 &16 kVA single phase transformer and 1000 x 500 x 170 mm for 16 & 25 kVA three phase Transformer. However, the dimensions of the box is for reference only, internal clearance as per our requirement shall be strictly maintained. Overall dimensions of the box shall be such that the box will withstand temperature rise limits as per IS and Company's Specification and to have sufficient space for working during maintenance. The size of the box will depend on the size of Electrical components and other relevant provision made in IS:13947/(P1,2&3), IS 2086and IS:4237 with latest amendment if any. Adequate slope on the top of box (as shown in the drawing) shall be provided to drain out rainwater from the top. The body and door of enclosure shall be individually in one piece without any welding, except for fixing of the accessories like hinges, clamps, mounting clamps, bolts etc. which shall be spot welded or MIG welded only. The door of Distribution box shall be fixed on three tamper proof inside hinges not

visible from outside. Hinges shall be welded from inside of the box and door shall be fixed with the two screws in each hinge. Hinges shall be made from 1.6mm MS sheet with hinge pin of diameter 3mm. The hinge pin shall have head on top so that it does not fall down during the normal usage. Base and door shall have flange / collars as shown in drawing. Collar of Base and door shall overlap by minimum 8mm. Rubber gasket shall be provided in between base and doors, such that it provides proper sealing between the door and base of box to avoid ingress of water. Degree of protection shall be **IP- 33** as per IS-13947 (amended up to date). Rubber Gasket shall be fixed with suitable adhesive. Two numbers 'U' shaped latch arrangement shall be provided to Seal the door with body for 10/16KVA single phase and three numbers 'U' shaped latch arrangement shall be provided for 16/25KVA three phase. 2.5mm & 8mm diameter hole shall be provided in U-shaped latch for sealing wires & padlock. Holes provided for sealing & padlock should be aligned when latch is in closed position. 'U' shaped latch arrangement shall be made from 1.6 mm thick MS sheet and shall be welded from inner side of the box. U-latch shall be joined with stainless steel rivet.

(iii) Viewing window opening of 80mm x 90mm shall be provided with toughened glass of 5mm thickness as shown in drawing. Size of glass shall be 100mm x 110mm. Glass shall be provided with a wraparound single piece rubber gasket (without joint) having minimum depth of 8mm made from good quality rubber so that it can withstand weather effect. Glass along with rubber gasket shall be fixed from inside of the door of distribution box with powder coated glass holder made of 20 SWG MS sheet without any welding joint and by draw process. Glass holder shall be fixed with minimum four welded screws & nuts from inside and not visible from outside.

(iv) Mounting arrangement of the meter shall be as shown in the drawing. It should be raised from the base of box by 15mm (minimum). It should be suitable for different makes of meters. Galvanized/Zinc Plated adjustable strip shall be provided on meter mounting arrangement for fixing of the meter. Three mounting MS screws, one for upper hanger (M4 threads x length 12mm) & two (M4 threads x 25 or 35mm length) in moving slotted flat shall be provided for fixing of the meter.

(v) Two sets of Louvers (One set on each side) shall be provided. The perforated sheet of 20 SWG CRCA MS shall be welded from inside of the louvers.

(vi) The surface of the enclosure shall be properly Pre-treated / Phosphated in a 7-Tank process and shall be applied with a powder coating of about 40 micron thickness. The powder coating shall be of Light Admiralty Grey colour shade (IS-5:1993 Colour No. 697). Powder coating shall be suitable for outdoor use. Rating and Type of distribution box shall be printed or embossed on the door of the distribution box.

(vii) EC grade Aluminium Bus bars of 100mm^2 (minimum) for Phase and Neutral, capable of carrying full load current shall be provided. Bus bar shall be completely insulated such that no live part including screws are accessible by hand/finger after fixing of cables. Insulation shall be Fire retardant. Bus bars shall be isolated with respect to body.

(viii) Two earthing bolts of diameter 10mm and 25mm long shall be welded from inside of the box and shall be provided with 2 nuts & washer. Earth marking shall be duly embossed near the earth bolts. There shall be no powder coating on the earthing bolts.

(ix) One No. Incoming & 2 Nos. outgoing cable holes shall be provided as shown in drawing. Cable holes shall be provided with superior quality rubber cable glands of internal diameter 30mm. Rubber glands shall be made such that internal diameter of glands provided for cables should be closed with the rubber film of minimum 1mm thickness. Cable will go through the glands by piercing the film of the glands.

(x) For mounting of box on pole, four holes shall be provided the back side of the box as shown in drawing.

(xi) Danger marking shall be provided on the box in red color.

(xii) Name of Utility and name of scheme i.e. RDSS shall be embossed on the distribution box.

(xiii) Each distribution box shall be supplied with proper packing in 3 ply corrugated box.

(xiv) Tolerance permissible on the overall dimensions of box shall be ±3%.

6. FINISHING OF DISTRIBUTION BOX:

The surface of the box shall be properly pretreated / phosphated in 7-tank process and shall be applied with powder coating. The process facility shall be in house of the manufacturer to ensure proper quality for outdoor application.

7. ACCEPTANCE TESTS :

Following acceptance tests shall be carried out while inspecting lot of material offered.

1) **Visual Examination**:
   The Distribution box shall be inspected visually, externally and internally for proper Powder Coating layer, fitting of all the components in accordance with technical Specification.
2) **Verification of dimensions**:
   Verification of dimensions, external / internal clearances will be carried out as per technical specifications.
3) **Verification of fittings**:

Components like insulated bus bars, MCCBs, Hinges, Rubber Glands etc will be verified as per technical specification.

4) **High voltage withstand test at 2.5KV:**

The A.C. voltage of 2.5KV, 50HZ shall be applied for one minute as follows:

i) Between Live Parts of each insulated bus bar
ii) Between each insulated bus bar and earthing Screw/bolts
iii) On bus bar insulation.
iv) On PVC coating of PVC cables.

There shall not be any puncture or flash over during this test.

5) **MCCB**:

Time current characteristics of each rating of MCCB shall be checked as per the requirement of the specifications.

6) **Current Carrying Capacity:**

The current of 200 Amp shall be applied for 30 minutes through high current source on each insulated bus bar. There shall not be overheating of the insulated bus bars during this test.

8. TESTING & MANUFACTURING FACILITIES:

The Tenderer must clearly indicate what testing and manufacturing facilities are available in the works of manufacturer and whether the facilities are adequate to carry out all Routine & Acceptance Tests. These facilities should be available to inspection Engineers, if deputed to carry out or witness the tests in the manufacturer's works. The tenderer must have all the in-house testing facilities to carry out the acceptance tests on the Box.

9. TESTS:

The Distribution box shall comply with the requirement of IP33. Each type of LV Switchboard shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards and during manufacture and on completion.

i) Routine Test

The tests shall be carried out in accordance with IS 13947 and 8623 include including but not necessarily limited to the following:

(a) Visual Check
(b) Verification of Component Rating
(c) Other Checks
i) Easy Accessibility and Maintenance
ii) Color Coding provided by colored tapes.
iii) Bus bar dimensions
iv) Degree of Protection check by paper.
(d) Dimension check

(e) Insulation Resistance Tests
(f) Mechanical Operation Tests
(g) Bus bar support and clearances
(h) Continuity of circuits and Function
(i) Powder Coating
(j) Overload Release setting of the Circuit Breakers

ii) Type Test

The box shall be fully type tested as per the requirement of IS 13947 (Part-1):1993 with latest amendment. The type test shall be carried out from the Govt. approved laboratories duly accredited by National Board of Testing & Calibration Laboratories (NABL) of Govt. of India.

10. Prototype & Drawings:-

The manufacturer has to manufacturer the prototype Unit for each rating as per this specification before bulk manufacturing. The manufacturer should intimate the readiness of prototype to employer. The Project Manager will inspect the prototype for approval. The manufacturer should submit the final drawings in line with this specification and prototype to employer for approval before bulk manufacturing. The approval of prototype & drawings shall be a responsibility of manufacturer/Contractor. Tentative drawing of box is enclosed herewith.

19. 63,100,200 & 315 kVA L.T. Distribution Box

1. SCOPE:

This Specification covers the design, manufacture, testing at works and supply of Distribution Boxes made out of **CRCA MS** for controlling the L.T. feeders from the L.T. side of Distribution Transformers. The system shall be A.C. 3 phase, 4 wire, 433 V, 50 HZ with effectively grounded neutral.

2. SERVICE CONDITIONS:

The equipment to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as specified by employer which is as hereunder;

2.1 Maximum ambient temperature (Degree C)

2.2 Maximum temperature in shade (Degree C)

2.3 Minimum Temperature (Degree C)

2.4 Relative Humidity (percent)

2.5 Maximum Annual rain fall (mm)

2.6 Maximum wind pressure (kg/sq.m)

2.7 Maximum altitude above mean sea level (Meter)

2.8 Isoceranic level (days per year)

2.9 Siesmic level (Horizontal Acceleration)

Moderately hot and humid tropical climate conductive to rust and fungus growth ….

3. SYSTEM DETAILS:

Distribution Boxes are meant for control and protection of Distribution Transformers with relevant parameters as under:-

S.N.	Particulars	Details			
1.	KVA rating	63 KVA	100 KVA	200 KVA	315 KVA
2.	Voltage	433 V, 3 Ph, (3x 250 V)			
3.	Frequency	50 HZ			
4.	Phases	3 phase, solidly grounded neutral			

5.	Approximate full load current of transformer	84 A	133 A	270 A	440 A
6.	No. of Outgoing circuits	2 nos		3 nos	4 nos

3.4 Applicable Standards:

IS :13947/ (Part 3) (amended upto date) for Isolator (Switch Disconnector)

IS: 13947/ (Part2)(amended upto date) for L.T. MCCBs.

IS: 8623 (amended upto date) for enclosure Box & for degree of protection provided by enclosures of electrical equipments.

IS: 4237, IS:8623 (amended upto date) – for general requirement of L.T. switchgears.

IS 13703 (Part I & II amended upto date) for HRC Fuse Base and HRC Fuse Link.

IS: 5 /2007 - Colours of Ready Mixed paints and Enamels.

IS: 13871/1993 (amended upto date) – Powder coatings – specifications

IS : 6005/1998 (amended upto date) – Code of Practice for phosphating of iron and steel.

IS: 13411/1992 (amended upto date) – Glass Reinforced Polyester Dough Moulding Compounds

3.5 MANUFACTURE/CONSTRUCTION OF BOXES:

Distribution Boxes shall have Isolator (Switch Disconnector) and HRC fuse base with links on incoming circuit and single pole MCCBs & Link Disconnector on outgoing circuits with necessary interconnecting Bus Bars/ Links.

Standard General Arrangement of Isolators, HRC fuse base with links, MCCBs, Link Disconnector, Neutral Links, Bus Bars, connecting links, Cable termination arrangement etc inside the Box is shown in the enclosed drawings.

3.6 INCOMING CIRCUIT –

6.1 Isolator (Switch Disconnector) -

Each distribution box shall have one triple pole Isolator (Switch Disconnector), conforming to relevant latest IS. The supplier shall indicate makes and types of offered isolator in GTP. The supplier shall submit Type Test Report of the Isolator as specified in Cl. No. 12.3 (II) for approval of Employer before commencement of supply. The Switch disconnector to be provided in the Distribution Box will be as per Employer specification.
The Isolator should be front operated triple pole type. The casing of Isolator shall be of non-tracking, heat resistant insulating material of Dough Moulding Compound (DMC) of D_3 Grade as per IS:13411 (amended upto date), no separate enclosure is required. Isolator Base should withstand the breaking capacity of 80 kA. To extinguish the arc immediately in isolators, in each phase arc-chutes with minimum 12 strips shall be provided.

The isolator should be front operated triple pole type. The isolator shall be robust in construction and easy for operation. The handle of the isolator should be detachable easily for security purpose while working on L.T. circuits.

The characteristics of Isolator shall be as follows:

S.N.	Characteristics	Rating			
		63 KVA	100 KVA	200 KVA	315 KVA
1.	Basic uninterrupted duty	200 A		600A	
2.	Mechanism	Manual quick make quick break			
3.	Standard applicable	IS : 13947 amended upto date			
4.	Utilization category	AC –23 A			
5.	Mechanical Endurance	As per IS 13497 amended upto date			
6.	Electrical Endurance	As per IS: 13947 amended upto date			
7.	Rated Duty	Uninterrupted			
8	Making /Breaking capacity	Not less than requirement of AC –23 A category			
9.	Two seconds rating	4 KA		8 KA	
10.	Rated insulation voltage	660 V			

The terminal connector strips of the isolator shall be projecting out of isolator

of 80 mm (minimum) in length on cable connection side and 60mm (minimum) on HRC fuse base side as shown in the drawings. In 63 /100/200/315 KVA distribution box, the cross section of the strips on outside of the isolator shall be provided as below:

63/100 KVA -	25X5 mm.
200 KVA-	50X 6 mm
315 KVA-	50X 6 mm

The material of isolator strips shall be EC grade tin-plated copper. The terminal strips shall be continuous from the point of contact separation inside the Isolator with cross section as mentioned above throughout the length. Gap of 50mm shall be maintained between each terminal throughout the length.

6.2 HRC FUSE

HRC Fuse of suitable capacity shall be provided between outgoing terminal of Switch Disconnector (Isolator) and incoming Busbar to facilitate electrical breaking of the circuit. Each Distribution Box shall have 3 Nos. of HRC Fuse Base with HRC Fuse Links (Blade type Contacts).

The supplier shall indicate in GTP, the make, type and capacity of HRC Fuse Base and Fuse Links offered.

(i) HRC FUSE BASE

The base of the HRC Fuse shall be of non-tracking, heat resistant insulating material of Dough Moulding Compound (DMC) of D_3 Grade as per IS:13411/1992. The Fuse Base shall be sturdy in construction.

The extension terminal connector strips of the Fuse Base shall be projecting out on both sides, made with two pieces (half portion of the terminal contact and extension strip should be continuous in one piece), as shown in the drawing. The dimensions shall be as shown in the drawing. The material for both strips shall be tin plated EC Grade copper. HRC Fuse Base & fuse link should have withstand the breaking capacity of 80 kA.

HRC Fuse base shall be suitable for fuse of 200A for 63/100 KVA distribution box and

400 A for 200 KVA and 630A for 315 kVA distribution box.

(ii) HRC FUSE LINK

The HRC Fuse Links shall be sturdy in construction of "Din Type". Breaking Capacity shall be 80 kA. For fault indication red pop up indicator should come out instantly on fusing. Manufacturer's name, current rating, breaking capacity and type shall be marked on HRC fuse link.

HRC Fuse link Current rating for 63/100 /200/315 KVA distribution box shall be as follows:

63 KVA	-	100 A
100 KVA	-	160 A
200 KVA	-	315 A.
315 KVA	-	500 A

The supplier shall submit Type Test Report of the HRC fuse base and HRC fuse link as specified in Cl. No. 12.3 (III) for approval of Employer before commencement of supply. The HRC fuse base with links to be provided in the Distribution Box will be as per Employer approval given in the detailed purchase order.

3.7 OUTGOING CIRCUITS:

(i) MCCBs

Each distribution box shall have 6 nos. of single-pole MCCBs in 63 KVA /100 KVA Box, 9 nos of single-pole MCCBs in 200 KVA box and 12 nos of single-pole MCCBs in 315 KVA box to protect outgoing circuits. MCCB shall be of reputed make and shall confirm to latest IS. The supplier shall indicate the makes and types of MCCBs offered in GTP. The supplier shall submit Type Test Report of the MCCB as specified in Cl. No. 12.3 (IV) for approval of Employer before commencement of supply. The MCCBs to be provided in the Distribution Box will be as per Employer approval as given in the detailed purchase order.

MCCB shall have quick make quick break mechanism. Making of MCCB shall only be manual but breaking of MCCBs shall be electrical as well as manual.

The detailed specification for MCCBs shall be as under.

S.No.	Particulars	Details			
1.	KVA rating	63 KVA	100 KVA	200 KVA	315 KVA
2.	Rated current	150 A		200 A	
3.	Fixed overload release setting (A)	60 A	90 A	120 A	120 A
4.	No. of poles	Single pole			
5.	Rated service short circuit breaking capacity (kA) which is equal to ultimate breaking capacity as per IS 13947 (amended upto date)	10 KA at 0.4 p.f . (lag)			
	The sequence of operation for this test shall be, O - t - CO - t - CO, and t = 3 min.). The test shall be done at 250V at 0.4 p.f. (lag). Voltage rating phase to phase 433 V and phase to earth 250V.				
6.	Power factor for short circuit (Max.)	0.4 lag			
7.	Utilization category	A			
8.	Rated Insulation Voltage	660 V			

The Busbar dropper and Terminal connection strip of Link Disconnector shall be placed in contact terminal of MCCB as shown in the drawing.

The rated service short circuit breaking capacity as specified above, shall be based on the rated service short circuit test carried out at specified power factors.

To extinguish the arc immediately in MCCBs, arc-chutes with minimum 8 strips shall be provided.

While the above stipulation regarding the test power factor and the sequence of operation shall be binding, the other procedure for making the short circuit test and circuit etc. shall generally be in accordance with the Indian Standard applicable to the type of circuit breakers under test.

7.2 TIME CURRENT CHARACTERISTICS of MCCBs:

The L.T. MCCBs shall have time current characteristics as follows:

Multiple of normal Current setting	**Tripping time**
1.05	More than 2.5 hrs.
1.2	More than 10 minutes and less than 2 hrs.
1.3	Less than 30 minutes
1.4	Less than 10 minutes
2.5	Less than 1 minute
4.0	Not less than 2 seconds
6.0	Less than 5 seconds
12.0	Instantaneous (less than 40 milli seconds.)

For above time/current characteristic, the reference calibration temperature of the breaker shall be 50°C. Deration, if any, up to 60°C. Ambient temperature shall not exceed 10% of the current setting indicated above.

c. LINK DISCONNECTOR :

Link Disconnector of 200 A capacity shall be provided between outgoing terminal of MCCB & cable connection to facilitate mechanical breaking (manual isolation) of the circuit. 63 /100 kVA Distribution Box shall have 6 Nos. of link Disconnectors, 200 kVA distribution box shall have 9 nos of link Disconnectors and 315 kVA distribution box shall have 12 nos of link Disconnectors.

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The supplier has to indicate the makes and types of Link Disconnector offered in GTP. The supplier shall submit Type Test Report of Link Disconnector as specified in Cl. No. 12.3 (V) for approval of Employer before commencement of supply. The link Disconnectors to be provided in the Distribution Box will be as per EMPLOYER's approval as given in the detailed purchase order.

The base of the Link Disconnector shall be of non-tracking, heat resistant insulating material of Dough Moulding Compound (DMC) of D_3 Grade as per IS:13411 (amended upto date). The Link Disconnector shall be sturdy in construction and easy in operation.

The link of Link Disconnector shall be of Tin-plated E.C. grade copper. The construction of the Link Disconnector shall be such that it shall be hinged type on

cable connection end and disconnectable at the MCCB end. The disconnection will be with the help of special handle/puller. One handle/puller shall be supplied alongwith each Distribution Box. The terminal connector strips of the Link Disconnector of 25 x 3 mm cross section, shall be projecting out of Link disconnector for minimum length of 80 mm. on cable connection side and 40 mm on MCCB outgoing side. The cross section of knife edge link shall be 20 x 5 mm. The material for both the strips and links shall be tin-plated E.C. grade copper. The size of bimetallic lugs hole & the hole on the disconnectors strip on cable side should be same.

3.8 BUSBARS AND CONNECTIONS:

The Incomer feeder should be on right side of the distribution box and all outgoing feeders will be on left side of the distribution box, with phase sequence RYB to be maintained. The phase busbars, incoming droppers and feeder droppers from busbars shall be of EC Grade Aluminium. The phase busbar strips shall be of size 25X8 mm for 63 KVA/100 KVA and 40X10 mm for 200 and 40X15 for 315 KVA box. Feeder droppers shall be 25X8 mm. Incomer dropper of 25 x 8 mm cross section for 63 /100 KVA box and 40 x 10 mm cross section for 200KVA box and 40X15 for 315 KVA box be provided. All busbars and droppers shall be properly drilled and de-burred. Each bus bar shall be of one single strip without any joint.

Busbars shall be provided with durable PVC insulating sleeves of standard colour code for different phases. Corrugated/Spring & Plain washers shall be used for Nut-Bolt connections.

Busbars shall be mounted on suitable size support insulators which should be tightened from inside. i.e. once fitted, should not be able to removed.

Minimum clearances, wherever shown, shall be as per General Arrangement Drawing enclosed with this specification. Other clearances shall be as per requirement of IS: 4237amended upto date.

3.9 ENCLOSURE:

9.1 The Box & Doors shall be made up of CRCA MS sheet of 2mm thickness.

9.2 The manufacturing process of Box shall be Deep Drawn / Sheet Bending Process (Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/1122 dated 15.05.2017)

9.3 In case of distribution boxes, the rounding of corners and slope on top shall be as shown in the drawing.

9.4 The welding process of distribution boxes shall be done by MIG (Metal Inert Gas) welding and workmanship/finishing should be good enough.

9.5 **For** Deep Drawn/ Sheet Bending Process (Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/1122 dated 15.05.2017) **Box**: the general clear dimensions of 63 / 100 KVA Distribution Box shall be 1000 x 1010 x 325 (LXHXW)mm. The center height of distribution box on front side shall be 1000 mm The general clear dimensions of 200 kVA distribution box shall be 1305 x 1050 x 325 (LXHXW) mm and for 315 kVA distribution box shall be 1545 x 1050 x 325 (LXHXW) mm. The center height of the distribution box on front side shall be 1050 mm

9.6 The Base and doors of enclosure shall be individually in one piece without any welding, except for fixing of the accessories like hinges, clamps, mounting clamps, bolts etc.

A. 63/100 kVA boxes shall have two doors as shown in the drawing fixed on right & left side of the box with four hinges provided from inside of box. On closing of doors, right door shall rest on the left door. Hinges shall not be visible and approachable after closing the box.

B. 200/315 kVA boxes shall have two doors as shown in drawing fixed on right side & left side of the box with four hinges on both sides shall be provided from inside of box. On closing of doors, right door shall rest on the left door. Hinges shall not be visible and approachable after closing the box.

Base and doors shall have flange / collars as shown in drawing. Collar of Base and doors shall overlap by 10mm. Rubber gasket of suitable size shall be provided in between base and doors, such that it provides proper sealing between the door and base of box to avoid penetration of dust & ingress of water. Degree of protection shall be **IP- 33** as per IS-8623 (amended up to date). Rubber Gasket shall be fixed with suitable adhesive. Four hinges on each side shall be provided from inside of the box to fix the doors. Hinges shall be minimum 50 mm in length & made from 2mm thick sheet. Hinge stainless steel pin diameter shall be 4mm. The hinges shall not be

visible from outside.

9.7 The MCCBs, Link Disconnector, Isolator and HRC fuse base with link shall be housed inside the enclosure. Isolator operating handle shall be accessible only after opening of the doors.

9.8 Four set of Louvers (two sets on each side) of suitable size shall be provided as shown in drawing. The louvers shall be provided such that heat dissipation is proper. The perforated sheet of 20 SWG with 2.5 mm holes shall be welded from inside of the louvers.

9.9 Mounting of components inside the enclosure shall allow free air circulation keeping the clearances as per drawings attached with specification.

9.10 **Locking Arrangement to the Box:**

The doors shall be closed with a push fit locking arrangement such that on pressing/pushing the right door, the distribution box gets locked from inside from top & bottom. This arrangement shall be operational for opening of the door with a handle provided outside the door. Handle shall be removable type only. A Nylon washer shall be provided between the handle and door to avoid penetration of water. One central lock with brass levers shall be provided inside the door. Key way shall be provided on the door for operating the central lock from outside. Key way shall be provided with cover.

9.11 A suitable cable termination arrangement with support insulators shall be provided on Isolators and Link Disconnectors. The bimetallic lugs of adequate size, as per enclosed specification & drawing, shall be provided. Clearances, Creepages and convenience in making connections shall be ensured.

9.12 EC grade Aluminium Neutral Busbar of 300 x 25 x 8 mm for 63/100 KVA box and 525 x 40 x 10 mm for 200 KVA and 40 x 15mm for 315 KVA Box capable of carrying for full load current. Neutral Busbar shall be isolated with respect to body. The bimetallic lugs of adequate size, as per enclosed specification & drawing, shall be provided. Neutral Busbar shall be as shown in the drawing attached with the specifications.

9.13 Bolts of M10 mm and 35 mm length with 2 Nos. plain washer and two Nos. nut are to be provided on both the sides for earthing of the distribution box. Earthing bolt is to be

fixed on U-structure (Earth Clamp) welded on both sides of the distribution box. Thickness of earth clamp shall be 2mm. The top surface of the earth clamp shall be properly Zinc plated. Earthing nut bolt and washer should be zinc plated. There should be no powder coating on top surface of the earthing clamps.

9.14 Three bottom plates for 63/100 KVA and 4 bottom plates for 200 KVA and 5 bottom Plates for 315 KVA shall be provided for incoming and outgoing cables as shown in the drawing. Bottom plate of size 125mm x 125mm fixed with four screws from inside shall be provided for incoming and outgoing cables. Bottom plates shall be provided with suitable holes and rubber glands for the cables. Rubber glands shall be made such that internal diameter of glands provided for cables should be closed with the rubber film of minimum 1mm thickness. Cable will go through the glands by cutting the film of the glands. Bottom plates shall also be provided with cable clamps as shown in drawing.

9.15 Necessary fixing arrangement shall be provided at the back of the enclosure to ensure proper fixing on double pole structure by means of suitable clamps at 4 places.

9.16 Danger marking shall be provided in red colour on the right door of the distribution box. Marking shall be scratch proof and properly readable.

9.17 All the components inside the Box shall be mounted on CRCA MS strips of 2mm thickness. The mounting strips shall be provided with required bends or ribs to give the extra strength and shall be powder coated or zinc plated.

9.18 All joints of current carrying parts shall be bolted with 8.8 grade High Tensile MS Nuts & Bolts, Corrugated/spring & Plain Washers. The nuts & bolts should be of hexagonal type. All the nuts, bolts & washers should be properly zinc plated.

9.19 Each distribution box shall be supplied with proper packing in five ply - corrugated box.

9.20 Name plate having details such as Month & year of manufacturing, , Sr.No, and rating of Distribution box, XXXXX"Name of Employer" shall be riveted on the Distribution box door. Name of Manufacturer shall be duly embossed on the door of the distribution box. The name plate should be of stainless steel of thickness 1 mm.

9.21 Incoming and outgoing circuit should be duly highlighted with paint by stencil printing.

9.22 Adequate slope on the top of box shall be provided to drain out rainwater from the top.

9.23 3 Nos. MCCBs and 3 Nos. HRC fuse links in spare should be invariably provided with each box.

9.24 Good-quality plastic sticker leaflet should be pasted inside of distribution box door. The matter of instruction leaflet shall be provided by the employer. All the instructions in leaflet should be in Hindi/English/Local language.

3.10 **CABLE TERMINATION:**

Adequate size of Bimetallic lugs shall be provided for 3½ core, LT XLPE cable on incoming side and out going side for 63/100/200/315 KVA boxes as below :

	Incoming side	Outgoing Side
63 KVA	70 sq.mm	50/ 70 sq.mm
100 KVA	150 sq.mm	50/70 sq.mm
200 KVA	300 sq.mm	150 sq.mm.
315 KVA	300 sq.mm	150 sq.mm.

3.11 **LUG :** Bimetallic lug should be made for electrolytic grade aluminum. Each lug should be copper coated by electrolytic process and rich layer of tin should be mounted through out the lug to protect from Galvanic Corrosion. The lugs shall be such that the rich layer of tin should not peel of during operation. Individual lot should be pre filled with conductive inhibition compound and lug should be duly capped to prevent oozing of compound. The ductility of material should be such that flow ability of material be adequate to flow in to the strand of the conductor and withstand on crimping pressure of 8500 PSI. The cut cross section of the joints
shall be homogeneous.

3.12 **FINISHING OF DISTRIBUTION BOX:**

The outer side and inside surface of the box shall be properly Pre-treated /Phosphated in seven tank process as per IS: 6005 and shall be applied powder coating of minimum 40 micron thickness. The Colour shade of light Admiralty gray (as per employer requirement) for 63, 100, 200 and 315 KVA box as per IS: 5/2007 (Colours of Ready Mixed paints and Enamels) shall be applied inside & outside surface of the box or as per state practice. Powder coating shall be suitable for outdoor use, conforming IS: 13871 (amended upto date) – Powder coatings. The process

facility shall be in-house to ensure proper quality for outdoor application.

3.13 TESTS & TEST CERTIFICATES:

In case of bought out items, routine and acceptance tests as per relevant IS and this specification shall be carried out at the original manufacturers' works.

a) Routine Test (Carried out on all boxes):

Overall Dimensions Checking.

Insulation Resistance Tests.

High Voltage Test at 2500 V, 50 Hz AC for one minute.

12.1.4. Operation Test on MCCB/Isolator/Link Disconnector / HRC fuse base and fuse links.

b) Acceptance Tests (on complete Distribution Box):

Following tests shall be carried out as per acceptance tests in addition to routine tests on one random sample of each rating out of the lot offered for inspection:

i) Temperature rise test on one sample of each rating.

Temperature rise test will be carried out as per the procedure given below:

For temperature rise test, a distribution box with all assembly of MCCBs / Link Disconnectors / Isolator / HRC fuse base with link shall be kept in an enclosure such that the temperature outside the box shall be maintained at 50 ° C.

20% more current than transformer secondary capacity i.e. for 63 KVA Distribution Transformers full load current 84A, 20 % more is 100 A shall be kept in incoming circuit keeping outgoing circuits short, till the temperature stabilizes and maximum temperature rise should be recorded.

ii) Time-Current Characteristics

The MCCB should be tested for time current characteristics at 1.05 & 1.2 times of overload release setting current and should pass the requirement given in clause- 7.2.

c) TYPE TESTS :

1 ON COMPLETE BOX:

a. Temperature rise test:- The temperature rise test should be carried out as per IS: 8623

High voltage test shall be carried out as per IS:8623 amended upto date.

Short Time Withstand Current Test on Distribution Box shall be carried out as per IS 8623 or latest version.

The Distribution Box should be subjected to Short Time Withstand Current Test for 4KA for 2 seconds for 63/100 KVA Box and 8 KA for 2 second for 200/315 KVA box) all the circuits independently. The test should be carried out after by-passing MCCBs.

Degree of protection for **IP- 33** on complete box shall be carried out as per IS: 13947/1993 or the latest version thereof.

Time /current characteristic test on MCCBs shall be carried out as per clause **7.2** of this specification as stated above.

2 **ON ISOLATOR (SWITCH DISCONNECTOR):**

All type tests on Isolator (Switch Disconnector) as per IS: 13947 (Part III) amended up to date shall be carried out.

3 **ON HRC fuses base and HRC fuse links :**

All type tests on HRC fuses and HRC fuse links IS 13703 (Part I & II amended upto date) for HRC Fuse Base and HRC fuse link shall be carried out.

4 **ON MCCB:**

All type tests on MCCB as per IS-13947 amended upto date shall be carried out.

5 ON Link Disconnector:

Following tests shall be carried out on link disconnector as per IS:

Short Circuit Withstand Strength

Temperature rise Limits

Mechanical Operations

12.4 TYPE - TEST CERTIFICATES:

The Distribution Box, Isolator (Switch Disconnector), HRC fuse, HRC Fuse Link and MCCB offered shall be fully type tested as per relevant IS and this specification. The Supplier shall furnish detailed type test reports before commencement of supply. The detailed Type Test Reports shall be furnished with relevant oscillogram and certified Drawings of the equipment tested. The purchaser reserves the right to demand repetition of some or all the Type Tests in presence of purchaser's representative at purchaser's cost.

All the type tests shall be carried out from laboratories accredited by National Accreditation Board of Testing And Calibration Laboratories (NABL), Department of science & technology , Govt. of India to prove that the complete Box, Isolator, HRC fuse, Link Disconnector & MCCB meet the requirements of the specification. The Manufacturer should also furnish certificate from laboratories that laboratories are having all the requisite test facility available in house. The type test Reports conducted in manufacturers own laboratory and certified by testing institute shall not be acceptable.

The Supplier should furnish the particulars giving specific required details of Distribution Boxes, MCCBs, Isolator and Link Disconnector.

3.14 TESTING & MANUFACTURING FACILITIES :

Supplier must be an indigenous manufacturer. The Supplier must clearly indicate what testing facilities are available in the works of manufacturer and whether the facilities are adequate to carry out all Routine & Acceptance Tests. These facilities should be available to Employer's Engineers, if deputed to carry out or witness the tests in the

manufacturer's works. The supplier must have all the in-house testing facilities to carry out the acceptance tests on the Box.

The supplier shall furnish detailed process of manufacturing & Powder coating.

3.15 PROTOTYPE & DRAWINGS:-

The manufacturer has to manufacturer the prototype Unit for each rating as per this specification before bulk manufacturing. The manufacturer should intimate the readiness of prototype to employer. The Project Manager will inspect the prototype for approval. The manufacturer should submit the final drawings in line with this specification and prototype to employer for approval before bulk manufacturing. The approval of prototype & drawings shall be a responsibility of manufacturer/Contractor. Tentative drawing of box is enclosed herewith.

20. 11kV Porcelain Insulators and Fittings

INSULATORS

1. SCOPE

This specification covers details of porcelain insulators (Pin and Strain Insulators) for use on 11 KV overhead power lines in rural electric distribution system.

2. APPLICABLE STANDARDS

Except when it conflicts with the specific requirements of this specification, the insulators shall comply with IS:731 and IS:3188 as amended from time to time.

3. GENERAL REQUIREMENTS

3.1 The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed.

3.2 Unless otherwise specified, the glaze shall be brown in colour. The glaze shall cover all the porcelain parts of insulators except those areas which serve as support during firing or are left unglazed for the purpose of assembly.

3.3 The design of insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. The porcelain shall not engage directly with hard metal.

3.4 Cement used in construction of insulators shall not cause fracture by expansion or loosening by contraction and proper care shall be taken to locate the individual parts correctly during cementing. The cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as uniform as possible.

3.5 The insulators should preferably be manufactured in automatic temperature - controlled kilns to obtain uniform baking and better electrical and mechanical properties.

4. CLASSIFICATION AND DIMENSIONS

4.1 Both pin and strain insulators shall conform to Type B of IS:731.

4.2 The dimensions of pin insulators shall be as shown in Fig. 1.

4.3 The strain insulators shall be of Ball and Socket type or Tongue and Clevis type, as required by the Purchaser. The dimensions of these insulators shall be as per Fig. 2.

5. TEST VOLTAGES

5.1 The test voltages of insulators shall be as under:

Highest	Visible	Wet Power Frequency	Power Frequency	Impulse

System voltage	Discharge Test	withstand Test	puncture withstand test		voltage withstand Test
			Pin Insulator	Strain Insulator	
kV(rms)	kV(rms)	kV(rms)	kV(rms)	kV(rms)	kV(Peak)
12	9	35	105	1.3 times of the actual dry flash over voltage of the Insulator	75

6. FAILING LOAD

6.1 Mechanical Failing Load (For Pin Insulators only) The insulators shall be suitable for a minimum failing load of 5 KN applied in transverse direction.

6.2 Electro-Mechanical Failing Load (For Strain Insulators) The insulators shall be suitable for a minimum failing load of 45 KN applied axially.

7. CREEPAGE DISTANCE

The minimum creepage distance shall be as under :

Highest System Voltage	Normal and Moderately polluted atmosphere	Heavily Polluted atmosphere	
		Pin insulator	Strain insulator
KV	mm	mm	Mm
12	230	320	400

Note : Higher value of creepage distance has been specified for strain insulators as these are normally used in horizontal position in 11 KV lines.

8. TESTS

The insulators shall comply with the following tests as per IS:731 :-

8.1 Type Tests

a) Visual examination
b) Verification of dimensions
c) Visible discharge test
d) Impulse Voltage Withstand Test
e) Wet Power Frequency Voltage Withstand Test

f) Temperature cycle test

g) Mechanical Failing load test (for Pin Insulators only) to be carried out as per procedure described at Sub-clause 8.4

h) 24-hour Mechanical strength Test for Strain Insulators

i) Puncture Test

j) Porosity Test

k) Galvanizing Test

l) Electro-mechanical failing load test (for Strain insulators only) to be carried out as per procedure described at Sub-clause 8.4.

m) Thermal Mechanical Performance Test (for Strain insulators only) to be carried out as per procedure described at Sub-clause 8.4

8.2 ROUTINE TESTS:

a) Visual examination

b) Mechanical routine test (for strain insulator only)

c) Electrical routine test (for strain insulator only)

d) Hydraulic Internal Pressure test on shells for strain insulators to be carried out as per procedure described at Sub-clause 8.4

8.3 ACCEPTANCE TEST:

a) Verification of Dimensions

b) Temperature cycle Test

c) Electro-mechanical failing load test (for strain insulators only) to be carried out as per procedure described at Sub-clause 8.4

d) Puncture test (for strain insulators only)

e) Porosity test

f) Galvanizing test

8.4 Following procedure shall be used for conducting tests on insulators :

1 Hydraulic Internal Pressure Test on Shells (For Disc Insulators)

The test shall be carried out on 100% shells before assembly.

Thermal Mechanical Performance Test (if applicable):

Thermal Mechanical Performance Test shall be performed in accordance with IEC- 383-1-1993 Clause 20 with the following modifications:

(1) The applied mechanical load during this test shall be 70% of the rated electromechanical or mechanical value.

(2) The acceptance criteria shall be

(a) X greater than or equal to R + 3S.

Where

X- Mean value of the individual mechanical failing load.
R- Rated electro-mechanical / mechanical failing load.
S- Standard deviation.

(b) The minimum sample size shall be taken as 20 for disc insulator units.

(c) The individual electromechanical failing load shall be at least equal to the rated value. Also puncture shall not occur before the ultimate fracture.

2 Electromechanical/Mechanical Failing Load Test.

This test shall be performed in accordance with clause 18 and 19 of IEC 383 with thefollowing acceptance

(i) X greater than or equal to R + 3S , Where
X- Mean value of the electro-mechanical/mechanical/ failing load.
R- Rated electro-mechanical / mechanical failing load.
S- Standard deviation.

(ii) The minimum sample size shall be taken as 20 for disc insulators units. However, for larger lot size, IEC 591 shall be applicable.

(iii) The individual electro-mechanical/mechanical failing load shall be at least equal to the rated value. Also electrical puncture shall not occur before the ultimate fracture.

9. MARKING

9.1 Each insulator shall be legibly and indelibly marked to show the following:

a) Name or trademark of manufacturer
b) Month and year of manufacture
c) Minimum failing load in KN
d) ISI certification mark, if any

9.1.1 Markings on porcelain shall be printed and shall be applied before firing.

10. PACKING

All insulators (without fittings) shall be packed in wooden crates suitable for easy but rough handling and acceptable for rail transport. Where more than one insulator is

packed in a crate, wooden separators shall be fixed between the insulators to keep individual insulators in position without movement within the crate.

11. INSPECTION

11.1 All tests and inspection shall be made at the place of manufacture unless otherwise especially agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities, without charge, to satisfy him that the material is being furnished in accordance with this specification.

11.2 The purchaser has the right to have the tests carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

INSULATOR FITTINGS

1. SCOPE

This specification covers details and test requirements for (i) Pins for 11 KV Insulators, (ii) Helically Formed Pin Insulator Ties (iii) Fittings for Strain Insulators with Helically Formed Conductor Dead-Ends and (iv) Fittings for Strain Insulators with conventional Dead-End Clamps.

2. APPLICABLE STANDARDS

Pins shall comply with the requirements of IS:2486 (Pt. I & II). Helically formed fittings shall comply with IS:12048-1987. Fittings for strain insulators shall comply with the requirements of IS:2486 Pt. I to IV.

3. PINS FOR INSULATORS

3.1 General Requirements

The pins shall be of single piece obtained preferably by the process of forging. They shall not be made by joining, welding, shrink fitting or any other process using more than one piece of material. The pins shall be of good finish, free from flaws and other defects. The finish of the collar shall be such that a sharp angle between the collar and the shank is avoided. All ferrous pins, nuts and washers, except those made of stainless steel, shall be galvanized. The threads of nuts and taped holes, when cut after galvanizing shall be well oiled or greased.

3.2 Dimensions

Pins shall be of small steel head type S 165P as per IS:2486 (Part-II) having stalk length of 165mm and shank length of 150mm with minimum failing load of 5 KN. Details of the pins are shown in Fig. 3.

3.3 Tests

Insulator pins shall comply with the following test requirements as per IS:2486 (Part-I)-1993 or latest version thereof:

3.3.1. Type Tests

a) Checking of threads on heads
b) Galvanizing test
c) Visual examination test
d) Mechanical test

3.3.2 Acceptance Tests

a) Checking of threads on heads
b) Galvanising test
c) Mechanical test

3.3.3 Routine Test

Visual examination test

4. HELICALLY FORMED PIN INSULATOR TIES

4.1 Helically formed ties used for holding the conductor on the pin insulator (Fig.4) shall be made of aluminum alloy or aluminized steel or aluminum-clad steel wires and shall conform to the requirements of IS:12048-1987.

4.2 The ties shall be suitable for pin insulator dimensions as per Fig. 1 of Pt. I and conductor sizes to be specified by the purchaser.

Note: Helically formed insulators ties are made to suit specific sizes of conductors, which should be clearly specified by the purchaser.

4.3 Elastomer pad for insulator shall be used with the ties to avoid abrasion of the conductor coming into direct contact with the insulator.

4.4 Tests

The ties shall be subjected to the tests specified in IS:12048-1987.

5. FITTINGS FOR STRAIN INSULATORS WITH HELICALLY FORMED CONDUCTOR DEAD-ENDGRIPS

5.1 Fittings for Strain Insulators of Tongue & Clevis Type

5.1.1 The fittings shall consist of the following components:

a) Cross arm strap conforming to IS: 2486 (Pt.II)-1989.
b) Aluminium alloy die cast thimble-clevis for attaching to the tongue of strain insulator on one end and for accommodating the loop of the helically formed dead-end fitting attheother end initssmoothinternal contour. The thimble shall be suitable for all sizes of conductors ranging from 7/2.11mm to 7/3.35mm ACSR. The thimble clevis shall be attached to the insulator by a steel cutter pin used with a non-

ferrous split pin of brass or stainless steel. The thimble shall have clevis dimensions as per IS:2486 (Pt.II)-1989.

c) Helically formed dead-end grip having a pre-fabricated loop to fit into the grooved contour of the thimble on one end and for application over the conductorat the other end. The formed fitting shall conform to the requirement of IS:12048-1987.

Note : As the helically formed fittings are made to suit specific sizes conductors, the purchase should clearly specify the number of fittings required for each size of conductor.

5.1.2 Nominal dimensions of the T&C type insulator fittings are shown in Fig. 5.

5.2 Fittings for Strain Insulators of Ball & Socket Type

5.2.1 The fittings shall consist of the following components:

a) Cross arm strap conforming to IS:2486 (Pt.II)-1989.

b) Forged steel ball eye for attaching the socket end of the strain insulator to the cross arm strap. Forgingsshall be made of steel as per IS:2004-1978.

c) Aluminium alloy thimble-socket made out of permanent mould cast, high strength aluminium alloy for attaching to the strain insulator on one end and for accommodating the loop of the helically formed dead-end fittings at the other end in its smooth internal contour. The thimble-socket shall be attached to the strain insulator with the help of locking pin as per the dimensions given in IS:2486 (Pt.II)-1989 and

d) Helically formed dead-end grip as per clause 5.1.1(c) above.

5.2.2 Nominal dimensions of the Ball & Socket type insulator fittings are shown in Fig. 6.

5.3 Tests

The helically formed fittings for strain insulators shall be subjected to tests as per IS:12048-1987. The other hardware fittings shall be tested as per IS:2486 (Part-I).

6. FITTINGS FOR STRAIN INSULATORS WITH CONVENTIONAL DEAD-END CLAMPS ALTERNATIVE TO FITTINGS COVERED IN CLAUSE 5)

6.1 Fittings for strain insulators with conventional dead-end clamps for use with tongue & clevis or ball & socket type insulators shall consist of the following components:

a) Cross arms strap conforming to IS:2486 (Pt.II)-1989

b) Dead-end clamp made of aluminum alloy to suit ACSR conductors from 7/2.11mm to 7/3.35mm. The ultimate strength of the clamp shall not be less than 3000 Kg. The shape and major dimensions of clamps suitable for B&S and T&C insulators are shown in figures 7 & 8 respectively.

6.2 Tests

The fittings shall be subjected to type, routine and acceptance tests in accordance with the stipulations of IS:2486 (Pt.I).

Note: Fittings for strain insulators as stipulated in Clause 5 are preferable to the fittings stipulated in Clause 6 both from the point of view of better quality of construction and ease of application.

7. PACKING

7.1 For packing of GI pins, strain clamps and related hardware, double gunny bags or wooden cases shall be used. The heads and threaded portions of pins and the fittings shall be properly protected against damage.

7.2 The gross weight of the packing shall not normally exceed 50 Kg. Helically formed fittings shall be packed in card-board / wooden boxes. Fittings for different sizes of conductors shall be packed in different boxes and shall be complete with their minor accessories fitted in place and colour codes on tags/fittings shall be marked to identify suitability for different sizes of conductors as per IS:12048-1987.

8 . INSPECTION

8.1 All tests and inspection shall be made at the place of manufacture unless otherwise especially agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities, without charge, to satisfy him that the material is being furnished in accordance with this specification.

8.2 The purchaser has the right to have the test carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

ANNEXURE-I

HYDRAULIC PRESSURE TEST ON DISC INSULATOR SHELL

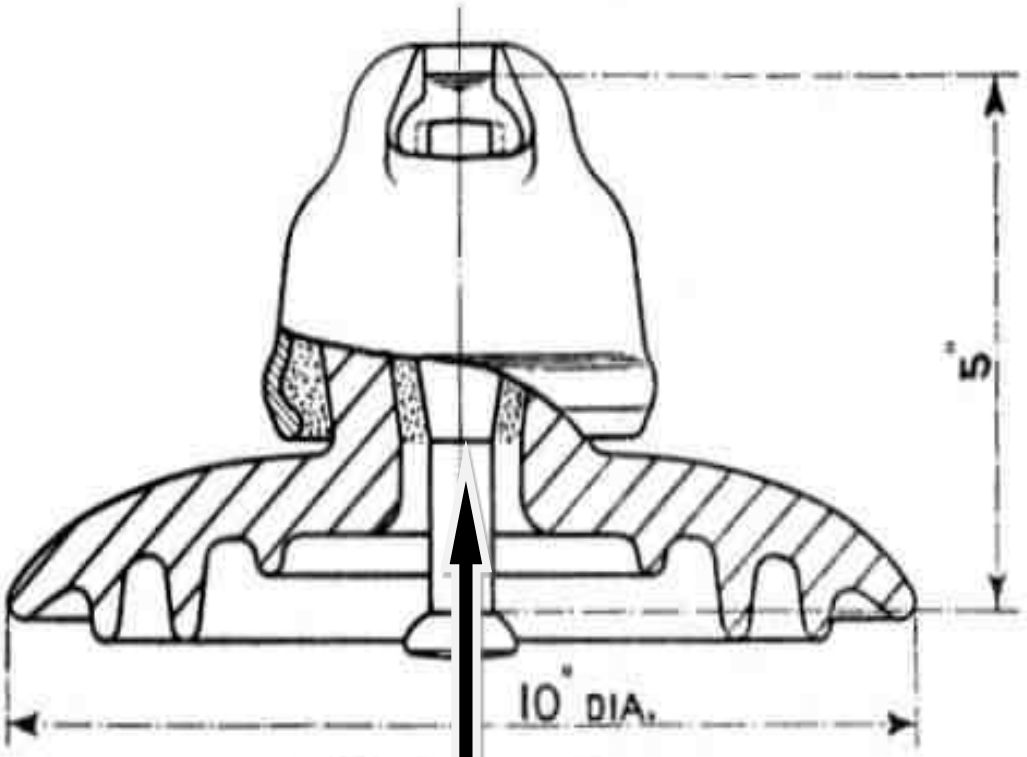


FIG. 10.4.—SUSPENSION INSULATOR.
(*Messrs Buller's, Ltd.*)

120 KG C/ M sq +/- 10 on the shell before cap and pinassembly to check the integrity of Porcelain

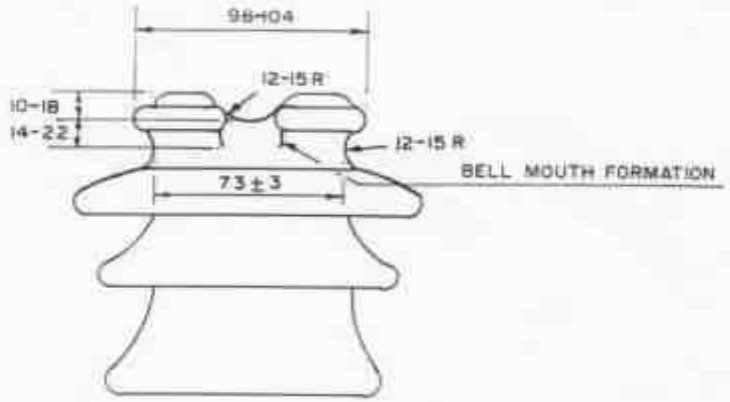


FIG-1.

११ के० वी० पिन विद्युतरोधक का विस्तार

DIMENSIONS OF 11 KV. PIN INSULATOR

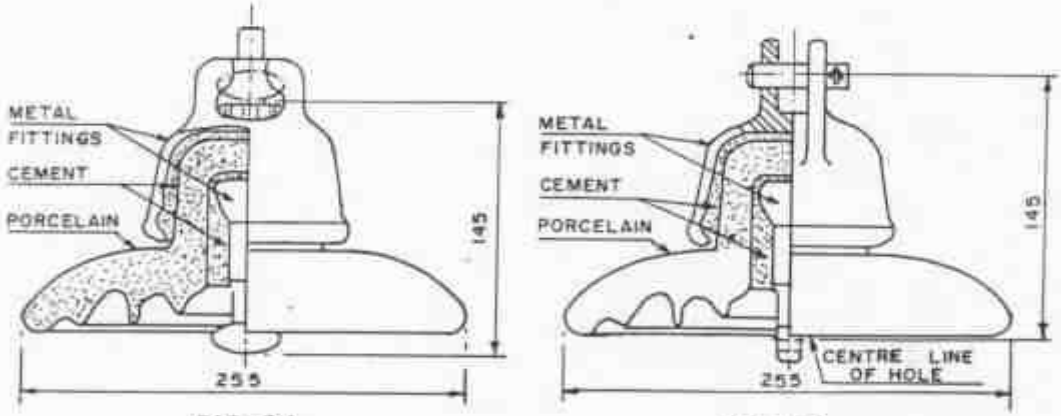


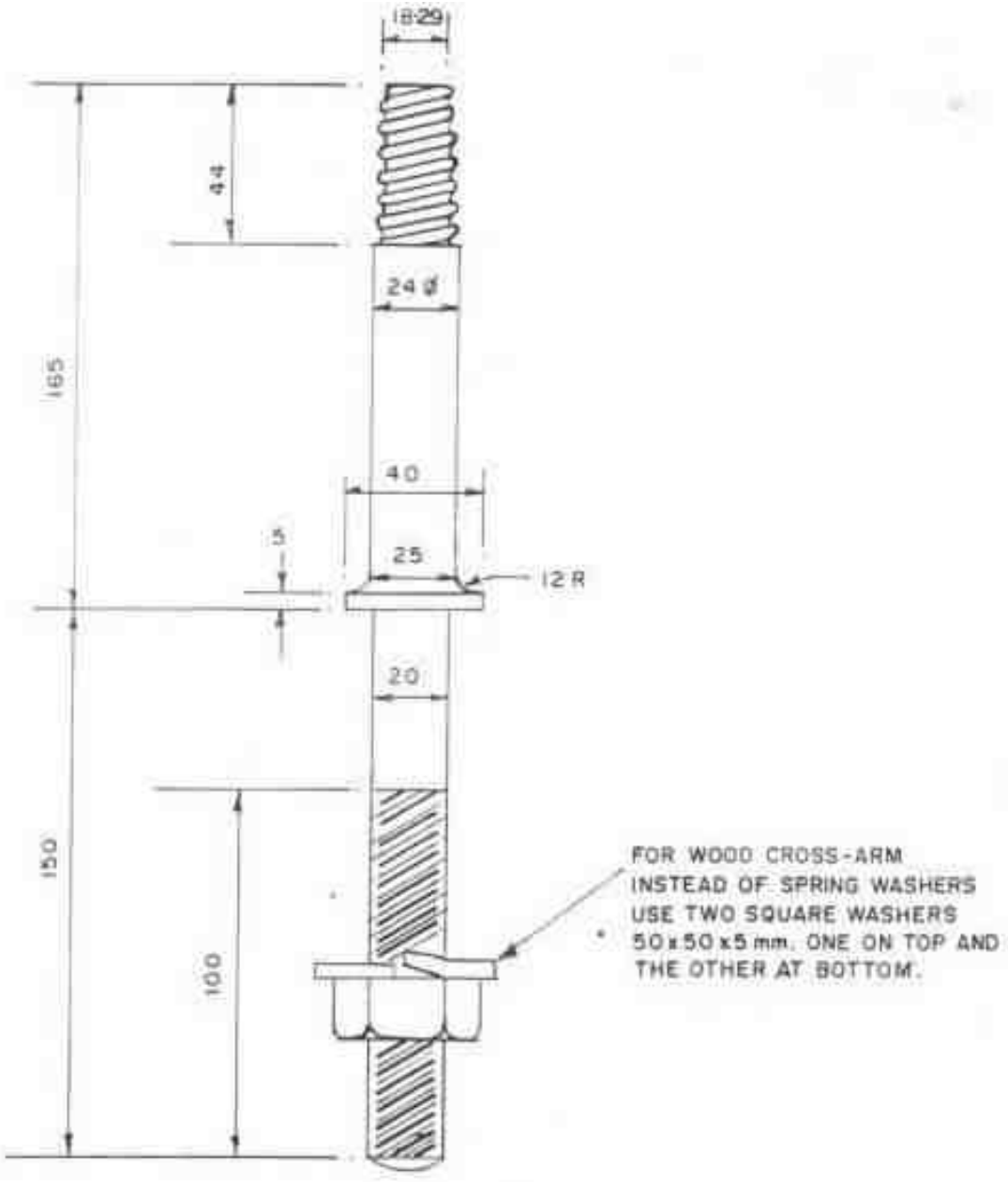
FIG-2A
BALL AND SOCKET TYPE.

FIG-2B
TONGUE AND CLEVIS TYPE.

FIG-2.

विकृति विद्युतरोधक का विस्तार

DIMENSIONS OF STRAIN INSULATORS



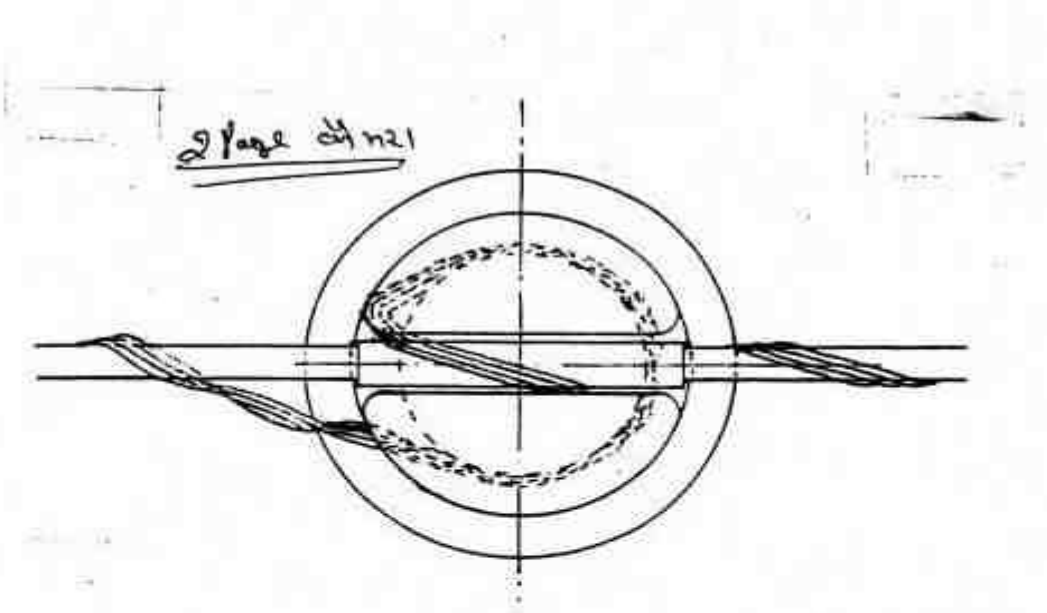
विद्युत रोधक पिन

INSULATOR PIN

(TYPE S 165P)

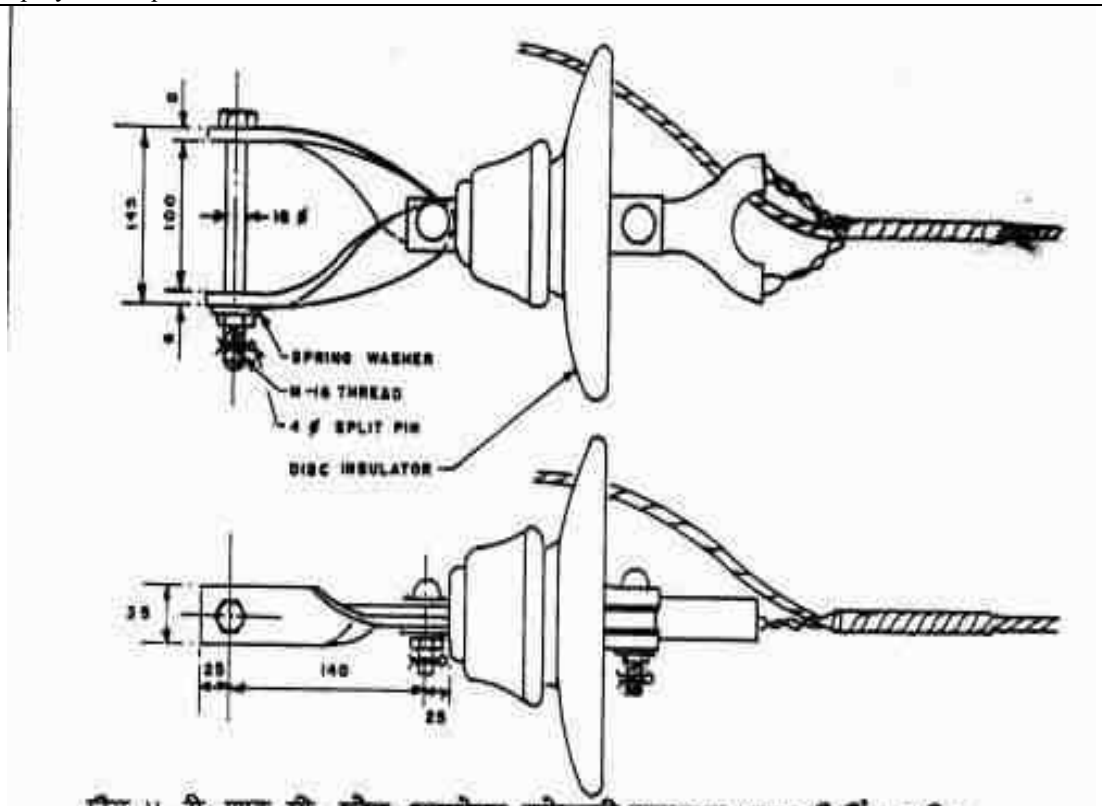
AS PER IS: 2486 Pt. II.

FIG-3.



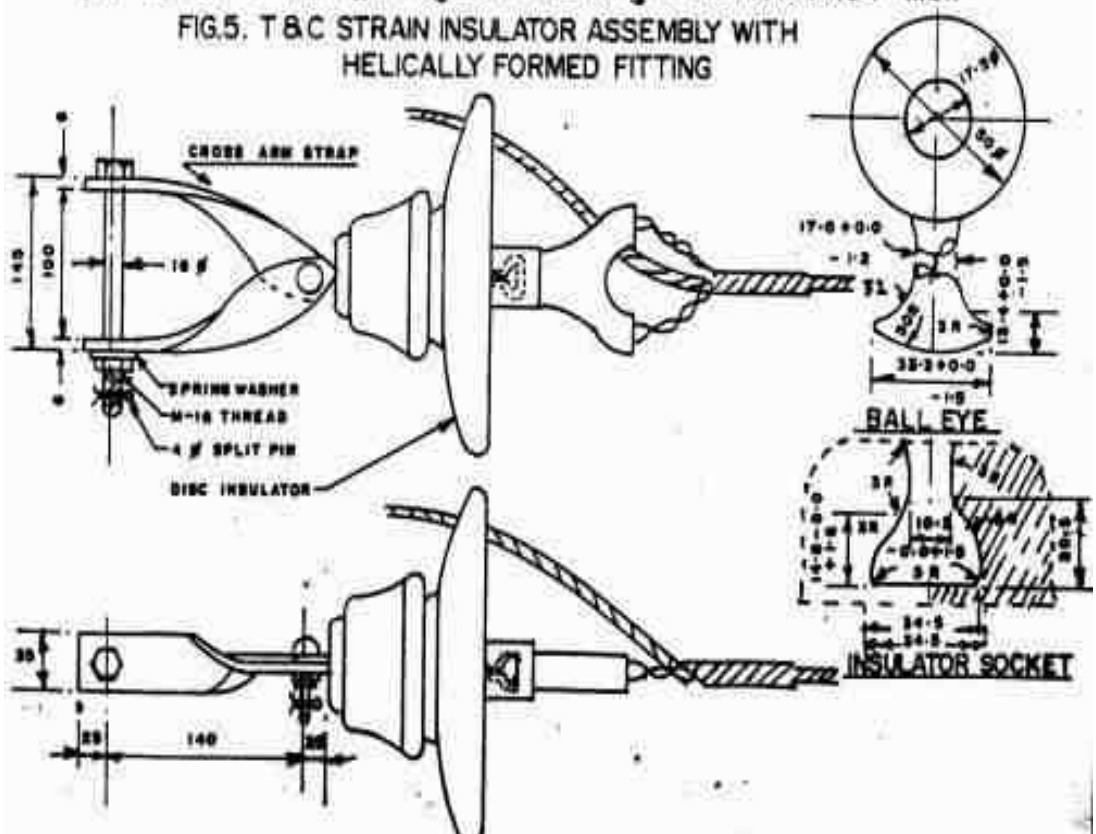
चित्र.४. ११ के.वी. पिन इन्सुलेटर टाई
(सीधी और १०°तक कौणीय स्थिति के लिए उपयुक्त)

FIG:- 4 – 11 KV PIN INSULATOR TIE
(SUITABLE FOR STRAIGHT RUNS AND ANGLE LOCATIONS UPTO 10°)



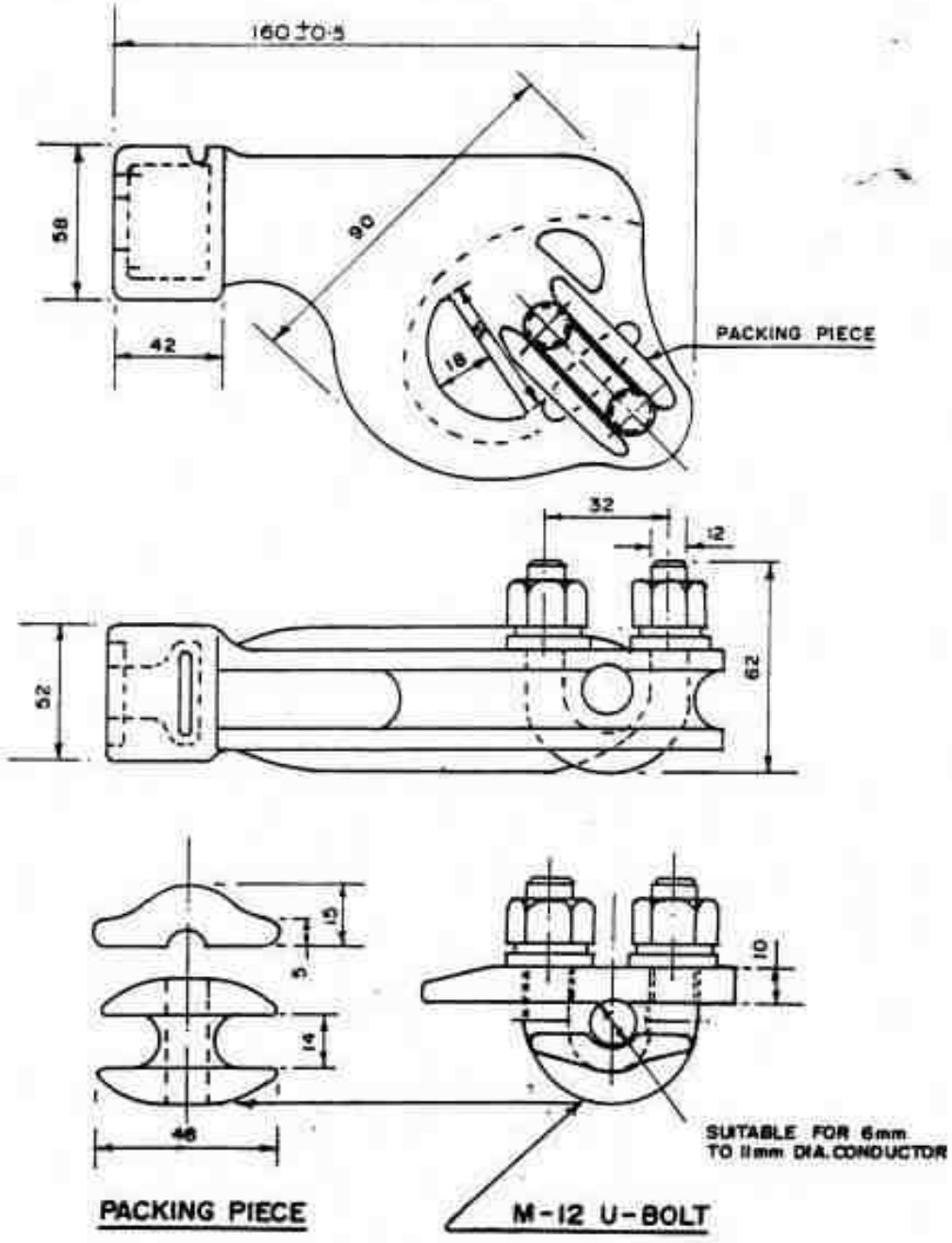
चित्र. ५. टी० एण्ड सी० स्ट्रेन इन्सुलेटर एसेम्बली घुमावदार आकार फिटिंग सहित

FIG.5. T & C STRAIN INSULATOR ASSEMBLY WITH HELICALLY FORMED FITTING



चित्र ६. बी० एण्ड एस० स्ट्रेन इन्सुलेटर एसेम्बली घुमावदार आकार फिटिंग सहित

FIG.6. B&S STRAIN INSULATOR ASSEMBLY WITH HELICALLY FORMED FITTINGS



चित्र :- ७. बॉल और सॉकेट प्रकार के विद्युतरोधक के लिए ११ के.वी. विकृति (स्ट्रेन) क्लैम्प

FIG. 7 – 11 KV. STRAIN CLAMP FOR BALL AND SOCKET TYPE INSULATOR.

ALL DIMENSIONS ARE IN mm.